Handbook of Lexical Functional Grammar

Edited by

Mary Dalrymple

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Preface

This handbook is the result of discussions which began in late 2018 among many of the handbook authors, who felt that a wide-coverage handbook of LFG would be very useful for practitioners of LFG as well as for people wanting to learn more about various aspects of the theory. We originally planned to finish the handbook by mid-2021, but, as with many things, the COVID-19 pandemic got in the way, and the number of originally planned chapters had to be reduced. We are nevertheless delighted with the results, and we anticipate that the handbook will be an essential resource for work in LFG for many years to come.

This handbook has been a community effort in the best sense, with involvement and input from handbook contributors at every stage of the process. I have been extremely grateful to all of the contributors for their flexibility, good humor, perseverance, and very hard work. At an early stage, Annie Zaenen and Nigel Vincent provided very helpful suggestions for the overall organization of the handbook. As always, Tracy Holloway King provided sage advice, and help with Latex conversion at crucial moments. Bozhil Hristov went far beyond the call of duty in proofreading many of the handbook chapters. We have also benefited greatly from the helpful advice and expert technical assistance of the editorial team, Sebastian Nordhoff and Felix Kopecky, and the vision of Stefan Müller and his team in establishing Language Science Press as an essential resource for linguistics.

Reviewers' suggestions and advice were crucial in improving the content and presentation of the chapters. All of the handbook authors also acted as reviewers for other handbook chapters, and we are grateful to them for taking on this work. Most authors reviewed two other handbook chapters, but the following authors took on reviewing responsibility for more than two chapters, and we are grateful to them for this extra effort: Ash Asudeh, Avery Andrews, Dag Haug, John Lowe, Peter Sells, and Tracy Holloway King. We also relied on a large team of external reviewers who provided very useful comments and feedback. Most external reviewers reviewed only one chapter, but we extend special thanks to those who reviewed more than one chapter: Amanda Thomas, Doug Arnold, and especially Joey Lovestrand, who contributed three reviews. We are particularly grateful to a team of Oxford graduate students who provided very detailed and helpful comments on the introductory chapters: Shuting Chen, Wilson Lui, Yiwei Si, Eden Watkins, and Xiulin Yang. For very helpful comments on the glossary, we are grateful to Ron Kaplan, Elaine Ui Dhonnchadha, Bozhil Hristov, Rachel Nordlinger, Hannah Booth, Nigel Vincent, György Rákosi, Alex Alsina, and Tibor Laczkó. We are also grateful to the Press's very competent and helpful team of proofreaders for their careful work on all of the chapters.

As always, I am grateful to Ken Kahn for all kinds of support as this handbook came together.

Oxford, October 2023 Mary Dalrymple

Part I

Overview and introduction

Chapter 1

Introduction to LFG

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This chapter provides a general summary of the architecture of LFG. It is mainly focused on describing the two main syntactic levels, c- and f-structure, and the projection architecture used in LFG in general. It also describes the notation for defining the range of possible c-structures and their corresponding f-structures. Core syntactic mechanisms such as structure sharing and X-bar theory are also briefly covered.

1 Introduction

In this chapter, I aim to summarize the main syntactic levels of LFG, constituent structure (c-structure) and functional structure (f-structure), while providing a general overview of the foundational features of this framework. In Section 2, I briefly describe the basic architecture of LFG and the overall role played by each of the syntactic levels. In Section 3, I describe the c-structure model used in standard LFG, its understanding of constituency, and the role of X′ theory. In Section 4, the notion of f-structure is introduced, together with notational conventions and a system of mapping c-structure to f-structure. In Section 5, I show how the basic system of c- and f-structure can be extended to include other levels of projection that comprise the architecture of LFG.

2 The basic architecture of LFG

At the core of LFG architecture as it was originally proposed in Kaplan & Bresnan (1982) is the split of syntax into two levels: constituent structure, or **c-structure**,

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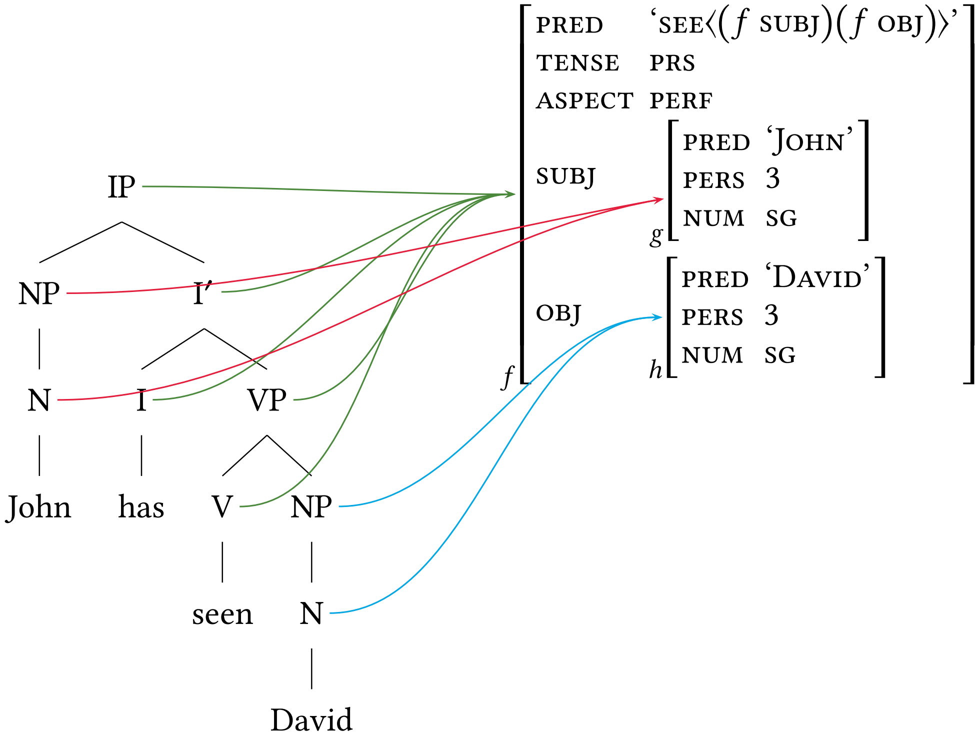
and functional structure, or **f-structure**. The correspondence function $\phi(x)$ maps every c-structure node to an f-structure. As an example, consider the LFG analysis of the sentence *John has seen David* in (1), where the mapping function is represented by the arrows.

(1)



As seen in (1), the two parallel structures are substantially different: c-structure is a phrase structure tree that represents word order and hierarchical embedding, while f-structure is a feature-value structure that represents predicate-argument relations and the grammatical features of all the major parts of the sentence. Features appear as atomic values of f-structure attributes, while arguments and adjuncts appear as f-structures embedded as values of attributes such as SUBJ and OBJ in (1); which arguments can and, indeed, have to appear in the f-structure is specified in the value of the PRED attribute. While the mapping between the two structures follows certain constraints imposed both by the formal metalanguage and theoretical considerations (on which see Belyaev 2023a [this volume] and Andrews 2023 [this volume], it is, in principle, language-specific: an LFG grammar consists of a set of rules and lexical entries that define the possible c-structures and their corresponding f-structures for a particular language.

This flexibility in the c- to f-structure correspondence ensures that each corresponds to a particular set of grammatical generalizations. Overall, f-structure is the main syntactic level that represents the predicates, their valencies and grammatical relations, as well as grammatical features such as number, case, aspect and gender. The majority of syntactic phenomena that have to do with feature assignment and feature checking are described using f-structure constraints; these include:

- feature government (case assignment, mood, constraints on the use of non-finite forms, etc.);
- agreement;
- anaphoric constraints;
- wh-movement, topicalization and other long-distance dependencies.

All generalizations that have to do with argument relations and grammatical features have to be stated in terms of f-structure. For instance, a constraint that requires the verb to agree with Spec,IP or to assign accusative case to Comp,VP would be complex and somewhat unnatural to formulate (although not impossible). It is much more simple and natural in LFG for such rules to refer to grammatical functions such as SUBJ and OBJ instead. This implies that the role of constituent structure is more restricted than in other frameworks; for the most part, c-structure constraints only capture generalizations related to word order and various embedding possibilities.

The correspondence architecture is not limited to syntax. Other projections that map c-structure nodes or f-structures to other structures (such as information structure, semantic structure, or prosody) have been proposed in the literature: see Section 5 for details.

3 C-structure

3.1 The notion of c-structure

C-structure (constituent structure) in LFG is a phrase structure tree. Possible trees are defined by a set of context-free statements ("phrase structure rules") of the type $A \rightarrow \alpha$, where A is a nonterminal symbol (representing some syntactic category), while α is a string of nonterminals or a single terminal. A simple set of rules that licenses the English sentence in (1) is given in (2).

(2) a. IP $\longrightarrow$ NP I′ b. I′ $\longrightarrow$ I VP c. VP $\longrightarrow$ V NP d. NP $\longrightarrow$ N

Such rules are well-established in modern linguistics since at least Chomsky (1957) and so hardly require further discussion. It should however be observed that, in LFG, these should not be understood as "rules" in the direct (procedural) sense, but rather a set of phrase structure principles that constrain hierarchical relations between mothers and daughters – crucially, not between levels further apart, such as granddaughters etc. Phrase structure grammars are one way of describing such principles that has proved most popular among LFG practitioners, but not the only way – possible alternatives are ID/LP rules (Falk 1983) and the specification language described in Potts (2002), which builds on the specification language in Blackburn & Gardent (1995).

The structures that are constrained in this way are not just strings,[1] but constituent structure trees whose nodes are individually mapped to f-structures, as shown in (1).

The syntax of phrase structure rules in LFG is somewhat more extensive than in many other frameworks, because the right-hand side α is allowed to be a regular expression and include such features as optionality (represented by parentheses around the symbol), disjunction (with the disjuncts in curly brackets, separated by either a vertical line (|) or a logical disjunction sign (∨): e.g. { NP | DP }), Kleene star (zero or more instances, NP*), Kleene plus (one or more instances, NP^+), and some other less frequently used expressions. Grammars where the right-hand side can include regular expressions are called extended context-free grammars or regular right part grammars and it is known (Woods 1970) that the set of languages they describe is the same as that of standard context-free grammar.

3.2 Main properties of c-structure

LFG is unique among all frameworks in the simplicity of its constituent structure representations. This is a deliberate design decision which is possible due to the parallel architecture approach of LFG. It has been widely accepted since Chomsky (1957) that context-free grammar is not by itself an adequate formalism for describing natural language; even if the majority of syntactic constructions can

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[1] In fact, in the original version of LFG architecture introduced in Kaplan (1989), c-structure is itself a projection from the string. In recent LFG work, this idea has been developed in more detail by distinguishing between the *s-string* (the string of syntactic units) and the *p-string* (the string of phonological units), see Dalrymple & Mycock (2011) and Bögel 2023 [this volume] for more information.

indeed be described by context-free grammar (Pullum & Gazdar 1982), the descriptions required would be cumbersome, artificial and theoretically unenlightening as a model of human linguistic competence. Therefore, most grammars which use constituent structure as the main level of syntactic representation introduce additional mechanisms such as transformations in order to increase their expressive power. But such additions are not required in LFG because all phenomena that require more powerful mechanisms are dealt with at f-structure and other levels. C-structure remains limited to modeling basic word order facts, hierarchical embedding, and recursion, the phenomena for which phrase structure always was and remains the most adequate formal representation.

The advantage of this simplicity is that constituent structure in LFG has a clear empirical basis and can be determined for individual languages based on classic tests not obscured by additional considerations. For example, since there is no syntactic displacement, constituents in LFG are continuous by definition – apparently "discontinuous" material may eventually converge in one f-structure, but will still be split into separate constituents at c-structure.

By contrast, some constituency diagnostics which are valid in other frameworks are not valid in LFG. For example, since c-command is a phrase structure-based relation in mainstream transformational grammar, the existence of binding asymmetries between subjects and objects implies a configurational structure where the subject c-commands the object or vice versa. Thus Speas (1990: 137) argues that, within standard GB assumptions, flat structure predicts the existence of subject reflexives bound by their objects; since few such languages, if any, are actually found, existence of a hierarchical structure with a VP and a subject c-commanding the direct object is part of Universal Grammar.

In LFG, such a conclusion is a *non sequitur* because constraints on anaphoric relations, and other related phenomena, are formulated chiefly in terms of f-structure; sometimes in terms of information structure, semantics, or even linear precedence; but almost never in terms of c-structure configuration. Reference to c-command is possible in principle,[2] but it is largely useless as a source of valid generalizations due to the core assumptions of LFG: the cross-linguistic variability of c-structure, the universality[3] of grammatical functions at f-structure, and variation in the syntax-semantics interface.

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[2] As, for example, in the definition of extended heads in Bresnan et al. (2016: 136). Note that this is a concept that is used to describe regularities in the c- to f-structure mapping, not a constraint on f-structure relations themselves.

[3] "Universality" here refers to universal availability, as in a grammatical toolbox (cf. Jackendoff 2002), not in the sense of mapping the same semantic roles to the same grammatical functions in all languages, or even in a single language. See Belyaev 2023b [this volume] for more detail.

Constituent structure representations in LFG are therefore rather "shallow" in that their makeup is determined by a limited set of empirical diagnostics mostly based on word order possibilities. These facts vary widely across languages, and so do c-structure rules and the resulting structures. While f-structures have a degree of universality (in the sense of sharing a single inventory of grammatical functions and broad similarity in the way analogous phenomena such as anaphora, coordination, agreement etc. are represented), c-structures are language-specific.

Still, even in c-structure there are certain basic theoretical constraints which are deemed to hold universally across languages. In mainstream LFG, these are ENDOCENTRICITY and LEXICAL INTEGRITY. The former is usually captured by a version of X-Bar Theory, which is generally the same as in GB (see Chomsky 1970, Jackendoff 1977) but less restrictive: no universal clause or NP structure, no universal mapping from X′-theoretic positions (specifier, complement) to grammatical functions are assumed; non-binary branching is allowed; various exceptions from endocentricity, most prominently the exocentric S node used in non-configurational languages are permitted. For more information on the version of X-Bar Theory used in LFG, see Belyaev 2023a [this volume] and Andrews 2023 [this volume].

Lexical integrity is another principle that has been assumed in LFG since its inception. At its core, this principle states that words are constructed from different elements and according to different rules than syntactic phrases, and that the internal structure of words is invisible to rules of syntax (Bresnan & Mchombo 1995: 181). In formal terms, this is usually interpreted such that the leaves of c-structure trees must be morphologically complete words (Bresnan et al. 2016: 92). For more detail on lexical integrity as it is used in LFG, the challenges it faces and proposed modifications, see Belyaev 2023a [this volume].

4 F-structure

4.1 Defining equations

As mentioned above, at the most basic level f-structures in LFG are a type of attribute-value structure.[4] However, unlike most other frameworks which deal

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[4] Carpenter (1992) is the standard reference on the mathematical properties of such feature structures. However, the structures described by Carpenter are *typed*, which is a crucial difference from LFG f-structures, which are untyped and defined using a functional notation.

with this data type, the LFG formalism does not refer to f-structures as objects that can be manipulated and to which various operations can be applied. In contrast, an f-structure is thought of as a *function* that maps attributes (attribute names) to their values.[5]

From this perspective, describing an f-structure consists in defining the value y for each argument x in the function's domain (i.e. the set of attribute names). In LFG, attribute-value pairs are usually described using the notation of function application probably inspired by the Lisp programming language, i.e. the more conventional $f(x) = y$ is expressed as $(f\ x) = y$. Thus, for the f-structure f in (1), the value of the attribute $\textsc{tense}$ is defined by the equation $(f\ \textsc{tense}) = \textsc{prs}$. By way of example, the full (minimal) set of equations that describes the f-structure of (1) is provided in (3).

(3) $(f\ \textsc{pred}) = \text{‘}\textsc{see}\langle(f\ \textsc{subj})\ (f\ \textsc{obj})\rangle\text{’}$
$(f\ \textsc{tense}) = \textsc{prs}$
$(f\ \textsc{aspect}) = \textsc{perf}$
$(f\ \textsc{subj}) = g$
$(f\ \textsc{obj}) = h$

$(g\ \textsc{pred}) = \text{‘}\textsc{John}\text{’}$
$(g\ \textsc{pers}) = 3$
$(g\ \textsc{num}) = \textsc{sg}$

$(g\ \textsc{pred}) = \text{‘}\textsc{David}\text{’}$
$(g\ \textsc{pers}) = 3$
$(g\ \textsc{num}) = \textsc{sg}$

Sets of equations as in (3) are called f-descriptions. A valid f-structure of a sentence is an f-structure that *minimally* satisfies this sentence's f-description. Thus, the f-structure displayed in (1) is the minimal f-structure that satisfies (3); were one to add the attribute-value pair [mood indicative], (3) would still be satisfied, but the structure would no longer be minimal.

Since an f-structure function application produces attribute values, and, as seen in (1) and (3), these values can also be f-structures, it is possible to use nested function applications. Thus, since $(f\ \textsc{subj}) = g$, $((f\ \textsc{subj})\ \textsc{pers})$ is equivalent to $(g\ \textsc{pers})$ and has the value 3. By convention, function application is

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[5] The term *f(unctional)-structure* can thus be understood in two ways: as a structure representing the "function" of words and phrases (as opposed to c-structure which represents "form") and, more formally, as a *function* proper. This set-theoretic understanding of f-structures is standard in the LFG literature, but f-structures can alternatively be modeled in terms of graph theory; an example of this approach is found in Kuhn (2003).

left associative, thus the parentheses can be omitted and the equation written as (f SUBJ PERS) = 3. Early on, LFG has also adopted an extension of function application called functional uncertainty (Kaplan & Zaenen 1989b), which allows replacing the right-hand side of the function application (the "path" of attribute names) by a regular expression; thus, (f COMP* SUBJ) denotes the value of the attribute SUBJ of f or an f-structure embedded in any number of COMP attributes within f. For a formal definition of functional uncertainty and a more detailed discussion, see Belyaev 2023a [this volume].

While it is possible to describe individual f-structures using sets of equations as in (3), it is obvious that such a system cannot serve as a basis for any regular description of grammar, as it lacks a way of specifying the mapping from words or phrases to the f-structures that represent them. In LFG, this task is mediated through c-structure; f-descriptions for individual sentences are constructed on the basis of ANNOTATED C-STRUCTURE RULES, which are described in the next section.

4.2 Annotated c-structure rules

The formal metalanguage introduced in Section 4.1 provides a way to describe abstract syntactic representations, but, used by itself, it does not allow describing actual grammars and making generalizations about linguistic notions. This is because f-structures should also be mapped to the building blocks of sentence structure – words and c-structure nodes – in a regular way. In other words, the correspondence function ϕ, introduced in Section 2, has to be defined. In LFG, this is done using ANNOTATED PHRASE STRUCTURE RULES. These rules contain additional statements, formulated in the functional description metalanguage, that specify the mapping from each node to the f-structure. In order to refer to the f-structure projections, the equations use the following additional notations:

(4) the current c-structure node: $*$
the immediately dominating c-structure node: $\hat{*}$

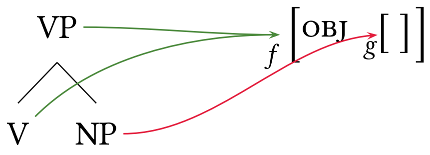
Using this notation, we can formulate phrase structure rules like the following:

$$(5)\quad \mathrm{VP} \longrightarrow \underset{\phi(\hat{*}) = \phi(*)}{\mathrm{V}} \quad \underset{(\phi(\hat{*})\ \textsc{obj}) = \phi(*)}{\mathrm{NP}}$$

In (5), the annotation for V stands for "this node (V) maps to the same f-structure as the dominating node (VP)", while the annotation for NP stands for "this node (NP) maps to the OBJ attribute of the f-structure of the dominating node (VP)".

The mapping that this rule defines is illustrated in (6). The nodes VP and V map to the same f-structure, labeled as f, while NP maps to the f-structure labeled as g – the direct object of the clause.

(6)



For convenience, $\phi(*)$ and $\phi(\hat{*})$ are usually replaced by the abbreviations ↓ (pronounced “down”) and ↑ (pronounced “up”), respectively. These metavariables are assumed to be the only way to refer to material up or down the tree in phrase structure rules; direct reference to “low-level” variables such as $*$ is generally not used in LFG analyses. The conventional representation of the rule in (5) is given in (7).

(7)	VP	⟶	V	NP
			↑=↓	(↑ obj)=↓

In the standard model of c-structure, lexical entries are nothing more than rules defining a preterminal node dominating a terminal node. However, they use a slightly different notation, where the word form is followed by its category and annotation, illustrated in (8).

(8)	*John*	N	(↑ pred)=‘John’ (↑ pers)=3 (↑ num)=sg

Since there is no further material down the tree, lexical entries typically only use the metavariable ↑ to provide information associated with the preterminal node. In some cases, ↓ is also used to draw subtle distinctions between information contributed by the word itself and the information contributed by the preterminal. For example, Zaenen & Kaplan (1995: 230) ingeniously map the verbal form to the pred value, while other grammatical features are assumed to be contributed by the V node. In practice, this possibility is seldom used.

The projection function ϕ maps c-structure nodes to f-structures, but one may also define an inverse correspondence ϕ^{-1} to proceed in the opposite direction. This function provides the set of c-structure nodes that map to the f-structure given as its argument. Note that the inverse projection is not a function, as the f- to c-structure relation is one-to-many. Inverse projections are used in f-descriptions in order to use c-structure features in f-structure constraints. For example, to check that the subject's f-structure maps to an NP, one may use the equation $\mathrm{NP} \in \mathrm{CAT}((\uparrow \textsc{subj}))$. This is seldom needed, because, by design, most constraints on f-structure attributes can be described solely in terms of f-structure. However, sometimes the inverse projection is indispensable, e.g. when formulating the notion of f-precedence (see Kaplan & Zaenen 1989a; also see Belyaev 2023a [this volume]) describing linear order conditions on anaphora (Rákosi 2023 [this volume]).

4.3 Well-formedness conditions

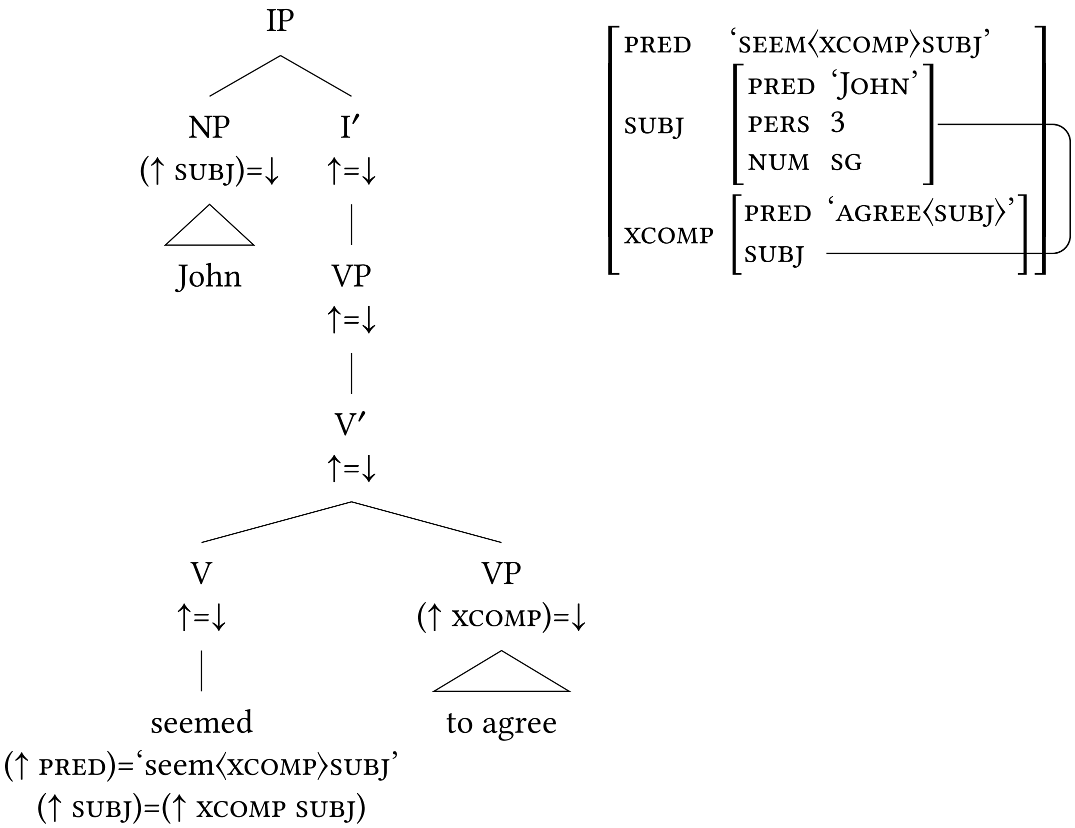
There are three conditions that any f-structure must satisfy in order to be treated as valid: Uniqueness (also known as Consistency), Completeness, and Coherence. Any f-structure that violates these conditions cannot be part of a valid analysis of any sentence. Uniqueness requires that each attribute have exactly one value – this actually follows from the notion of f-structure as a function, since a function, by definition, is a many-to-one or one-to-one mapping. Completeness requires that each argument listed in the PRED value of an f-structure (which is the locus of valency information) is present in the f-structure; Coherence, complementarily, requires that no extra arguments *not* listed in the PRED value are introduced. For more detail on how these conditions actually operate, see Belyaev 2023a [this volume].

4.4 Structure sharing and "movement"

Unlike transformation-based grammatical approaches, LFG has no special formal mechanism such as movement or Internal Merge to handle dependencies between different structural positions. The closest equivalent to such a mechanism is STRUCTURE SHARING, which consists in one f-structure being the value of two or more distinct attributes. The possibility of structure sharing follows from the general makeup of the formalism: If f-structures are functions and features are their arguments, it is expected that these structures are reentrant: a function can return the same value for different arguments. Since reentrancy is obviously required for the simplest cases such as reentrant atomic values, structure sharing is only a natural consequence of this property.

A classic example of the use of structure sharing to describe a movement-like process is the LFG analysis of raising. Raising verbs such as English *seem* are analyzed as having a non-thematic subject that is shared with the subject of the complement clause:

(9)



This correctly predicts that the raised subject appears as the argument of the matrix clause while being subcategorized for and assigned a semantic role in the complement clause. For more detail on control and raising, see Vincent 2023 [this volume].

It is important to note that while structure sharing is, in formal terms, the closest counterpart to movement in LFG, this does not mean that all phenomena that are treated via movement in transformational frameworks should involve structure sharing in LFG. This is because movement is normally the *only* mechanism for “non-canonical” or “displaced” positioning of material in transformational frameworks, while LFG draws a crucial distinction between c- and f-structure. Two sentences may differ in the c-structure while having the same f-structure – this is called SCRAMBLING and this is the most widespread mechanism of syntactic “displacement” in non-configurational languages or languages that allow mapping to the same grammatical function in different positions. For example, Arka (2003) proposes the following rule for S in Balinese:

(10) $$\text{S} \longrightarrow \left\{ \begin{array}{c|c} \text{VP} & \text{NP} \\ \uparrow=\downarrow & (\uparrow \textsc{gf})=\downarrow \end{array} \right\}^{*}$$

This allows any number of NPs to alternate with any number of VPs in any order; each NP may be freely assigned to any grammatical function. Therefore, sentences with the same predicate and the same set of NP arguments will have identical f-structures, with the only difference being found at c-structure. But no c-structure configuration will be considered as "basic" in any formal sense of the term.[6]

5 Additional levels of projection

C-structure and f-structure were originally thought of as the only levels of grammar in LFG: c-structure as a kind of "form" representation, and f-structure as a "functional" representation, in some sense reflecting semantics and having a degree of universality compared to c-structure. It quickly became clear, however, that these two levels are not enough to represent the full complexity of grammatical phenomena. First, semantics should be separate from f-structure to handle phenomena that are not represented in syntax, such as quantifier scope. Second, f-structure in its standard form is a collection of information of different types: purely morphological and morphosyntactic atomic features; grammatical functions; valency information (PRED features); and semantic information (if features such as ANIM are used to describe effects of animacy on grammatical marking). Third, f-structure simply cannot handle some phenomena, like prosody, which require a different kind of structure whose constituents are not equivalent to either c-structure constituents or f-structures.

A possible way to overcome these difficulties would be to extend the role of the existing c- and f-structure, which would mirror similar developments in transformational grammar, with its central role of constituent structure and the proliferation of functional projections (see Sells 2023 [this volume]). However, the architecture of LFG permits a more elegant solution. While the original system does only consist of c- and f-structure, there is nothing intrinsic about this binarity: the two are connected by a projection function ϕ that maps nodes to f-structure. It is possible to define other functions that would connect c- or f-structures to various other structures; thus, where $\phi(*)$ (abbreviated $\downarrow$) stands for the f-structure of the annotated node, $\mu(*)$ would be the morphosyntactic structure (m-structure) of

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[6] Of course, even in non-configurational languages, certain word orders are often viewed as less marked compared to others. This is probably due to differences in information structure, which in modern LFG literature is usually treated as a separate level that may interact with other levels such as c-structure, f-structure, and prosody (Zaenen 2023 [this volume]; see also Dalrymple & Nikolaeva 2011). Crucially, an information structure difference between sentences does not automatically entail any difference at either c- or f-structure.

this c-structure node, and $\sigma(\phi(*))$ (abbreviated $\uparrow_\sigma$) would be the semantic structure (s-structure) that the f-structure that corresponds to this node maps to (if s-structure is viewed as projected from f-structure). The simultaneous description of two or more grammatical structures by the same rule or lexical entry is called CODESCRIPTION, which is the main principle governing the interaction of levels in LFG.

This modularity has been successfully used to model a number of grammatical levels, such that LFG, as it is currently practiced, is no longer centered around the interaction between c- and f-structure, although these still play a major role as the main syntactic representations. It is also crucial that LFG, by design, still retains a degree of "syntactocentricity" in that all additional projections are defined with reference to c-structure nodes. This is different from the notion of a truly parallel architecture advocated e.g. in Culicover & Jackendoff (2005), where each level of representation (specifically, in their model, syntax and semantics) is conceived of as a separate "combinatorially autonomous" system that is linked to other levels via a system of correspondence constraints. In LFG, only c-structure is combinatorial in this sense,[7] with possible trees defined directly through phrase structure rules; the content of other projections is not autonomously generated, but defined through phrase structure annotations that connect the elements of these projections to c-structure nodes. Thus, while c-structure is not as central as constituent structure in other frameworks, it acts as a "hub" that connects all the different levels of sentence structure together.[8]

There is currently no agreed-upon set of representational levels. Some, like s-structure or prosodic structure, are almost universally adopted and consistently interpreted in terms of projection. Others, like information structure (i-structure), are assumed by most authors, but specific interpretations vary: for example, i-structure is projected from c-structure in King (1997), Butt & King (1997), but

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[7] C-structure rules are somewhat less central in approaches like Halvorsen (1983) and Andrews (2008), which use description by analysis, rather than the standard codescription approach, to describe the syntax-semantics interface: In these approaches, meaning is constructed on the basis of f-structure, without direct reference to c-structure. Even here, however, semantics is not a separate combinatorial system but is constructed on the basis of another structure which, in turn, is projected from c-structure; this still seems rather different from Culicover and Jackendoff's vision of parallel architecture.

[8] This flavour of syntactocentricity is far less radical than in mainstream generative grammar and may in fact be unavoidable in a (broadly) lexicalist framework, inasmuch as words are viewed as the "building blocks" of sentences. In fact, I am not aware of a fully developed and formalized implementation of any truly parallel architecture. There is no way around the fact that phonetic form is the only part of language that is directly available for perception; thus the part of grammar that is tasked with combining such "surface" elements into complete utterances – i.e. syntax in the narrow sense – will always have a special role.

from s-structure in the more recent proposal of Dalrymple & Nikolaeva (2011). Finally, some levels are specific to particular approaches and are not universally adopted, e.g. morphosyntactic structure (m-structure), viewed as projected from c-structure (Butt et al. 2004, Butt, Fortmann, et al. 1996) or f-structure (Sadler & Nordlinger 2004); or argument structure (a-structure), which is used in some approaches to argument mapping (Butt et al. 1997) but is viewed as redundant in some more recent proposals such as (Asudeh & Giorgolo 2012, Asudeh et al. 2014, Findlay 2016). One version of how the correspondence architecture might look is provided in (11).[9]

(11)

$$\begin{tikzcd}
& \text{p-structure} & \text{l-structure} & & \text{m-structure} & \text{i-structure} \\
\textbf{Form} \arrow[ur, "\beta"] \arrow[r, "\pi"] & \text{c-structure} \arrow[ur, "\lambda"] \arrow[rr, "\phi"] \arrow[dr, bend right, "\alpha"'] & & \text{f-structure} \arrow[ur, "\mu"] \arrow[r, "\sigma"] & \text{s-structure} \arrow[ur, "\iota"] \arrow[r, "\psi"] & \textbf{Model} \\
& & \text{a-structure} \arrow[ur, bend right, "\lambda'"'] & & &
\end{tikzcd}$$

To date, additional levels and projections that have been discussed and described in the LFG literature include the following (references to some of the proposals are given in parentheses; most have separate chapters in the handbook, which describe proposed representations in detail):

- argument structure (a-structure) (Butt et al. 1997), see Findlay et al. 2023 [this volume];
- semantic structure (s-structure) (Dalrymple 1999), see Asudeh 2023 [this volume];
- information structure (i-structure) (King 1997, Butt & King 1997, Dalrymple & Nikolaeva 2011), see Zaenen 2023 [this volume];
- prosodic structure (p-structure) (Dalrymple & Mycock 2011, Bögel 2012), see Bögel 2023 [this volume];
- morphological / morphosyntactic structure (m-structure), see (Butt et al. 2004, Sadler & Nordlinger 2004), Asudeh & Siddiqi 2023 [this volume];
- grammatical marking structure (g-structure) (Falk 2006);

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[9] The argument structure projection functions α and λ' are from the proposal in Butt et al. (1997). In this approach, which is not universally accepted in the literature, the projection function ϕ is the composition $\alpha \circ \lambda'$. I use the label λ' to distinguish this from the projection function λ that maps c-structure to l-structure, specifying category labels (Lowe & Lovestrand 2020).

- l-structure, a level that represents complex categories of c-structure nodes in the approach of Lowe & Lovestrand (2020): see Belyaev 2023a [this volume].

6 Conclusion

In this chapter, I have described the main architectural notions of LFG – the c- and f-structures. LFG can be viewed as incorporating the best features of constituent-structure-based (at c-structure) and dependency-based (at f-structure) frameworks, while avoiding their main drawbacks. Frameworks that use phrase structure as the only syntactic representation require additional mechanisms such as transformations, multiple dominance or separate linearization to properly capture word order variation and feature constraints; LFG manages to keep c-structure relatively simple due to the fact that all feature interactions are captured at f-structure, without referring to constituent structure positions. At the same time, the fact that f-structure does not directly refer to individual words or phrase structure nodes allows adequately capturing word order variation while keeping predicate-argument representations fairly uniform across languages. I have also described how the core architecture may be extended to other projections beyond f-structure. Each of these modules captures a separate part of grammar (prosody, semantic structure, information structure, etc.) and has its own internal makeup. The modules are linked together using annotations of c-structure rules in the same way as f-structure is projected from c-structure. Hence, grammars in LFG are factorized into several distinct components, each of which is responsible for its own range of phenomena and largely operates according to its own principles, with c-structure serving as a "hub" tying all the components together.

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Chapter 2

Core concepts of LFG

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This chapter provides an in-depth coverage of the main features of the LFG framework, focusing mainly on its syntactic representations: c- and f-structure. The makeup of each level is discussed in detail. For c-structure, I describe the version of X′ theory used in LFG and the status of lexical integrity as a core principle of the framework. I discuss the notion of f-structure as a function/set of feature-value pairs that is used in the majority of LFG work; attribute value types and well-formedness conditions on f-structure (Uniqueness, Completeness and Coherence) are covered as well. I also describe the metalanguage for defining f-structures and the mapping from c- to f-structures, and note some linguistically relevant consequences of how this mapping is organized. Three proposed extensions of the standard architecture are also discussed: templates (constructions), minimal c-structure, and lexical sharing.

1 Introduction

This chapter provides a detailed survey of the main syntactic levels of LFG, constituent structure (c-structure) and functional structure (f-structure). It complements the more general introduction in Belyaev 2023b [this volume]. In Section 2, I describe the c-structure model used in standard LFG, its understanding of constituency, and the role of X′ theory. In Section 3, the notion of f-structure is discussed, including the metalanguage used for describing f-structures and constraints on possible f-structure. In Section 4, I discuss the mapping from c- to f-structure. Finally, in Section 5 I describe recently proposed modifications to the basic architecture of LFG that have not yet been universally accepted, but which may shape the development of this framework in the future.

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2 C-structure

The nature of constituent structure (c-structure) in LFG and its main properties are summarized in Belyaev 2023b [this volume]. Briefly, c-structure is a phrase structure tree; constraints on possible trees are usually described via context-free rules as in (1). Other metalanguages are sometimes used as well.

(1) S ⟶ NP VP

An important feature of c-structure in LFG is that empty nodes are not usually employed. This is not a limitation imposed by the framework itself, but a theoretical decision. It is formally possible to define grammars with null terminal nodes in LFG: this is implemented in XLE (Crouch et al. 2011) and was used to capture long-distance dependencies in early versions of LFG (Kaplan & Bresnan 1982). However, since Kaplan & Zaenen (1989b) it has become a universal practice to capture long-distance dependencies through functional uncertainty at f-structure, and the use of empty categories at c-structure has become unnecessary (see Kaplan 2023 [this volume]). For more information on the formal features of c-structure in LFG, see Andrews 2023 [this volume].

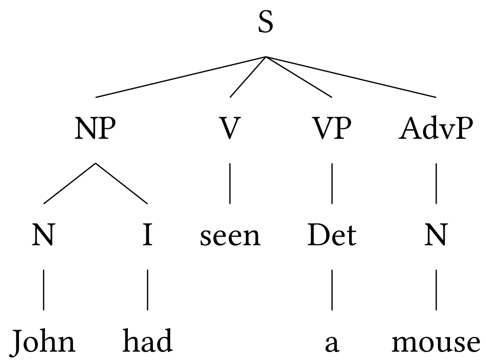
Without additional theoretical restrictions, context-free grammars allow far more possible phrase structure trees than actually attested in natural languages. In this section, I will focus on two main constraints on c-structure in LFG: X-Bar Theory and lexical integrity.

2.1 X′ Theory

Every theory of constituency based on phrase structure grammar faces what Everett (2015), in his review of Adger (2013), called “Lyons’ Problem”. Lyons (1968) famously asked what guarantees that NPs are headed by Ns, VPs are headed by Vs, etc., such that rules like VP ⟶ … V … or NP ⟶ … N … are allowed, but rules like NP ⟶ … V … are not.

Indeed, from the point of view of context-free rules, VP and V are atomic symbols that are not related to each other; labeling one of the daughters of NP as N is merely a convention, and nothing in the formalism excludes a hypothetical language with constituent structures like in (2) – “monsters” in Bresnan et al.’s (2016) terms.

(2)



Intuitively, there are many things that are wrong with this structure: an I head cannot be the daughter of NP; the VP cannot be headed by, or even immediately dominate, a Det; an AdvP cannot be headed by a noun.[1] The principle that prohibits this is called endocentricity; roughly stated, it means that the external distribution of a phrase (e.g. NP) is determined by the category of one and only one of its daughters, the head. Disallowing non-endocentric structures requires a theory of constituent structure labels that limits the range of available configurations. To this end, X-bar (X′) theory has been proposed in mainstream generative grammar (Chomsky 1970, Jackendoff 1977).

X′ theory enforces endocentricity by introducing the notion of projection and "bar level" and requiring that each non-maximal projection (X^0 and X′; X″, or XP, is usually assumed to be the maximum level of projection) be dominated by a node belonging to the same category, with the bar level either incremented by one or unchanged. The sisters of c-structure heads (complements, specifiers and adjuncts) have to be maximal projections or non-projecting words (on which see below).

One variant of X′ theory has been adopted in LFG from the very early days and continues to be used in most LFG work. An in-depth exposition of X′ theory as it is used in LFG, with certain additional theoretical innovations, can be found in Bresnan et al. (2016). The most important features of X′ theory as it is practiced in LFG are as follows. First, as in the original formulation, X′ theoretical constraints are viewed as constraints on phrase structure *rules*; the later GB view of a kind of universal "X′ schema" has not gained acceptance in LFG, primarily because

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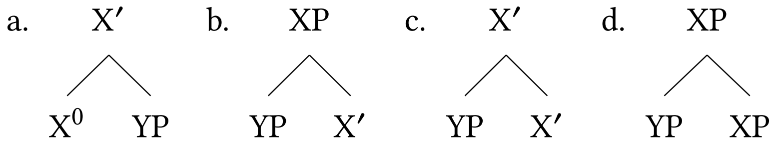
[1] Curiously, each of the features of this illustration *ad absurdum* has a counterpart in real languages: noun phrases do sometimes mark the tense of their clauses, verbs do mark the definiteness of their arguments, and bare nouns (although probably not nouns like 'mouse') are used adverbially. But there is broad consensus in theoretical lingustics that such phenomena are more exceptions than rules and should *not* be modeled by allowing the theory of phrase structure to license such configurations.

the architecture of the framework is fundamentally based on language-specific rules and does not allow such schemas.

Second, X′ theory in LFG allows for the following positions: complement (3a), specifier (3b), X′ adjunct (3c) and XP adjunct (3d).[2]

(3)



As in all versions of X′ theory, only maximal projections may appear in these positions.

There is some disagreement concerning the possibility of X′ adjunction: While most authors accept both kinds of adjunction, Toivonen (2003) only allows XP-adjunction (and head adjunction, see below) because in her theory only constituents of the same bar level may be adjoined.

The LFG literature also generally allows for multiple complements and specifiers dominated by the same mother node; thus, a sequence of several phrases instead of YP is possible in (3a–c); multiple adjuncts in one position are also usually allowed, even though this creates redundancy since this structure could always be replaced by multiple binary adjunction.

Third, LFG uses the following functional projections: DP for NPs, IP and CP for VPs. Some work also uses additional phrases, such as KP/CaseP for clitic case markers (Broadwell 2008). The number of functional positions is limited compared to mainstream theories, and this is not merely a stipulation: LFG requires all constituency in a given language to be empirically motivated in a way that is more narrow than in frameworks that represent the bulk of syntactic information in phrase structure (such as transformational frameworks). Specifically, heads may only be stipulated if there is actual lexical material that can occupy them; therefore, even the existence of projections such as CP or IP cannot be automatically assumed for all languages. More abstract projections such as TopicP or ForceP are not usually introduced because there are few suitable candidates for the status of heads of these phrases, and little distributional evidence to argue that their specifiers are distinct structural positions.

It turns out, in fact, that the set of functional projections listed above is fully adequate for the overwhelming majority of languages. Moreover, some categories, like DP, are not viewed as universal; authors, such as Sells (1994) for Japanese and

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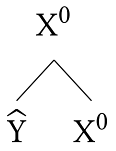
[2] The order of constituents is only an illustration; X′ theory itself does not impose any specific order.

Korean, even limit the number of projections to one (X') instead of the standard two.

Fourth, LFG admits non-projecting words, i.e. lexical items that do not project X' and XP levels and hence cannot have complements or specifiers; their maximum projection level is 0. The category of non-projecting words is marked as X^0. Toivonen (2003) develops a detailed theory of non-projecting words. Being maximal projections, they can appear at any non-head X' theoretic positions (i.e. specifier, complement, or adjunct), but the only dependents that they may have are X^0 adjuncts, which must themselves be non-projecting. Thus, an additional type of adjunction – head adjunction – is introduced into X' theory, illustrated in (4), where X^0 can also be $\widehat{X}$, but, crucially, $\widehat{Y}$ cannot be Y^0, as that would violate the principle that only maximal projections can appear in non-head positions.

(4)



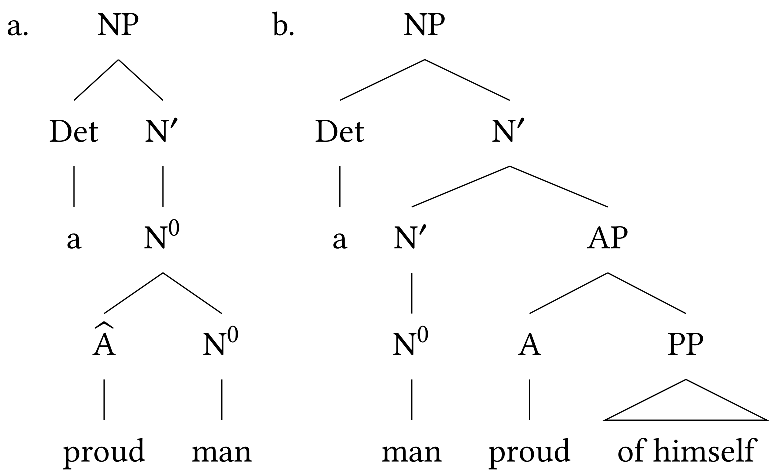
The theory of non-projecting words presented in Toivonen (2003) further requires that only same-level projections are adjoined; this effectively prohibits adjoining non-projecting words at X' or XP level, as well as any adjunction at X' level in languages where XP is the maximal projection (because only maximal projections can be adjuncts, as stated above). However, these more restrictive principles are not accepted by all authors who use non-projecting words in their analyses: for example, Spencer (2005) analyzes case markers in Hindi as $\hat{P}$ nodes adjoined to NP. X' adjunction also remains quite common in LFG analyses.

Sadler & Arnold (1994) use non-projecting words to account for the behaviour of English prenominal adjectives, which cannot have phrasal complements if they are prenominal; consider the contrast between (5a) and (5b), while (5c) is ungrammatical.

(5) a. a **proud** man
b. a man [**proud** of himself]
c. * a [**proud** of himself] man

Sadler and Arnold argue that this contrast is due to the fact that prenominal adjectives in English are non-projecting words with the category $\widehat{A}$ that are adjoined to N^0, while postnominal adjectives form AP and can therefore have complements. Thus the structure of (5a) is (6a), while the structure of (5b) is (6b).

(6)



Finally, X′ theoretic principles are not viewed as fully universal in LFG. The most prominent exception is the exocentric category S.[3] This category does not have a "head" in the normal sense: it can be "headed" by a verb, but also by an adjective or another nonverbal predicate; this is why the term S is used instead of, for example, VP. The category S is most extensively used in nonconfigurational languages (see Andrews 2023 [this volume]), but this is not its exclusive role. Many languages have a fairly configurational structure overall but allow predicates of various categories to be embedded under a general "predicative marker", which sits in the I or C node. For example, Kroeger (1993: 119) proposes the phrase structure in (7) for Tagalog. The SPEC position can be optionally occupied by fronted constituents of several types (such as topics); the I node is occupied by an auxiliary or the finite verb; the predicate XP can be a VP in verbal sentences, but can also be AP or NP if the predicate is nonverbal. Hence, the structure is indeed non-endocentric, and the use of the label S is justified.

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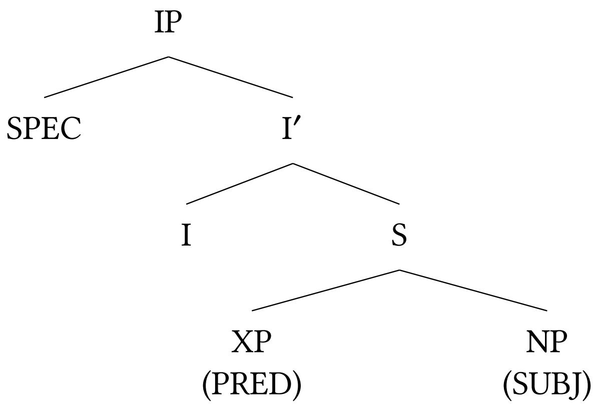
[3] Bresnan et al. (2016: 112ff.) present the category S and non-projecting words as effectively the *only* exceptions from standard principles of X′ theory. This, however, is a theoretical idealization insofar as it applies to actual LFG analyses, which routinely make us of *ad hoc* categories such as CL, CCL (for "clitic", "clitic cluster") in Bögel et al. (2010) and Lowe (2011). Such minor innovations do not seem to influence the overall theory in any meaningful way, since they deal with exceptional cases such as second-position clitics or language-specific, idiosyncratic linear order distributions. It is also conceivable that many of them could be converted to analyses that conform to X′ theoretic principles; for example, CCL could be treated as a phrase consisting of multiple $\widehat{\text{D}}$ head adjunction (if the clitics are pronominal).

(7)



Since c-structure is not the only level of representation in LFG and models only a subset of syntactic phenomena (word order, embedding), X′ theory does not do much by itself to limit the range of possible languages. Unlike frameworks such as GB, for which the theory was originally devised, X′ positions are not inherently or uniquely associated with specific syntactic or semantic functions – as a result, X′ theory, understood purely in terms of c-structure, is little else than a system of labeling nodes which allows us to generalize endocentricity at constituent structure level. In order to make it more meaningful, it should be augmented by a set of principles that determine the mapping of X′ positions to f-structure – such a system has been developed in LFG, and will be described in Section 4.3.

2.2 Lexical Integrity

As its name implies, Lexical Functional Grammar was originally conceived as a lexicalist framework, a term that has several meanings. In the most general sense, lexicalism implies that the features of individual syntactic elements (morphemes and wordforms) as well as their subcategorization frames are determined in the lexicon, and cannot be modified in the syntax (such as by promoting the direct object in a passive construction). Lexicalism in this sense requires no additional stipulation and is enforced by the LFG architecture itself: there are no transformations or other means to change the c-structure or f-structure features; syntax can only mutiply define lexical features, but cannot override them.[4]

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[4] Kaplan & Wedekind (1993) introduced the restriction operator: $f\backslash_{A}$ denotes the f-structure f with the attribute A and its value removed. As suggested by an anonymous reviewer, this violates lexical integrity in the weak sense, because here the syntax effectively accesses an f-structure constructed otherwise (possibly by means of morphology) to retrieve some of its information. This operator is not widely employed but was used in several LFG analyses, notably in Asudeh (2012) and Falk (2010).

LFG is also lexicalist in another sense: it subscribes to the idea that the building blocks of syntax are not roots or affixes, but individual words that are constructed from different blocks and according to different rules than syntactic constituents.[5] Thus, the distinction between morphology and syntax in LFG is viewed as fundamental, which is against the views of many recent approaches, both formal (Bruening 2018) and typological (Haspelmath 2011).

This understanding of lexicalism is more formally termed LEXICAL INTEGRITY and has been given two formulations in LFG (8)–(9).

(8) Words are built out of different structural elements and by different principles of composition than syntactic phrases. (Bresnan & Mchombo 1995: 181)

(9) Morphologically complete words are leaves of the c[onstituent]-structure tree and each leaf corresponds to one and only one c[onstituent]-structure node. (Bresnan et al. 2016: 92)

The definition in (8) is rather broad and can be compatible with several different understandings of the morphology–syntax interface, as long as the border between the two levels in maintained in some way. The second definition (9) is more specific and is only compatible with one view of the interaction between morphology and syntax. For example, lexical sharing, which allows one word to correspond to two X^0 nodes (discussed in Section 5.2.2), is compatible with (8) but not with (9).

Interestingly, despite the rather strict definition in (9), much work in LFG uses the concept of "sublexical nodes", like in the rule for Greenlandic nouns in (10), from Bresnan et al. (2016: 368). This is formally incompatible with (9) because the preterminal nodes correspond to morphemes, not morphologically complete nodes.

(10) $\text{N} \longrightarrow \text{N}_{\text{stem}} \quad \text{N}_{\text{aff}}$

In practice, such analyses are rather harmless because in their predictions they are equivalent to analyses that strictly adhere to (9): since all morphology is sublexical, the position of individual affixes cannot have any syntactic relevance, as opposed to approaches like Distributed Morphology (Halle & Marantz 1993), where morphological features often occupy higher-level functional projections

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[5] These two understandings of lexicalism are sometimes conflated, but they are actually independent: A framework may be lexicalist in the former sense, but consider the distinction between words and syntactic phrases to be ephemeral.

that can scope over syntactic phrases. However, the use of sublexical representations does raise the issue of how the individual contribution of morphemes to f-structure should be represented – standard LFG does not provide such a way, because words are viewed as complete, unsegmented bundles of morphosyntactic information. These issues are discussed in detail in Asudeh & Siddiqi 2023 [this volume].

3 F-structure

3.1 The notion of f-structure

As described in Belyaev 2023b [this volume], c-structure in LFG is complemented by an additional level of representation called f-structure. F-structure is an attribute-value structure that includes information on valency, grammatical functions, and the features of clauses and their syntactic arguments. An f-structure for the English sentence *John has seen David* is given in (11).

(11)

$$
{}_{f}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{see}\langle(f\ \textsc{subj})(f\ \textsc{obj})\rangle\text{’}\\
\textsc{tense} & \textsc{prs}\\
\textsc{aspect} & \textsc{perf}\\
\textsc{subj} & {}_{g}\left[\begin{array}{ll}\textsc{pred} & \text{‘John’}\\ \textsc{pers} & 3\\ \textsc{num} & \textsc{sg}\end{array}\right]\\
\textsc{obj} & \left[\begin{array}{ll}\textsc{pred} & \text{‘David’}\\ \textsc{pers} & 3\\ \textsc{num} & \textsc{sg}\end{array}\right]
\end{array}\right]
$$

F-structure is usually thought of as a set of attribute-value pairs, or a function that maps attribute names to their values. This understanding of f-structure has important implications for the architecture of LFG. Specifically, it implies that f-structures are solely and uniquely defined by their set of attribute-value pairs; there is no type system as in Carpenter (1992) or HPSG (Pollard & Sag 1994). Therefore, there is no such thing as two different f-structures having the same set of attributes and values; the notion of an empty f-structure is also problematic, because all empty structures are equivalent to each other.[6] This notion of

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[6] Observe that the standard LFG notation does not even have a way to specify empty f-structures, on the tacit assumption that every non-vacuous f-structure would have at least one feature. However, the notion could be useful e.g. for expletive arguments that are not specified for any morphosyntactic features such as pers or case but simply appear to satisfy Completeness.

identity is somewhat mitigated by the uniqueness of pred values (Section 3.3.4), which ensures that any two independently introduced, semantically interpreted f-structures are formally distinct, even if they have the same lexical predicate and the same set of morphosyntactic features. However, not all f-structures have pred values; thus, for instance, all expletive subjects of the same form are described by the same f-structure, regardless of the clauses in which they occur. For example, all bundles of agreement features (agr) with the same set of values are identical to each other. One agr bundle may be required to be identical to another via agreement sharing (Haug & Nikitina 2015) in the f-description (using an equation such as (↑ agr)=(↑ subj agr)), but it will also be identical to all other such bundles elsewhere in the same sentence, if they occur. Counterintuitive though such results may seem, it is not clear whether they can lead to any undesirable effects in practice. The notion of identity of f-structures is important for understanding the concept of structure sharing (Section 3.3.3).

3.2 The metalanguage

3.2.1 Defining equations

The standard notation for describing f-structures are defining equations.These utilize the idea that f-structures are functions. For example, the value of the attribute tense of f-structure f in (11) can be defined by the equation (f tense)=prs. It is possible to use nested function applications; thus, since (f subj)=g, ((f subj) pers) is equivalent to (g pers) and has the value 3. By convention, function application is left associative, thus the parentheses can be omitted and the equation written as (f subj pers)=3.

Defining equations are grouped into f-descriptions. An f-description describes the *minimal* f-structure that satisfies all the equations included in the description. The default relation between equations forming an f-description is conjunction, but disjunction is also possible; for example, { (↑ subj pers)=1 | (↑ subj pers)=2 } means that the subject is defined as being either 1st or 2nd person.[7] For more examples and discussion of defining equations, see Belyaev 2023b [this volume].

3.2.2 Constraining equations

The f-structure equations described above are all evaluated to construct the minimal complete and coherent f-structure that satisfies all of them together (if such

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[7] Disjunction can be represented by either a vertical line (|) or a logical disjunction sign (∨); both notations are found in the literature.

an f-structure exists). In this sense, they are “constructive”, or DEFINING: informally, a defining equation introduces a feature value, regardless of whether it is the only such equation or the same value is defined elsewhere.

But sometimes it is necessary to check the value of a feature without actually assigning it. For example, a matrix verb might require its complement to have a specific mood value, such as subjunctive. A defining equation like ($\uparrow$ COMP MOOD)=SBJV also licenses a complement that is not marked for mood, i.e. does not have a lexically defined MOOD feature (e.g., it is non-finite), which probably leads to an incorrect prediction (unless additional constraints block the use of such forms in this context).

Defining equations also provide no way to capture purely negative requirements, i.e. to ensure that a feature *does not* have a specific value. Clearly, this is not equivalent to the disjunction of other possible values of the feature, since, first, absence of the feature also satisfies the negative condition; second, the disjunction would freely assign any feature value except for the disallowed one, which is definitely not what a negative constraint should do.

The need for such constraints is accounted for in LFG by allowing a special class of equations, CONSTRAINING EQUATIONS. These equations are special in that they do not participate in constructing the f-structure of the sentence. In contrast, they are only evaluated once the minimal f-structure satisfying all defining equations has been constructed. Then, violation of a constraining equation leads to ungrammaticality.

The simplest type of constraining equations involve equality relations; these are annotated in the same way as defining equations, but with a subscript *c*, e.g.: $(f\ a) =_c \mathrm{X}$. To illustrate how constraining equations work, consider the following f-descriptions and their corresponding f-structures:

(12) a. $$\begin{array}{lcl}(f\ \mathrm{A}) & = & \mathrm{X}\\ (f\ \mathrm{B}) & = & \mathrm{Y}\\ (f\ \mathrm{A}) & =_c & \mathrm{X}\end{array} \rightarrow {}_f\!\begin{bmatrix}\mathrm{A} & \mathrm{X}\\ \mathrm{B} & \mathrm{Y}\end{bmatrix}$$ (constraining equation satisfied)

b. $$\begin{array}{lcl}(f\ \mathrm{B}) & = & \mathrm{Y}\\ (f\ \mathrm{A}) & =_c & \mathrm{X}\end{array} \nrightarrow {}_f\!\begin{bmatrix}\mathrm{B} & \mathrm{Y}\end{bmatrix}$$ (constraining equation not satisfied)

In (12a), the constraining equation is satisfied because the feature value is defined elsewhere. By contrast, in (12b) the constraining equation is not satisfied because A has no value, and a value cannot be assigned by a constraining equation.

Note that constraining equations serve as a good illustration of the LFG principle of separation between description and the object being described. Just as multiple feature definitions are not represented in the f-structure, there is also no trace of constraining equations having been "checked" in (12a). The only thing a constraining equation does is to put constraints on permissible structures; it does not contribute to the structures themselves.

The other two types of constraining equations are existential and negative constraints. Existential equations check that a feature has *any* value rather than testing for a specific value. They are written as simple function applications: $(f\,a)$ means that the f-structure f must have the feature a with any value; the absence of an equality statement indicates that we are dealing with an existential constraint. Negative constraints check that a feature does not have a given value ($(f\ a) \neq x$; this is compatible with the feature having no value) or has no value ($\neg(f\ a)$; this is called a negative existential constraint).

Constraining equations are also implicitly introduced by conditional statements of the form $X \Rightarrow Y$. These are, by definition (Bresnan et al. 2016: 61, Dalrymple et al. 2019: 168), equivalent to a disjunction: $\neg A \vee (A_c \wedge B)$.

Off-path constraints are conceptually similar to conditional statements in that they are used to restrict function application to apply only to f-structures satisfying additional conditions on their features. For example,

$$(f \quad \underset{(\rightarrow \mathrm{B}) =_c y}{\mathrm{A}} \quad \mathrm{C}) = x$$

means that the value x is only assigned to the feature C of the f-structure $(f\ \mathrm{A})$ if $(f\ \mathrm{A})$ has an attribute B with the value y. If only constraining equations are used in such statements (as assumed in some of the literature), they could all in principle be rewritten as conditional statements (provided that local names are used: see Section 3.2.5), but the notation is more cumbersome. This is indeed assumed in some LFG literature, and perhaps most prominently in the XLE implementation (Crouch et al. 2011), where defining equations cannot be used in off-path constraints (see Patejuk & Przepiórkowski 2014: 7 for a discussion). However, in spite of their name, the theoretical literature (Bresnan et al. 2016: 65, fn. 26, Dalrymple et al. 2019: 230) unanimously suggests that off-path constraints can be constructive, and this feature is used in some LFG analyses.[8] Off-path constraints are especially important for Functional Uncertainty expressions (Section 3.2.3), where a path may be a regular expression with many elements and the direct use of conditional statements is impractical.

It is clear from the discussion above that while the concept of constraining equations appears rather simple, it actually introduces some additional complexity into the system. Instead of just evaluating an f-description that consists of a

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[8] I am thankful to an anonymous reviewer for drawing my attention to this fact.

set of defining equations, the resolution of a valid f-structure for a sentence must proceed through two steps: (a) evaluation of defining equations; (b) evaluation of constraining equations. The notion of constraining equations has also raised concerns about the metatheoretical status of LFG grammars; in particular, Pullum (2013) and Blackburn & Gardent (1995) have argued that constraining equations introduce a degree of procedurality into the framework, which is incompatible with the notion of model-theoretic syntax. However, the specific implications of this procedurality have never been systematically studied. It is clear that many, perhaps most, grammars that use constraining equations could be rewritten without them, but with more notational complexity: for example, by requiring every f-structure to have certain attributes, introducing "empty" attribute values (i.e. treating "no value" as one of the values for atomic features), and so on. Thus the issue might, in the end, be more of notation rather than substance, as suggested, in fact, in the conclusion to Blackburn & Gardent (1995).

3.2.3 Functional uncertainty

The basic LFG architecture outlined in the preceding sections is adequate to handle most phenomena that are relevant to the local structure of clauses and noun phrases, such as argument selection and realization, modification, and word order. However, it is missing a component that could handle unbounded dependencies of any kind, i.e. those dependencies between elements of a sentence that are not tied to any specific structural position. For example, consider the behaviour of "cyclic" extraction from complement clauses. This process is in principle unbounded: an interrogative might be extracted from the matrix clause (13a), from the complement clause (13b), from the complement of the complement (13c), etc.

(13) a. **Who** does John like _?
b. **Who** does John think Mary likes _?
c. **Who** does John believe David thinks Mary likes _?

For (13a), one might write an f-structure equation annotating the extracted NP node such as (↑ OBJ)=↓, and augment it with a disjunction for each other available grammatical function – which, by itself, is not very elegant, but seems to adequately account for the facts. To capture (13b), another set of equations must be added to the disjunction, this time with COMP before OBJ: (↑ COMP OBJ)=↓, etc. This already seems like a rather artificial solution, but when (13c) is considered, yet another disjunction is required: (↑ COMP COMP OBJ)=↓, etc. Clearly, the sequence of COMP's can be arbitrarily large (if memory constraints and other extralinguistic considerations are not taken into account), and any grammatical framework must account for such boundless iteration. LFG, in its basic form described above, clearly cannot do so.

Intuitively, what is required is to allow generalizing over sets of functional equations, specifically, introducing disjunction to allow selecting different GFs, and arbitrary iteration of comp. This is achieved by the notion of functional uncertainty, introduced to LFG in Kaplan & Zaenen (1989b). In a nutshell, functional uncertainty extends the LFG notion of function application by allowing function names – x in a statement like $(f\ x)$ – to be regular expressions. Thus, a single f-structure equation may correspond to a (possibly infinite) set of statements. More formally, functional uncertainty defines function application as in (14).

(14) $(f\ \alpha) = v$ holds if and only if f is an f-structure, α is a set of strings, and for some s in the set of strings α, $(f\ s) = v$.

Thus, the distribution in (13) can be captured by a single equation, such as in the following rule for extracted interrogatives:

(15)
$$\begin{array}{lcc} \text{CP} \longrightarrow & \text{NP} & \text{C}' \\ & (\uparrow \textsc{dis}) = \downarrow & \uparrow=\downarrow \\ & (\uparrow \textsc{comp}^{*}\ \{\textsc{obj} \mid \textsc{obj}_{\theta} \mid \textsc{obl}_{\theta}\}) = \downarrow & \end{array}$$

The disjunction in the NP annotation is typically abbreviated as gf, which stands for “any grammatical function” – but which GFs exactly can appear in a given position is construction-specific; for example, adjuncts may or may not be included in the list of gfs. In general, so-called “island constraints” are typically captured in LFG as constraints on paths in functional uncertainty equations (Kaplan & Zaenen 1989b). This correctly predicts that what counts as an “island” varies across languages and across different constructions within the same language.

3.2.4 Inside-out function application and functional uncertainty

Standard function application in LFG is “outside-in”: an expression $(f\ a)$ refers to a feature that belongs to the f-structure f or at any deeper level of embedding. This presupposes a “top-down” style of describing and constraining f-structures. However, it may sometimes be useful to describe constraints on the *external* distribution of an f-structure: for instance, limit the range of attributes it may occupy, or define some features of “sister” f-structures, i.e. f-structures that occupy different attributes in the containing f-structure (e.g., subj constraining attributes of obj). For this, LFG uses an additional mechanism called inside-out

EXPRESSIONS. Inside-out expressions use the same parenthetical notation as ordinary LFG notation, but the f-structure now acts as an argument rather than as a function. Formally, inside-out expressions are defined as follows:

(16) $(a\ f) = g$ holds if and only if g is an f-structure, a is a symbol, and the pair $\langle a, f \rangle \in g$.

Informally, this definition means that $(a\ f)$ refers to an f-structure g (or set of f-structures) whose attribute a has f as its value. For example, in (17), $(\textsc{a}\ g) = f$ holds because $(f\ \textsc{a}) = g$ is satisfied.

(17) $_f\begin{bmatrix}\textsc{a} & _g\begin{bmatrix}\textsc{b} & x\end{bmatrix}\end{bmatrix}$

Functional uncertainty can also be extended to cover inside-out expressions by replacing a in the definition above by a regular expression α. The formal definition is as follows:

(18) $(\alpha\ f) \equiv g$ if and only if g is an f-structure, α is a set of strings, and for some s in the set of strings α, $(s\ f) = g$.

Inside-out function application is by its nature a rather limited formal device compared to "outside-in" function application. It is mainly used either to constrain the grammatical functions that an f-structure may occupy, or to constrain the features of a higher-level f-structure. Importantly, it cannot actually be used as the main mechanism of constructing f-structures. For example, one may formulate a defining equation such as $((\textsc{a}\ f)\ \textsc{a}) = f$ to force f to appear in grammatical function A. But this definition will produce an "orphaned" f-structure which can only be integrated with other f-structures by additional "outside-in" statements, which, in turn, make such an inside-out statement redundant.

Which grammatical phenomena is inside-out functional uncertainty used to model? Perhaps the simplest is the restriction of certain grammatical forms to certain syntactic positions. For example, if nominative marking in a given language is always associated with the grammatical function SUBJ, one may avoid referring to a feature CASE, instead adding (SUBJ ↑) to the lexical entries of all nominative nouns. This correctly ensures that nominative nouns are only used in those positions which the grammar defines as being associated with subjects.

Another phenomenon where inside-out function application plays a role is agreement on modifiers. For example, Russian adjectives agree in gender and number with their heads. In standard LFG terms, this means that they are lexically annotated to co-define (together with the head noun) the features CASE and

NUM of the f-structures whose ADJUNCT position they occupy. An adjective like *krasnaja* 'red' (fem. sg.) might have the following lexical entry:[9]

(19) *krasnaja* Adj $(\uparrow \textsc{pred}) = \text{`}\textsc{red}\text{'}$
$((\textsc{adj} \in \uparrow)\ \textsc{num}) = \textsc{sg}$
$((\textsc{adj} \in \uparrow)\ \textsc{gend}) = \textsc{fem}$

A somewhat more exotic phenomenon that inside-out functional uncertainty succeeds at capturing is "case stacking" in Australian languages, where NP-internal dependents are marked not only with the case that indicates their position within this NP, but also for the case that indicates the position of this NP at a higher level. Nordlinger (1998) develops a theory called Constructive Case[10] to account for this behaviour; "stacked" cases are treated as denoting the case values of the f-structures that contain the noun as their complement, via the mechanism of inside-out functional uncertainty.

3.2.5 Local names

F-structures in annotated rules are typically referred to relative to the nodes in the phrase structure rule, i.e. using paths that begin in the metavariables ↑ or ↓. This is sufficient if these paths are uniquely and unambiguously resolved; the relevant reference may just be repeated in all equations that use it. But in some cases functional annotations do not uniquely identify f-structures that should be referred to. This most frequently occurs when functional uncertainty is involved (described in Section 3.2.3), i.e. when paths are regular expressions that can resolve to different f-structures. Another example is when the same set of rules can apply to different f-structures, either in free variation or subject to additional conditions. Consider a hypothetical language where verbal agreement morphology can alternatively define the person and number features of the subject or direct object.[11] In this case, it is of course possible to introduce disjunction of two sets of equations, as in (20), but this clearly misses the crucial generalization that the same features are defined in both disjuncts.

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[9] The set membership symbol ∈ may be used in inside-out statements just as well as it can be used in outside-in statements. $(\textsc{a} \in f) = g$ entails that $(g\ \textsc{a} \in) = f$, which is notationally equivalent to $f \in (g\ \textsc{a})$. See Section 3.3.3.

[10] "Constructive" is, in fact, somewhat of a misnomer: as shown above, inside-out statements cannot actually "construct" anything, but can only test for feature values of f-structures that have already been constructed.

[11] This example is actually not so hypothetical: such an analysis of Dargwa is proposed in Belyaev (2013), where person-number agreement can be associated with either subject or object, and the choice is then "filtered" using a set of OT constraints.

(20) { (↑ subj pers) = 1
(↑ subj num) = sg
| (↑ obj pers) = 1
(↑ obj num) = sg }

A more economical way to formulate this constraint is to introduce a temporary label for the f-structure involved – a local name – and then refer to this name in the two equations assigning person and number features. Normal names in LFG, by convention, are written with an initial % and assigned using the standard equation operators, as in (21):

(21) { %agr = (↑ subj) | %agr = (↑ obj) }
(%agr pers) = 1
(%agr num) = sg

While local names are not very frequent in LFG analyses, their use is essential for some phenomena where there is a need to consistently refer to an f-structure whose identity is not uniquely deducible from its path (set members, functional uncertainty, etc.).

3.2.6 F-precedence

The basic architecture of LFG is devised to be modular, such that different linguistic phenomena are accounted for at separate levels. In the interaction between c- and f-structure, c-structure is exclusively concerned with linear order and hierarchical embedding, while f-structures do not reflect linear order or constituent structure in any way. Therefore, linear order is relevant for most morphosyntactic constraints only in a limited way, insofar as it distinguishes between different c- to f-structure mappings (such as, for example, in English, where Spec,IP is mapped to subject and precedes the verb and Comp,VP). Without extensions to the standard LFG notation, there is no way to state a constraint like "the verb agrees in person and number with whatever NP stands to its left", because agreement features are the domain of f-structure, and functional equations can only refer to f-structure functions, not linear or constituent-based positions.

However, in certain cases linear order does seem to play a role in determining constraints on syntactic relations. A well-known example is the availability of discourse anaphora between adverbial clauses and main clauses: If the antecedent precedes the pronoun, coreference is possible regardless of which clauses the two are located in (22), while cataphora (backwards anaphora) is only possible if the cataphor stands in the subordinate clause (23).

(22) a. [When John$_{\mathrm{i}}$ came], I saw him$_{\mathrm{i}}$.
b. I saw John$_{\mathrm{i}}$ [when he$_{\mathrm{i}}$ came].

(23) a. [When he$_{\mathrm{i}}$ came], I saw John$_{\mathrm{i}}$.
b. * I saw him$_{\mathrm{i}}$ [when John$_{\mathrm{i}}$ came].

Such behaviour has been generalized since Langacker (1969) as "precede-and-command".[12] Coindexation is possible if at least one of the following is true: the antecedent c-commands[13] the pronoun; the antecedent precedes the pronoun.

Similar constraints operate in other languages. For example, Mohanan (1982) argues that in Malayalam, pronouns *must* follow their antecedents. In LFG, such constraints can be captured using the relation of F-PRECEDENCE (Kaplan & Zaenen 1989a), which is a way of introducing linear order constraints in f-structure using the inverse projection ϕ^{-1}, which maps f-structures to the corresponding c-structure nodes.

(24) f *f-precedes* g ($f <_f g$) if and only if for all $n_1 \in \phi^{-1}(f)$ and for all $n_2 \in \varphi^{-1}(g)$, n_1 c-precedes n_2.

The formal definition in (24)[14] essentially means that an f-structure f_1 f-precedes f_2 iff all c-structure constituents that map to f_1 linearly precede the constituents that map to f_2. Given this definition, anaphoric constraints such as precede-and-command may be formulated as the requirement that the pronoun's antecedent f-precede the pronun.

Note that f-precedence is a rather straightforward relation if an f-structure corresponds to a single constituent. In more complex situations, such as when discontinuous constituents are involved, or one of the elements does not have a c-structure exponent, its application is not so intuitive. In particular, in the latter case, null elements f-precede and are f-preceded by all other elements in the sentence, because one of the sets n_1, n_2 is empty. This property of f-precedence is used to analyze the behaviour of null anaphora in languages like Malayalam (Mohanan 1982) or Japanese (Kameyama 1985), where null pronouns behave differently from full pronouns. For such languages, the definition in (24), combined

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[12] The relevance of linear order has been hotly contested in the literature on anaphora, especially in mainstream transformational grammar; for a recent take on precede-and-command, see Bruening (2014). This is not relevant for our discussion, though, as within LFG no one ever argued against linear-order constraints on anaphora.

[13] In LFG, c-command is replaced by outranking on the grammatical function hierarchy: see Rákosi 2023 [this volume].

[14] C-precedence requires that all daughter nodes of a node precede all daughter nodes of another node – essentially a linear precedence relation for c-structure constituents.

with the generalization in the preceding paragraph, correctly predicts that linear order does not influence the anaphoric requirements of null pronouns (Dalrymple et al. 2019: 257).

An alternative definition of f-precedence, that leads to a different treatment of null pronouns, is proposed in Bresnan et al. (2016: 213):

(25) f f-precedes g if and only if the rightmost node in $\phi^{-1}(f)$ precedes the rightmost node in $\phi^{-1}(g)$.

Under this definition, null pronouns in fact do not f-precede and are not f-preceded by any constituent, because their inverse projections lack a rightmost node. To capture the data of Japanese or Malayalam using this definition, a different, negative formulation of the precedence binding constraint should be used: "The domain of a binder *excludes* any pronominal that f-precedes it" (Bresnan et al. 2016: 213, emphasis mine), i.e. the pronoun *must not* f-precede its antecedent. For more information on f-precedence and linear order constraints on anaphora in general, see Rákosi 2023 [this volume].

Thus, the use of inverse projection does allow a degree of influence of linear order on syntactic constraints, in a limited way (as intended): linear order may serve as an additional constraint on relations formulated in f-structure terms, but does not serve as the only or as the main factor determining these relations.

3.3 Attribute value types

3.3.1 General remarks

The system of attribute values in the core LFG architecture is very straightforward. There are only three types of values: atomic values, semantic forms and other f-structures (of which sets are a special instance).

The simplicity of this system follows from the fact that, as mentioned above, LFG has no type system for f-structures. This means that the list of potential attributes and their values for any given f-structure is defined only by annotated phrase structure rules and lexical entries. Thus, there is nothing in the formal architecture or in any part of an LFG grammar that would prohibit a "clausal" f-structure to have the feature CASE or a "nominal" f-structure to have the feature TENSE; such constraints are only implicit in the way these f-structures are constructed and mapped from c-structure nodes.

Similarly, the attributes themselves are not by default associated with any specific value type: LFG grammars by themselves contain no stipulation of possible attributes and the values they may take. Only grammatical function values are required to be f-structures, and PRED values to be semantic forms due to Completeness and Coherence (see Section 3.4). Nothing prevents the value for CASE or PERS to be an f-structure rather than an atomic value; in fact, the former option has been used in analyses such as Dalrymple & Kaplan (2000).

This simplicity of the type system may be viewed as an advantage, as it simplifies the LFG metalanguage without introducing unnecessary redundancy (see Asudeh & Toivonen 2006: 412ff. for a criticism of the Minimalist feature system). There are few problems that a more complex type system would solve, as the architecture of a well-defined grammar typically prevents f-structures from being assigned incorrect attribute values. Still, sometimes it is necessary to check that an f-structure belongs to a given type – for example, whether it is nominal or clausal. LFG provides several ways to do so: one might directly check the category of the corresponding c-structure node using an inverse projection (Section 4.1), or check for certain characteristic attributes (such as CASE for nominals or TENSE for finite clauses) using constraining equations. The latter method, however, is error-prone, as the grammar writer has to ensure that all relevant f-structures have these attributes. This issue can be partly remedied using templates (Asudeh et al. 2013), but templates are an optional, purely notational device; care must be taken that templates are used consistently.

Another solution has been implemented in XLE, which allows the grammar writer to optionally use FEATURE DECLARATIONS to describe the restrictions on feature values (Crouch & King 2008). This is a robust system which, if employed properly, can provide grammars with a higher degree of generalization while also decreasing the number of accidental errors in feature descriptions. Unfortunately, it is virtually unknown in the LFG theoretical literature, being meant as an engineering solution rather than a theoretical proposal and limited to computational work that uses XLE (see Forst & King 2023 [this volume] for more detail).

3.3.2 Atomic values

The simplest type of attribute value is an atomic value: essentially a token that represents a given value of a grammatical feature (e.g. ACC for the feature CASE, PRESENT for the feature TENSE, etc.). There is no single agreed-upon set of "standard" features and the valid values they might take: in principle, it is the task of the grammar writer or analyst to determine the set of features required to describe a particular language.

In current LFG practice, there is, however, a set of informal conventions on the general inventory of atomic features. These fall into two types. The first type are morphosyntactic features of the same kind as those standardly used in typology and descriptive grammars: features such as CASE, TENSE, ASP, PERS, etc. An overview of the use of features in syntactic and morphological description can be found in Corbett (2012).

The second type are more technical features that are specific to the LFG understanding of specific syntactic phenomena. For example, Dalrymple (2001: 396ff.) uses the feature LDD (for Long-Distance Dependency) to mark whether an f-structure is available for extraction. If $(f\ \text{LDD}) = -$, the f-structure f cannot be in the path that specifies a long-distance dependency. This feature is checked by an off-path constraint (see Section 3.2.2). These and similar constraints are discussed in more detail in Kaplan 2023 [this volume].

Similarly, features such as PRONTYPE or NUCLEAR are used in Dalrymple (1993), Bresnan et al. (2016) to distinguish between different kinds of pronouns to account for the differences in binding constraints. See Rákosi 2023 [this volume] for more detail.

In spite of the theoretical significance and cross-linguistic ubiquity of such features as LDD and PRONTYPE, it is generally assumed that they are also not universal and not part of an innate grammatical blueprint (although, to my knowledge, this question has never been explicitly discussed in the literature). Thus, while Bresnan et al.'s (2016) approach to anaphora relies on grammar-wide constraints and distinguishes pronouns via their features, Dalrymple (1993) rather assumes that all binding constraints are lexically specified by the pronouns themselves. The latter point of view is supported by the cross-linguistic diversity of binding domains. It might be that both approaches are valid, but the efficiency of each depends on the language in question. Hence, like in many other domains, LFG as a framework is agnostic as to whether cross-linguistic similarities are due to innate, universal constraints or are a result of independent, functionally motivated convergence of grammars in the course of their evolution. Particular analyses can strike a balance between these two factors that explain cross-linguistic similarities.

3.3.3 F-structure

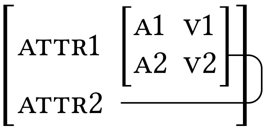
As seen in (11), f-structures can themselves serve as attribute values. F-structures are predominantly values of grammatical functions such as SUBJ, OBJ, etc., and discourse functions such as DIS (or TOPIC and FOCUS in earlier approaches; see Belyaev 2023a [this volume]). F-structures are sometimes also used to represent "compound" attribute values; for example, agreement features are sometimes represented as the “bundle” AGR in (26), and PRED values can be viewed as composite (Section 3.3.4).

(26)
$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{house}\text{’} \\ \textsc{agr} & \begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{bmatrix} \end{bmatrix}$$

Just as different atomic-valued attributes can have identical values, one f-structure can also serve as a value for several attributes. This phenomenon is called STRUCTURE SHARING and is the closest LFG counterpart to the notion of “movement” in transformational frameworks; it is discussed in more detail in Belyaev 2023b [this volume]. This configuration can be visually represented in two ways: either the f-structure is fully spelt out in every occurence (27a), or only once – then the other occurences are connected by lines (27b) or coindexed (27c).

(27) a.
$$\begin{bmatrix} \textsc{attr1} & \begin{bmatrix} \textsc{a1} & \textsc{v1} \\ \textsc{a2} & \textsc{v2} \end{bmatrix} \\ \textsc{attr2} & \begin{bmatrix} \textsc{a1} & \textsc{v1} \\ \textsc{a2} & \textsc{v2} \end{bmatrix} \end{bmatrix}$$

b.



c.
$$\begin{bmatrix} \textsc{attr1} & {}_{f}\begin{bmatrix} \textsc{a1} & \textsc{v1} \\ \textsc{a2} & \textsc{v2} \end{bmatrix} \\ \textsc{attr2} & f \end{bmatrix}$$

Some grammatical phenomena, in particular coordination, adjunction and feature indeterminacy, are represented in LFG via set-valued attributes, as in (28).

(28)
$$f{:}\begin{bmatrix} \textsc{a} & \left\{ \begin{matrix} \begin{bmatrix} \textsc{distr1} & l \\ \textsc{distr2} & m \end{bmatrix} \\ \begin{bmatrix} \textsc{distr1} & l \\ \textsc{distr2} & n \end{bmatrix} \end{matrix} \right\} \end{bmatrix}$$

At first sight, this may appear to violate the notion of f-structure as a function, and the consequent Uniqueness constraint (Section 3.4.1). However, sets in LFG are not multiple values of a single attribute; they are rather viewed as a special kind of f-structure – a *hybrid object* that has both attributes that pertain to it as a whole and attributes whose value is determined based on the values of the set members. This is based on the distinction between DISTRIBUTIVE and NON-DISTRIBUTIVE features.[15] The value of a *distributive* feature for a set is determined as follows:

(29) If a is a *distributive* feature and s is a set of f-structures, then $(s\ a) = v$ holds if and only if $(f\ a) = v$ for all f-structures f that are members of the set s. (Bresnan et al. 1985, Dalrymple & Kaplan 2000)

A distributive feature for a set is only defined as having a value if it has this value in all f-structures in the set. Thus, for (28), the equation $(f\ \text{A DISTR1}) = \text{L}$ is true; conversely, no equation invoking the feature DISTR2 (such as $(f\ \text{A DISTR2}) = \text{M}$ or $(f\ \text{A DISTR2}) = \text{N}$) can be satisfied, since the set elements differ in the value of this feature. Crucially, there is no requirement that distributive features be the same for all elements of a set unless they have been invoked; the structure in (28) is valid as long as the grammar does not assign any value to $(f\ \text{A DISTR2})$.

While distributive features are resolved on the basis of their values for individual members of a set, *non-distributive* features apply to sets as a whole:

(30) If a is a *non-distributive* feature, then $(f\ a) = v$ holds if and only if the pair $\langle a, v\rangle \in f$. (Bresnan et al. 1985, Dalrymple & Kaplan 2000)

In (3.3.3), the value of the attribute A illustrates a set with a non-distributive feature.

(31)
$$f{:}\left[\text{A}\ \left[\begin{array}{l}\text{NDISTR}\ \ \text{N}\\ \left\{\begin{array}{l}\left[\text{NDISTR}\ \ \text{L}\right]\\ \left[\text{NDISTR}\ \ \text{M}\right]\end{array}\right\}\end{array}\right]\right]$$

This notation, standard in LFG work, is meant to represent that, while the feature NDISTR has the values L and M for the individual set members, it has the value N for the whole set. The equation $(f\ \text{A NDISTR}) = \text{N}$ is therefore satisfied regardless of the set members' values of NDISTR.

Distributive and non-distributive features in LFG are used to model different ways in which feature values are resolved and checked in coordination and similar structures. For example, number is typically viewed as non-distributive, because a coordinate NP triggers plural agreement regardless of the number features of its conjuncts. In contrast, case is usually distributive: when a case value is assigned to a coordinate phrase, it must be borne by all its conjuncts. The issue of sets and distributivity with respect to coordination is dealt with in Patejuk 2023 [this volume].

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[15] This distinction is normally understood as being grammar-wide, or even universal; some authors have recently proposed treating distributivity as a property of *feature application*, not features as such; the most recent such account seems to be Przepiórkowski & Patejuk (2012), and similar ideas are explored in Belyaev et al. (2015) and Andrews (2018).

3.3.4 Semantic forms

A semantic form is a special type of attribute value that is exclusively assigned to the attribute pred. Semantic forms consist of the predicate name followed by the list of its syntactic arguments; arguments that are assigned thematic roles are written in angled brackets, while arguments that are not thematic (such as expletive subjects or “raised” subjects and objects) are written outside angled brackets. For example, the pred value for a transitive verb like ‘see’ will be ‘see ⟨subj obj⟩’. A verb like ‘rain’, which has no thematic arguments but an expletive subject, will have the pred value ‘rain⟨⟩subj’. Finally, an “object raising” verb like ‘believe’ will have the pred value ‘believe⟨subj⟩obj’: its subject is assigned a semantic role, while its object is not.

In the preceding paragraph, arguments were represented as mere lists of grammatical function names. This convention, which is followed in much LFG work (see e.g. Dalrymple 2001, Dalrymple et al. 2019), is but a simplification: arguments inside pred values are usually understood as direct references to the corresponding attribute values. Thus, in the left-hand side of (32), the pred value is represented as ‘see⟨(f subj) (f obj)⟩’. As observed in Kuhn (2003: 63), pred values as used in typical LFG representations can be viewed as shorthands for complex structures such as in the right-hand side of (32);[16] fn is an abbreviation for functor; sfid stands for “semantic form identifier”, on which see below. Similar structures are used in implemented parsers like the Xerox Grammar Writer’s Workbench (Kaplan & Maxwell 1996) and the Xerox Linguistic Environment (XLE, Crouch et al. 2011; see Forst & King 2023 [this volume]).

(32)
$$
{}_{f}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{see}\langle(f\ \textsc{subj})(f\ \textsc{obj})\rangle\text{’} \\
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘John’} \\ \textsc{num} & \textsc{sg} \\ \textsc{pers} & 3 \end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘David’} \\ \textsc{num} & \textsc{sg} \\ \textsc{pers} & 3 \end{array}\right]
\end{array}\right]
=
\left[\begin{array}{ll}
\textsc{pred} & \left[\begin{array}{ll} \textsc{fn} & \textsc{see} \\ \textsc{argument1} & \\ \textsc{argument2} & \\ \textsc{sfid} & i \end{array}\right] \\
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \left[\begin{array}{ll} \textsc{fn} & \text{John} \\ \textsc{sfid} & j \end{array}\right] \\ \textsc{num} & \textsc{sg} \\ \textsc{pers} & 3 \end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \left[\begin{array}{ll} \textsc{fn} & \text{David} \\ \textsc{sfid} & k \end{array}\right] \\ \textsc{num} & \textsc{sg} \\ \textsc{pers} & 3 \end{array}\right]
\end{array}\right]
$$

---

[16] I follow the representation used by Kuhn (2003), which does not distinguish between thematic and non-thematic arguments. In XLE, this is implemented by distinguishing between the attributes arg1, arg2, … for thematic arguments and notarg1, notarg2, …. for non-thematic arguments.

If semantic forms were just a bundle of a functor and one or more argument slots, there would be no need to treat them as a special argument value type. What distinguishes them from any other value is their *uniqueness*: each introduction of a PRED value is treated as unique. That is, whenever an expression like (f PRED)=‘FN’ introduces a new semantic form, it is assigned a unique identifier, even if it is lexically identical to another predicate. Thus the equivalence in (33): each PRED assignment is viewed as also introducing an invisible “index” to distinguish between individual PRED values. Thus, if atomic values can be introduced multiple times, PRED values cannot; different grammatical or discourse functions can have the same PRED value only through structure sharing,[17] when the whole f-structure is constrained to be identical. In XLE and other implemented versions of LFG, this uniqueness effect is achieved by including a special feature SFID in the PRED, that is assigned a unique value each time a PRED is introduced in the f-description.[18]

The uniqueness of PRED values is needed to prevent multiple introduction of arguments and will be discussed in Section 3.4.1.

(33)
$$\left\{ \begin{array}{l} (f\ \textsc{pred}) = \text{‘}\textsc{apple}\text{’} \\ (f\ \textsc{pred}) = \text{‘}\textsc{apple}\text{’} \end{array} \right\} \equiv \left\{ \begin{array}{l} (f\ \textsc{pred}) = \text{‘}\textsc{apple}_1\text{’} \\ (f\ \textsc{pred}) = \text{‘}\textsc{apple}_2\text{’} \end{array} \right\}$$

In current LFG research, PRED values mainly serve only to specify argument lists to satisfy Completeness and Coherence, and to provide unique “labels” for f-structures that have PREDs. Even this limited functionality is contested in the literature, with some authors proposing to abandon f-structures in favour of a purely semantic approach, see Section 3.4.4. Originally, however, PREDs were thought to have a more central role, providing a kind of link from syntax to semantics (Kaplan & Bresnan 1982). It is important to observe that PREDs are no

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[17] Or, as an anonymous reviewer observes, through sharing of the PRED value itself, as e.g. in the analysis of adjective coordination in Belyaev et al. (2015).

[18] XLE extends standard LFG by allowing any atomic value to be unique – an *instantiated symbol* notated via a subscript following its name: VAL_. Thus in XLE, semantic forms do not seem to require any special machinery as such. However, an anonymous reviewer observes that if the left-hand side of (32) is indeed the abbreviation of its right-hand side, it should be possible to manipulate argument structure in the syntax via equations such as (↑ PRED ARGUMENT3)=↓. XLE seems to circumvent this by tacitly introducing a negative existential constraint that prevents any additional attributes from appearing in PRED except the ones included at its introduction. This includes both argument features and any other feature names: both the XLE version of the above statement and (↑ PRED FOO)=BAR lead to an existential constraint violation. It is also impossible to “construct” a semantic form using a set of separate statements for the individual features; thus even XLE does technically treat semantic forms as a special value type.

longer viewed in these terms in the LFG literature; the functor names are only arbitrary labels, and all semantic derivation is separate from syntax, being done through Glue Semantics, described in Asudeh 2023 [this volume].[19]

3.4 Well-formedness conditions

There are three conditions that any f-structure must satisfy in order to be treated as valid: Uniqueness (also known as Consistency), Completeness, and Coherence. Any f-structure that violates these conditions cannot be part of a valid analysis of any sentence, regardless of the rules of a particular grammar.

3.4.1 Uniqueness

3.4.1.1 Definition

Uniqueness (Consistency) is the requirement that every attribute in an f-structure must have a single value. Thus, the two equations in (34) do not describe any valid f-structure.

(34) Ill-formed f-structure:

$(f\ \textsc{a}) = \textsc{l}$
$(f\ \textsc{a}) = \textsc{m}$

$${}_{f}\begin{bmatrix} \textsc{a} & \begin{array}{c} \boxed{\textsc{l}} \\ \boxed{\textsc{m}} \end{array} \end{bmatrix}$$

It should be noted that Uniqueness is not, in fact, a constraint that needs to be stipulated separately: it follows from the notion of f-structure as a function, since a function maps arguments to single values (thus defining a one-to-one or many-to-one, but not a one-to-many or many-to-many correspondence).

3.4.1.2 Multiple specification of a value

Uniqueness does not in any way imply that multiple specification of an attribute value is ruled out. When the *same* value is assigned to an attribute two or more times, the resulting f-structure is valid, as seen in (35).

(35) $(f\ \textsc{a1}\ \textsc{a2}) = \textsc{l}$
$(f\ \textsc{a1}\ \textsc{a2}) = \textsc{l}$
$(g\ \textsc{a2}) = \textsc{l}$
$(g\ \textsc{a3}) = \textsc{m}$
$(f\ \textsc{a1}) = g$

$${}_{f}\begin{bmatrix} \textsc{a1} & {}_{g}\begin{bmatrix} \textsc{a2} & \textsc{l} \\ \textsc{a3} & \textsc{m} \end{bmatrix} \end{bmatrix}$$

---

[19] A kind of hybrid approach is proposed in Andrews (2008), which introduces a variant of Glue Semantics where meaning is at least in part derived from f-structure feature values; in this approach, PRED features do play a prominent role in semantic composition.

In (35), the attribute (g A2) is assigned its value three times and referred to in two different ways, but this "history" of its origin is not displayed in the resulting f-structure and is not recoverable from it in any way. This is an illustration of the LFG distinction between a *description* and the *object* that it describes, a crucial feature of LFG that separates it from most other frameworks, where syntactic constraints are usually encoded in the structure itself in one way or another.

Turning to a linguistically meaningful example, this distinction between description and object is manifest in the standard LFG approach to agreement (see Haug 2023 [this volume] for more detail). Agreement targets do not normally have a "copy" of their controller's features; they only lexically specify the same features that are separately specified by the controller. If there is a conflict, the resulting f-structure is invalid. If there is no conflict, the agreement features are displayed in the f-structure once and there is nothing in the f-structure indicating that agreement feature checking has taken place. Compare the Italian examples (49) and (50) below, which map to the same f-structure even though the person-number features are described in two positions in (49) but defined once in (50).

3.4.1.3 Uniqueness and PRED values

One place where multiple specification is virtually prohibited is PRED features, whose values are special objects called semantic forms. As described above in Section 3.3.4, each assignment of a PRED value is treated as a unique object; it is thus impossible to assign a PRED value more than once, even if the value to be assigned has the same functor name.

The reason why PRED values are treated in this way is to ensure that each argument position, and each predicative element in general, is instantiated by exactly one lexical head. Since there is no one-to-one correspondence between c-structure positions and f-structure functions, this cannot, in the general case, be ensured by phrase structure rules alone. Even in a configurational language like English, a displaced constitutent is not directly linked to its "original" (normal, unmarked) position at c-structure; consequently, the c- to f-structure correspondence allows introducing it twice, as in (36).[20]

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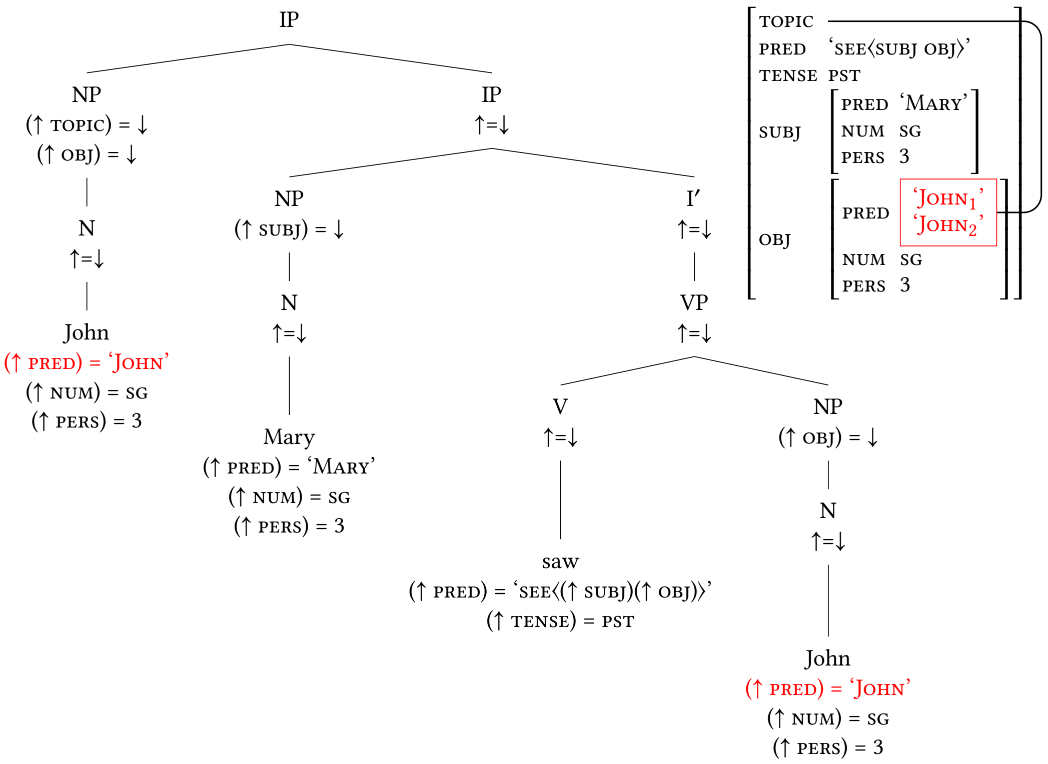
[20] For the sake of exposition, I assume that the topicalized direct object appears as an IP adjunct – this carries no theoretical significance.

(36) Ill-formed f-structure for **John, Mary saw John*:

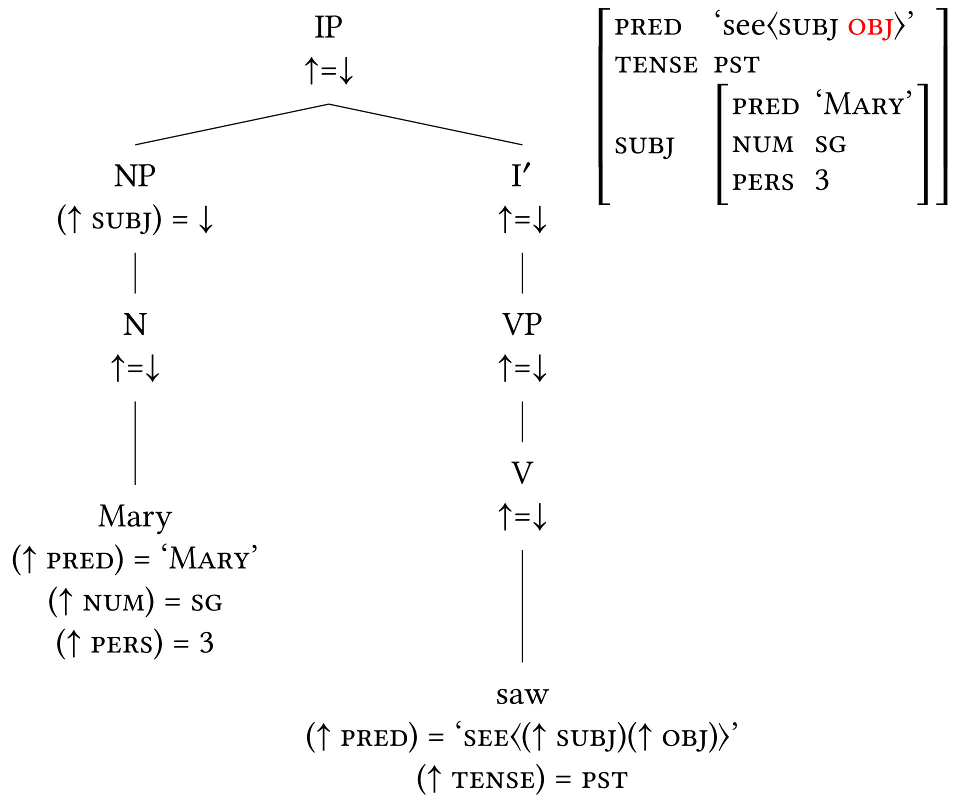


What ensures the ungrammaticality of (36) is precisely the uniqueness of PRED values. This effect is even more pronounced in non-configurational languages, where no c-structure position is tied to any grammatical function, and any number of NPs may be freely mapped to any grammatical function; see Andrews 2023 [this volume] for detail.

3.4.2 Completeness

The Completeness condition requires every grammatical function governed by the PRED value of a given f-structure to exist in this f-structure. In other words, all arguments of a predicate must be "filled" by f-structures. This disallows examples such as (37).

(37) Ill-formed f-structure for **Mary saw*:



C-structure rules cannot be conditioned by argument structure; hence, Completeness violation is the only reason why this sentence is ungrammatical. The c- to f-structure correspondence is otherwise entirely valid.

It is important to understand that completeness only refers to f-structure and has nothing to do with whether arguments are expressed overtly or covertly. Since LFG avoids empty nodes, covert subjects in pro-drop languages do not correspond to any c-structure NP or DP, but Completeness still has to be satisfied at f-structure. This is normally done via equations introducing the pronominal PRED of the subject in the verb's lexical entry: see (48) below.

An additional Completeness constraint has to do with the parameter of semantic argumenthood. It states that semantic arguments (i.e. those whose names stand within angled brackets in the PRED) have to themselves contain a PRED. Conversely, non-arguments (those whose names stand outside angled brackets) are required not to contain a PRED, unless these f-structures are arguments or adjuncts elsewhere (such as, for example, in raising constructions). This is meant to exclude, respectively, expletive arguments in positions where semantic roles are assigned (38), and meaningful NPs in expletive positions (39).

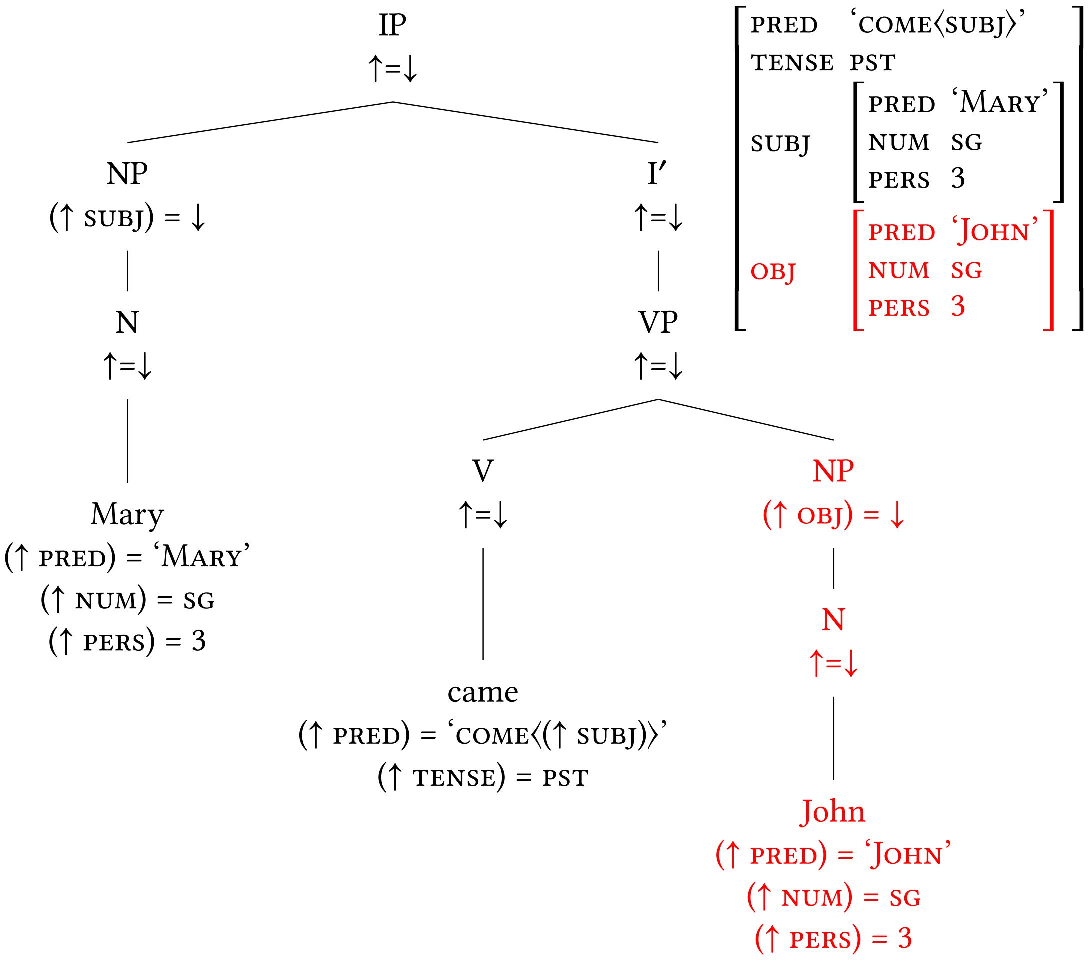
(38) *I saw **there**.

(39) ***The sky** rained.

3.4.3 Coherence

The Coherence condition is the converse of Completeness: no governable functions (i.e. f-structure functions representing grammatical functions such as subj, obj, etc., see Belyaev 2023a [this volume]) may appear in an f-structure without being listed in a pred value. This ensures that no "orphaned" arguments appear in an f-structure, disallowing examples such as (40).

(40) Ill-formed f-structure for **Mary came John*:



Here, again, the c- to f-structure correspondence itself is valid, but the resulting f-structure is incoherent.

The coherence condition only applies to argumental grammatical functions and does not say anything about adjuncts or discourse functions. Where these elements may appear is constrained by a separate condition called Extended Coherence (Bresnan et al. 2016: 63). Extended Coherence requires that the f-structure where adjuncts appear have a PRED value. This ensures that no adjuncts appear in PRED-less f-structures. Discourse / overlay functions (DIS in more recent approaches, TOPIC and FOCUS in earlier work) are required to be linked to a grammatical function in some way: either functionally (via structure sharing) or anaphorically. For more information on the differences between various types of grammatical functions, see Belyaev 2023a [this volume].

3.4.4 Redundancy of PRED?

The description of Completeness and Coherence in this chapter follows the traditional LFG model, which had little to say about semantics; therefore, all valency restrictions had to be modeled at f-structure. Since at least the papers in Dalrymple et al. (1993), Glue Semantics (see Asudeh 2023 [this volume]) has been gaining acceptance in LFG as the model of the syntax-semantics interface. Glue Semantics is resource-sensitive, which automatically ensures both Completeness and Coherence: Completeness, because all premises of the meaning constructor introducing the main predicate have to be saturated; Coherence, because no unused resources have to be left. The role of uniqueness of PRED for ensuring lack of multiple argument introduction / duplicate heads (Section 3.4.1) also follows from Glue semantics due to the fact that any resource can only be consumed once. Therefore, many authors, among others Kuhn (2001), Asudeh & Giorgolo (2012), Asudeh et al. (2014), have argued that PRED features in their original form are no longer necessary in LFG. At least argument lists can, for the most part, be safely dispensed with.[21] Many authors, therefore, continue to use PRED values but only include the name of the functor, not arguments in angled brackets; the remaining role of PRED values is only to provide an index for the f-structure, guaranteeing its uniqueness (that may be relevant for purely syntactic purposes that are not handled in semantics), and to provide information on the lexical content of its head.

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[21] Non-thematic arguments like *it* in *it rained* might still be relevant insofar as they are not selected by any semantic predicate. However, these arguments may be forced to appear using existential constraining statements.

4 The c- to f-structure mapping

4.1 Annotated c-structure rules

The metalanguage discussed in the preceding section can describe individual f-structures, but cannot, by itself, generate or evaluate natural language expressions. F-descriptions must come from somewhere. The only generative component in LFG is c-structure; therefore, phrase structure rules must be coupled with some mechanism that specifies how the nodes in the c-structure tree are mapped to f-structures – the projection function ϕ. In LFG, this is normally done using ANNOTATED PHRASE STRUCTURE RULES where nodes at the right-hand side are supplemented by f-descriptions that reference the c- to f-structure mapping. This referencing is done by introducing two additional notational symbols:

(41) the current c-structure node: $*$
the immediately dominating c-structure node: $\hat{*}$

These are normally not used directly in LFG grammars; instead, two metavariables $\downarrow$ and $\uparrow$ are used, which signify the following:

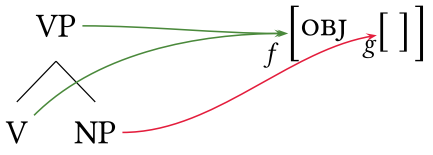
(42) $\downarrow = \phi(*)$ (the f-structure corresponding to the current c-structure node)
$\uparrow = \phi(\hat{*})$ (the f-structure corresponding to the immediately dominating c-structure node)

This notation allows formulating rules of the type:

(43) $$\text{VP} \longrightarrow \underset{\uparrow=\downarrow}{\text{V}} \qquad \underset{(\uparrow\ \text{OBJ})=\downarrow}{\text{NP}}$$

In (43), the annotation for V stands for “this node (V) maps to the same f-structure as the dominating node (VP)”, while the annotation for NP stands for “this node (NP) maps to the OBJ attribute of the f-structure of the dominating node (VP)”. The mapping that this rule defines is illustrated in (44). The nodes VP and V map to the same f-structure labeled as f, while NP maps to the f-structure labeled as g – the direct object of the clause.

(44)



The LFG metalanguage also allows for a notation for the inverse projection ϕ^{-1}, that maps f-structures to the c-structure node(s) that map to them. This mapping is one-to-many and thus, unlike the direct projection, not a function. For example, in (44), $\phi^{-1}(f)$ refers to two nodes: VP and V. The inverse projection is, by design, seldom used and, in fact, rarely required; but it is indispensable for certain construction which place selective requirements on the categorial status of their elements, such as the verb *wax* in examples like *wax poetical*, which is only compatible with an AP complement (the construction is discussed in Pollard & Sag 1994; for an LFG implementation, see Dalrymple et al. 2019: 6.10.3).

4.2 Some consequences of the mapping

4.2.1 Locality

The annotated rule format described in the preceding section is not merely a question of notation; it defines a rather rigid constraint on the way c-structure nodes can be mapped to f-structure. Namely, the mapping is strictly local: it can refer only to the nodes that are involved in a given phrase structure rule. It is not possible to freely traverse the tree and refer to, say, the node dominating the mother node, the child node of the current node, or the root node. LFG assumes that no linguistically meaningful generalizations can be captured using such "long-distance" references. For the majority of cases, this is clearly true, and consequently, there have been no serious attempts to extend the LFG metalanguage in this direction.[22]

However, the strict locality of c-structure to f-structure mapping does create problems for the analysis of certain idiomatic combinations – multi-word expressions (MWEs), as they are called in the literature. Such MWEs often span whole syntactic phrases, and the lexical constraints involved cannot be captured locally. One solution that has been proposed in LFG is to replaced the context-free c-structure by a variant of Tree-Adjoining Grammar (TAG), see Findlay (2017, 2019); this proposal is described in some detail in Findlay 2023 [this volume].

Within the local domain of c-structure rules, the mapping to f-structure is further constrained in that it is only possible to refer to the immediately dominating and current nodes, but not to any of the sister nodes. Unlike the locality constraint, this has been challenged in some LFG literature. For example, Dalrymple

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[22] As observed by an anonymous reviewer, if ↑ and ↓ are only abbreviations of $\phi(\hat{*})$ and $\phi(*)$, it is possible to also use $\phi(\hat{\hat{*}})$ and so on, making annotated rules potentially non-local. As mentioned above, low-level "designators" like $*$ are not normally used in LFG analyses: grammars are expected to operate only with ↑ and ↓.

(2001: 120), Dalrymple et al. (2019: 222–223), developing the ideas of Nordlinger (1998), extend this notation by defining the metavariables <* and *> for "left sister of the current node" and "right sister of the current node", respectively; the corresponding f-structures are $\phi(<\!*)$ and $\phi(*\!>)$. Similarly, XLE defines the metavariables LS* and RS* for the same concepts.

The status of such innovations in the general LFG framework is uncertain. On the one hand, the analyses that introduce such notational conventions make convincing cases that they are necessary for analyzing certain phenomena, or at least vastly simplify such analyses. On the other hand, it is telling – and usually implied – that their use is somewhat exceptional and limited to a handful of specific phenomena. The fact that phrase structure nodes and lexical items do not refer to the information contributed by their left or right sisters in the vast majority of cases seems to be an important cross-linguistic generalization – one that is lost if this possibility is introduced in the formalism. If such formal devices are necessary, additional theoretical stipulations should supposedly constrain their use, but in practice, this possibility is almost never explored.

4.2.2 Monotonicity

As Bresnan et al. (2016: 73ff.) observe, the limitations of the metalanguage described above (even if additional designations like <* and *> are included) lead to several important consequences for grammatical architecture. Specifically, the locality of the c- to f-structure mapping leads to the monotonicity of information flow in the syntax: the f-structure of a larger fragment is always more specific than the f-structure of a smaller fragment.

Let us first consider what "being more specific" means for an f-structure. By definition, f-structures are sets of feature-value pairs. It is clear, then, that g in (45) is more specific than f, as it has exactly the same features and values as f and one additional feature.

(45)
$$ {}_{f}\begin{bmatrix} \textsc{a} & \textsc{x} \\ \textsc{b} & \textsc{y} \end{bmatrix} \qquad {}_{g}\begin{bmatrix} \textsc{a} & \textsc{x} \\ \textsc{b} & \textsc{y} \\ \textsc{c} & \textsc{z} \end{bmatrix} $$

Now consider a more complex case. In (46), f and g have the same features, but intuitively, g is more specific than f because the f-structure value of A in g is more specific than the value of A in f.

(46)
$$ {}_{f}\begin{bmatrix} \textsc{a} & \begin{bmatrix} \textsc{c} & \textsc{z} \end{bmatrix} \\ \textsc{b} & \textsc{y} \end{bmatrix} \qquad {}_{g}\begin{bmatrix} \textsc{a} & \begin{bmatrix} \textsc{c} & \textsc{z} \\ \textsc{d} & \textsc{m} \end{bmatrix} \\ \textsc{b} & \textsc{y} \end{bmatrix} $$

Thus, specificity can be defined recursively: g is at least as specific as f if for every attribute a in f, $(g\,a) = (f\,a)$ or $(g\,a)$ is at least as specific as $(f\,a)$ (Bresnan et al. 2016: 74). This relation is essentially equivalent to subsumption (Dalrymple et al. 2019: 240), and can be notated accordingly: $g \sqsupseteq f$ or $f \sqsubseteq g$ means that g is at least as specific as f, or f subsumes g.

Now recall that every f-description can in principle correspond to infinitely many f-structures that satisfy it. Let us, then, define $\phi(d)$ to be the smallest f-structure ϕ that satisfies d; this gives the mapping ϕ from the set of functional descriptions D to the set of f-structures F. This mapping is MONOTONIC: the larger the f-description d, the more specific the corresponding f-structure f. In other words, $\phi : D \rightarrow F$ has the property that if $d \subseteq d'$ and both d and d' have f-structure solutions, then $\phi(d) \sqsubseteq \phi(d')$.

This property of the mapping between f-descriptions and the corresponding f-structures follows from the nature of the f-structure equations: New equations can only specify additional information about the f-structure or check existing information; they cannot, as it were, "delete" existing feature values or otherwise make the structure less specific.

4.2.3 Fragmentability

Another feature of syntax in the LFG architecture that follows, in part, from monotonicity is FRAGMENTABILITY of language (Bresnan et al. 2016: 79–82). Recall that f-descriptions in annotated c-structure rules can only refer to the f-structures of the nodes involved in the rule (the node at the left side of the rule – the dominating node – and its daughters). This means that, the larger the tree, the longer its f-description; due to monotonicity, the f-structure of a larger tree fragment is, then, always more specific than the f-structure of any of its subtrees. Therefore, a valid f-structure can be constructed for any tree fragment dominating an arbitrary sequence of terminal nodes (a substring of a complete sentence), and this f-structure will not be overridden by any additional information that is contained in the complete sentence (unless it renders the f-structure ill-formed, in which case the sentence is ungrammatical).

Note that this property of the c- to f-structure correspondence does not depend on whether the tree fragment corresponds to a sequence of terminal nodes in a complete sentence; it may even not be a constituent. Any sentence fragment is "self-contained" in the sense that its content is not modified by additional nodes in the tree.[23] Consider the c- and f-structures in (47). Here, the combina-

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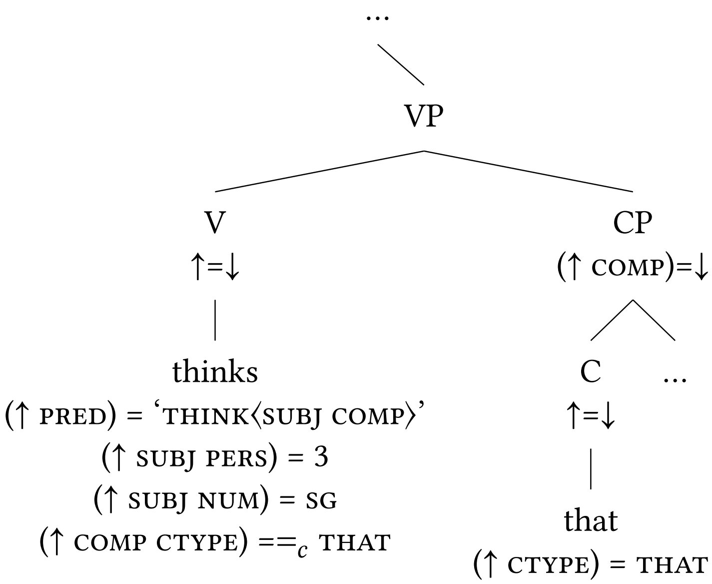
[23] Note, however, that a tree fragment may be ambiguous between two or more interpretations; this ambiguity may be resolved by further material in the tree.

tion "thinks that", which is not even a constituent in a fully formed sentence, contributes the argument structure of the matrix clause, the person and number features of the subject, and the complement type. It can be extended both upwards (with the addition of a subject) and downwards (with the addition of a complement clause), with f-structure information increasing monotonically in both cases.

(47)



$$\left[\begin{array}{ll} \text{PRED} & \text{`THINK}\langle\text{SUBJ COMP}\rangle\text{'} \\ \text{TENSE} & \text{PRS} \\ \text{SUBJ} & \left[\begin{array}{ll} \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{array}\right] \\ \text{COMP} & \left[\begin{array}{ll} \text{CTYPE} & \text{THAT} \end{array}\right] \end{array}\right]$$

Within the non-transformational architecture of LFG, the properties of monotonicity and fragmentability may seem trivial. But this is not so for transformational frameworks, where elements may be extracted from within constituents, thus violating the principle of fragmentability: sentence fragments may become modified during derivation, losing some of the information they initially contain. Fragmentability captures the fact that sentence fragments frequently occur in natural discourse and are parsed without effort by native speakers.

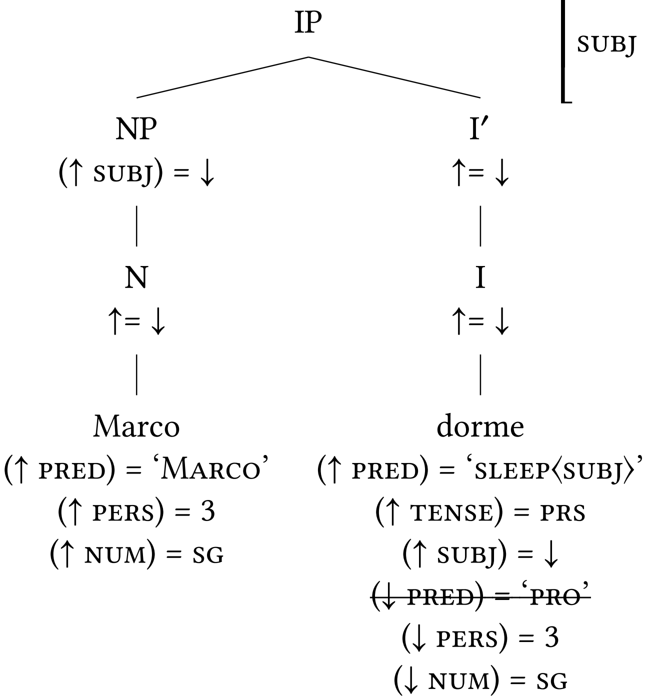
4.2.4 Non-configurationality

Another consequence of the mapping between c- and f-structure is NON-CONFIGURATIONALITY of language. This property means that information in the f-structure does not necessarily correspond to specific positions in the tree. Thus, features of a single constituent may be "collected" from several nodes or assigned several times in different positions. This is usually related to the interaction between syntactic and morphological encoding.

For example, in Italian, a pro-drop language, a third person singular verb form might be defined as in (48) – with the optional assignment of a pred feature to the subject (the standard analysis of pro-drop in LFG). If there is a subject NP in Spec,IP, this annotation is not selected, as it would lead to a pred conflict. If, however, there is no overt subject, this annotation *must* be used, because otherwise the resulting f-structure would violate Coherence: subj would have no pred value. Both options can be seen in (49) and (50).

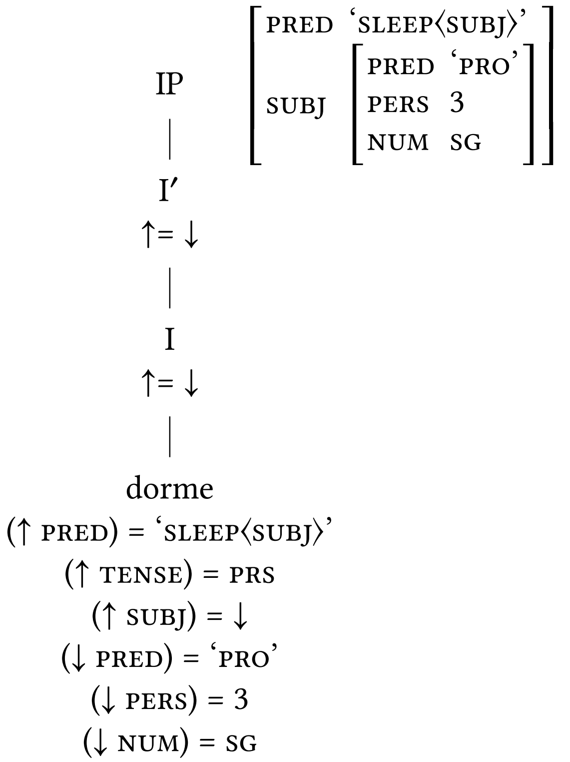
(48) *dorme* V (↑ pred) = ‘sleep⟨subj⟩’
(↑ tense) = prs
(↑ subj) = ↓
((↓ pred) = ‘pro’)
(↓ pers) = 3
(↓ num) = sg

(49)



$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{sleep}\langle\textsc{subj}\rangle\text{’} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘Marco’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{bmatrix} \end{bmatrix}$$

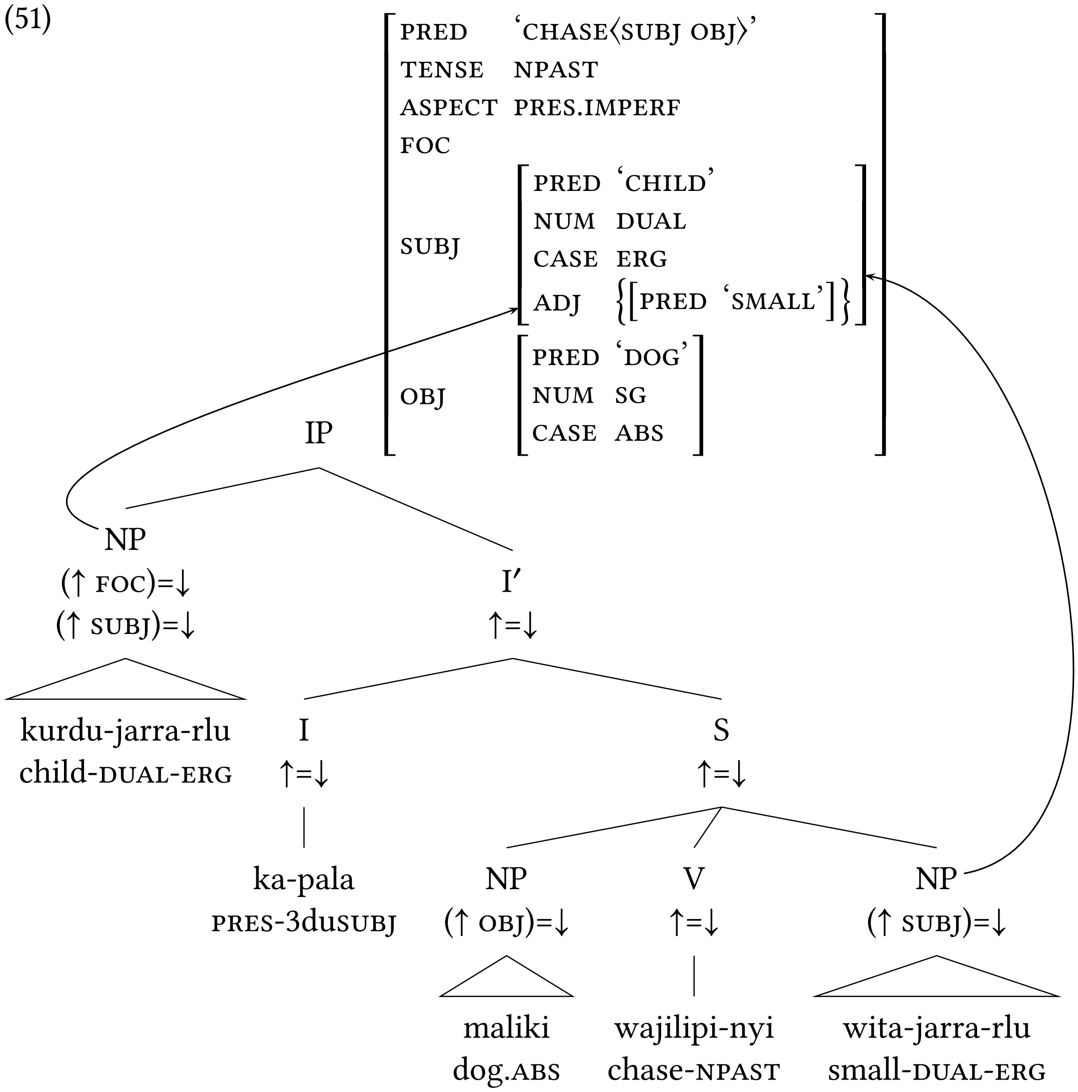
(50)



Thus, in Italian, the PERS and NUM features of the subject are always assigned at the I node, and they may also be assigned at the N head, if it is present. The PRED feature, in contrast, can be supplied either at the I node (if no overt head is present) or at the N node. This means that even in languages with relatively rigid word order and clausal phrase structure such as Italian (and English, although examples are less illustrative; see Bresnan et al. 2016), there is no universal mapping between c-structure positions and f-structure features.

"Non-configurationality" is usually understood in a more narrow sense, describing languages with no evidence for a hierarchical clause structure, such as Warlpiri (Hale 1983, Austin & Bresnan 1996). In (51), from Austin & Bresnan (1996: 229), two NPs, one having a head and the other only specifying an adjunct, map to the same f-structure function SUBJ. Thus information that is split at f-structure is collected together at f-structure.

(51)



These, of course, are only more radical manifestations of the phenomenon illustrated above. In Italian, the features of certain grammatical functions can be defined in different positions, but these positions, at least, are generally fixed, such that the overt subject, if present, occupies the Spec,IP postion, the full NP direct object occupies Comp,VP, and the verb provides the agreement and PRED features of the subject. In radically non-configurational languages, in contrast, there is no association between c-structure positions and grammatical functions at all: any NP daughter of the S node can be mapped to any grammatical function, and any category, not only the verb, can function as the predicate of the clause. Non-configurational syntax and its challenges are described in more detail in Andrews 2023 [this volume].

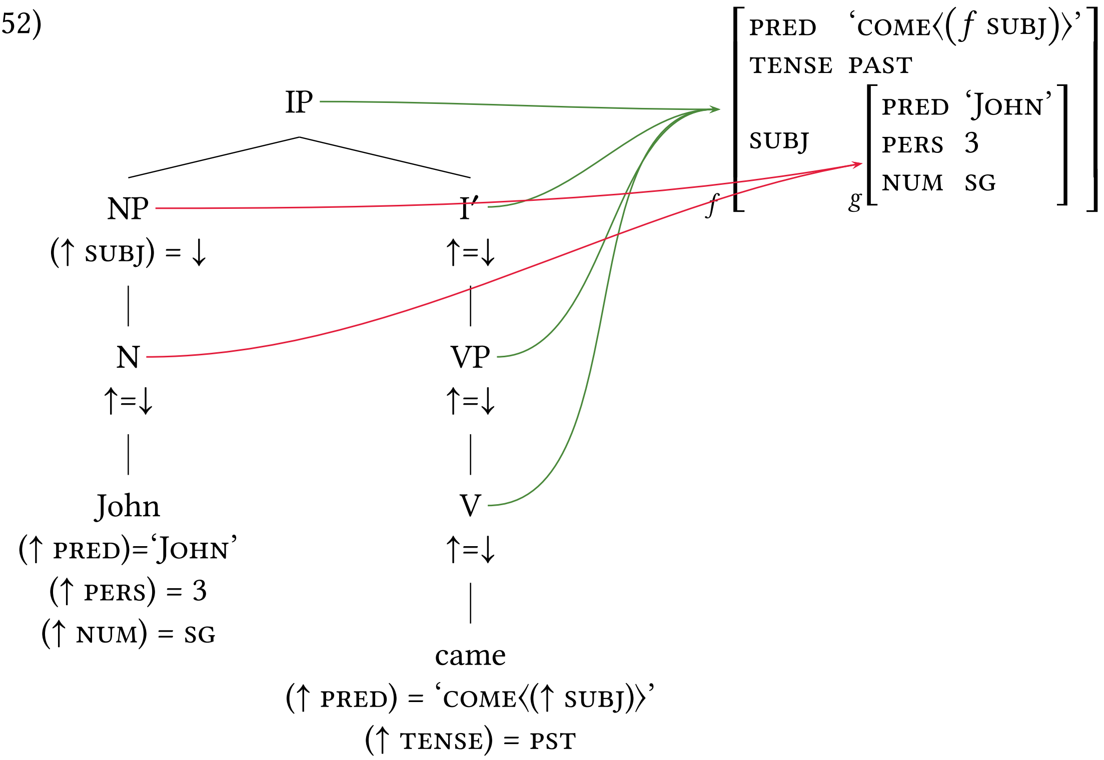
4.2.5 Equality, unification, and non-compositionality

As seen in Belyaev 2023b [this volume] and elsewhere above, statements specifying the equality of one f-structure to another – most prominently, ↑=↓ – play a key role in the LFG c- to f-structure mapping and syntactic analyses. These kinds of statements allow mapping more than one c-structure node to the same f-structure and permit structure sharing and the checking of compatibility of f-structure features. Equality in LFG is very similar in its effects to UNIFICATION found in many other non-transformational formalisms – such that LFG itself is included in the class of UNIFICATION-BASED GRAMMARS in Shieber (1986).

However, as Kaplan (1989: 8ff.) points out, there is a crucial difference between LFG grammars and most unification-based frameworks (GPSG, HPSG, etc.): namely, the distinction between linguistic representations and the *descriptions* of said representations. The clearest case of this distinction are constraining equations, which impose additional constraints on admissible f-structures which, if not violated, do not show up anywhere in the f-structure. Defining equations behave similarly: the same feature may be defined several times in the tree, but the f-structure will contain no trace of its "pedigree": only the resulting feature value will be included.

Another way in which LFG grammars are different from unification grammars is their NON-COMPOSITIONALITY. Even if a c-structure node is annotated with the "unificational" statement ↑=↓, the f-structure it maps to in the complete sentence may contain additional values that are introduced higher in the tree. Thus, in (52) the VP node maps to an f-structure that includes a SUBJ feature that is not introduced anywhere in the VP subtree.

(52)



In a single-tier unificational model like GPSG or HPSG, where the counterpart to f-structure information directly occupies phrase structure nodes together with categorial information, the flow of information would be different: The content of a dominating node would be a function of the content of its children, hence, information contained in VP would be a subset of the information contained in IP. In LFG, as discussed above, *f-descriptions* do indeed increase monotonically, and a *fragment* associated with a node like VP does indeed contain a subset of the information contained in a larger constituent. However, in the full structure, this is not the case: every node mapped to a given f-structure maps to *all* the information contained in this f-structure, even to the information that is introduced only higher above.

4.3 Regularities in the c- to f-structure correspondence

In Section 2.1, I briefly described X′ theory in the way that it is used in most LFG work. However, given that c-structure plays a limited role in LFG compared to the frameworks for which X′ theory was originally devised, in this form it amounts to little more than a system for labelling nodes. In order to give significance to the notion of being a head, a specifier, a complement, or an adjunct, X′ theory must be augmented by f-structure mapping principles.[24] A set of such principles is broadly accepted in LFG, although some details vary. For a more detailed exposition of X′ theory, see Dalrymple et al. (2019), Bresnan et al. (2016).

4.3.1 Heads

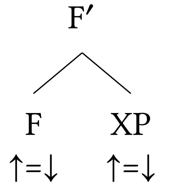
Headedness is a key concept of X′ theory; all projecting nodes, i.e. preterminal nodes (X^0) and intermediate projections (X′), are heads. We saw in all examples above that all projections of a single X′ category are mapped to the same f-structure, and this is for good reason: X-bar theory aims to model endocentricity, and so heads map to a "matrix" f-structure while specifiers, adjuncts, and complements (with the exception of functional categories) map to its dependents. Thus, heads are always annotated as ↑=↓. This principle was first proposed in Bresnan (1982a) and further developed in Zaenen (1983), where it is called the Head Convention. Additionally, XP is also annotated as ↑=↓ when other categories are adjoined to it.

This principle of head annotation allows us to formalize endocentricity as the requirement that every lexical category have a head (Bresnan et al. 2016), or, more correctly, an extended head (see below), because some phrases can have a lexically instantiated functional head but no lexically instantiated lexical head.

4.3.2 Complements

Complements are annotated differently depending on whether they are attached to functional or lexical heads. In essence, functional projections are little more than extensions of lexical projections, and generally map to the same f-structure: for example, CP, IP and VP map to the same clausal structure, while DP and NP map to the same nominal structure. Thus, complements of functional projections are f-structure co-heads, annotated as ↑=↓ (53). The heads of functional categories are known as extended heads of lexical categories; a formal definition of extended head can be found in Bresnan et al. (2016: 136).

(53)



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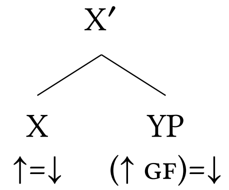
[24] It is by no means implied that these principles dictate the *only* annotations that can be associated with a given node: additional annotations are not only possible, but sometimes even required to produce a valid f-structure (for example, dis must usually be associated with a grammatical function).

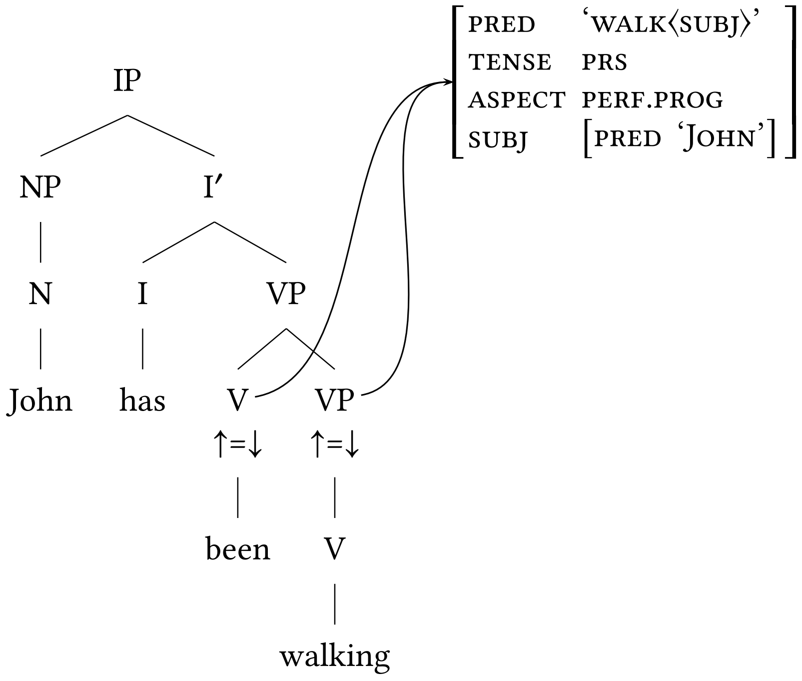
Complements of lexical projections are assigned to various functions of their heads' f-structures. Most typically these are, more specifically, grammatical functions, i.e. those functions that are governed by predicates and have no additional discourse significance (54); the label gf stands for "grammatical function" and includes such notions as subject (subj), direct object (obj), secondary object (obj$_\theta$) and oblique (obl$_\theta$). In Bresnan et al. (2016), this is formulated as a strict requirement that the complement may be any grammatical function except subj (which, in their model, is both a grammatical and a discourse function, see Belyaev 2023a [this volume]). However, this restricted understanding of lexical complements is not universally accepted. For example, Laczkó (2014) analyzes postverbal subjects in Hungarian as occupying the same position as postverbal direct objects, i.e. VP complements.

(54)



Complements of lexical heads may also behave in the same way as complements of functional projections, i.e. be annotated as ↑=↓. This possibility should be allowed for to handle cases where the same f-structure extends over more than two projections, e.g. in certain English auxiliary constructions (55), see Bresnan et al. (2016: 111).

(55)



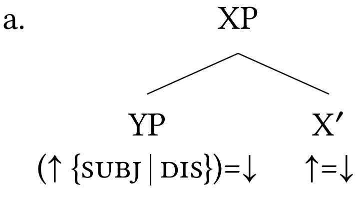
The higher VP in this case thus operates as a kind of intermediate functional projection. An alternative solution would be to introduce an additional functional projection for English, but this does not seem justified as the forms used in these positions are identical to V complements of simpler auxiliary constructions. At the same time, the X′ model itself is obviously too simplistic to describe the full system of constraints on the English system of verbal periphrasis. This requires reference to morphological features of c-structure nodes; see Forst & King 2023: Section 2.2 [this volume] for a discussion of complex c-structure categories which can encode such information.

4.3.3 Specifiers

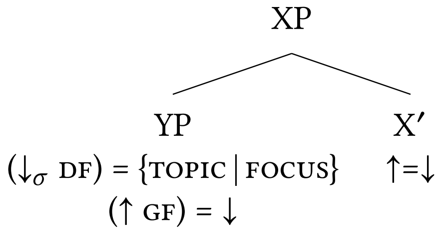
Specifiers are similar to complements in that they are mapped to f-structure positions in the f-structure of their heads. In the literature on LFG, there are two views on exactly what functions specifiers can be mapped to. The traditional approach as described in Dalrymple (2001), Bresnan et al. (2016) is that specifiers map to DISCOURSE FUNCTIONS (DF), which consist of TOPIC, FOCUS and SUBJ (which is unique in being simultaneously a grammatical function and a discourse function). However, a trend in much LFG work (King 1997, Butt & King 1997, Dalrymple & Nikolaeva 2011) is to eliminate information structure functions from syntax, instead relegating them to a separate projection, i-structure. Thus Dalrymple et al. (2019) instead propose that specifiers must be *either* syntactically prominent or prominent in information-structure terms. Syntactic prominence means that the f-structure of the specifier is either the subject, or it bears the overlay function DIS (which replaces the earlier TOPIC and FOCUS and handles long-distance dependencies). Discourse prominence means that the specifier occupies the discourse functions TOPIC or FOCUS at i-structure.[25] This question is discussed in more detail in Kaplan 2023 [this volume].

According to this approach, then, specifiers can be given annotations as in either (56a) or (56b):

(56) a.



b.



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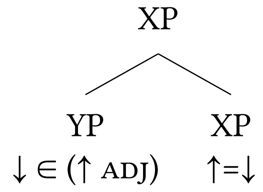
[25] In contemporary LFG, discourse functions are usually modeled not in f-structure but in a separate projection: see Kaplan 2023 [this volume] for more information. The notation in (56) follows the model of information structure in Dalrymple & Nikolaeva (2011).

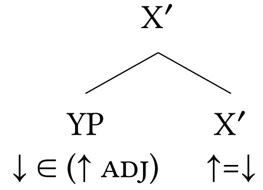
4.3.4 Adjunction

Unlike specifiers and complements, adjuncts may be freely iterated.[26] Naturally, then, they tend to be associated with the only grammatical function that is always set-valued,[27] ADJ (or XADJ), see (57). As new adjuncts are added to the tree, they get added to the adjunct set, thereby not violating uniqueness.

(57) a.



b.



C-structure adjuncts do not always map to f-structure adjuncts, however. Extraposed focused or topicalized material is often adjoined at c-structure, especially at XP level; it is then associated with an information structure function like TOPIC or FOCUS, a grammatical function, and the overlay function DIS.

Some analyses also use adjunction as the main mechanism of introducing grammatical functions, not only adjuncts, into the f-structure, without them having any special information structure role. A prominent example is the analysis of Japanese and Korean in Sells (1994, 1995). Building on the ideas of Fukui (1986), Sells proposes that the maximal projection in Japanese and Korean is X′, and that the main sentence-building operation is the adjunction of verbal arguments and adjuncts to V′, and nominal dependents to N′. Adjunction of this sort can be described in LFG notation by rules such as (58), where GF is any grammatical function. Unlike flat structures of non-configurational languages, the resulting structures like (59), from Korean, are binary-branching, but the use of unrestricted adjunction of this kind ensures that the order of constituents is free.

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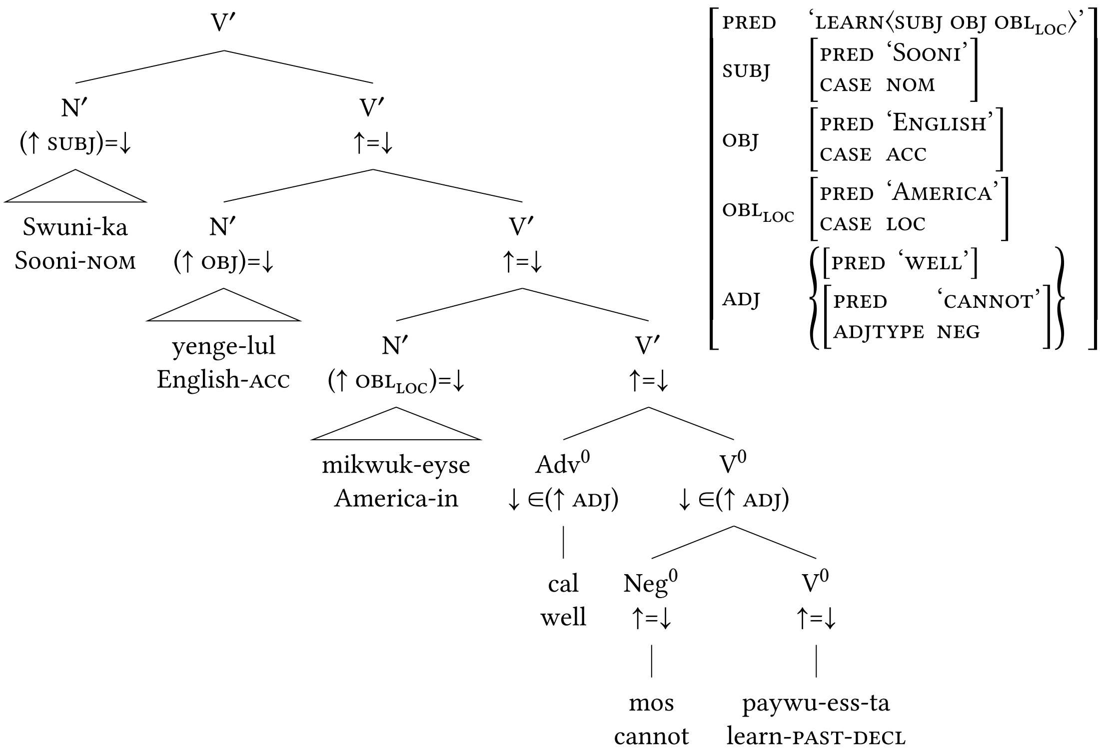
[26] As noted in Section 2.1, some versions of LFG X′ theory allow multiple complements or specifiers. However, this is not the same as adjunct iterations, because, if multiple complements or specifiers are used in a grammar, these receive different annotations, thereby not causing a conflict. In contrast, multiple application of the same adjunct rule will lead to a uniqueness violation if it selects the same grammatical function.

[27] Due to the possibility of coordination, all grammatical functions can be set-valued. However, this requires the use of a special syntactic configuration at c-structure, whereas adjuncts are set-valued "by definition".

(58) $$\begin{array}{llll} \text{X}' & \longrightarrow & \text{Y}' & \text{X}' \\ & & (\uparrow \textsc{gf}){=}\downarrow & \uparrow{=}\downarrow \end{array}$$ (Sells 1994: 354)

(59)



‘Sooni did not learn English well in America.’ (Sells 1994: 355)

4.3.5 The category S

As discussed above, the category S, being by definition exocentric, does not have a head in the X′-theoretic sense. This does not mean, however, that it has no head in the sense of c- to f-structure mapping, i.e. no node that is annotated as ↑=↓. In fact, S usually includes at least one such node that represents the predicate; for example, in (7), representing the clause structure of Tagalog, the predicative XP is annotated as ↑=↓, which causes the f-structure of the clause to be unified with the f-structure of the predicate, regardless of what its c-structure category may be.[28] Moreover, unlike X′-theoretic structures, a nonconfigurational S node can have more than one head: for example, a V node representing the lexical verb

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[28] The actual developed analysis can be somewhat more complex, as there are several views on nonverbal predication in LFG, and the (non-)identity of its structure to that of verbal predications.

and an Aux node representing an auxiliary that contributes tense, agreement and other grammatical information.

It is remarkable that S is the only systematic exception from the X′ schema[29] that is admitted in mainstream LFG, at least in theory. While the use of S for both nonconfigurational and "partially non-endocentric" languages like Tagalog or Irish is universally accepted as a valid and theoretically solid decision, there has been no discussion of exocentric NPs or other categories in the literature. Whether this represents a lack of empirical evidence for such structures in languages of the world, or is simply the result of a lack of focus and a kind of predetermined conviction, is not clear.

4.3.6 Optionality of c-structure positions

Now that X′ theory is supplemented by f-structure well-formedness constraints and annotation principles, we can introduce an additional feature of LFG c-structures: ECONOMY OF EXPRESSION, which amounts to optionality of most nodes, because the relevant grammatical constraints are for the most part captured at f-structure. This broad principle is formulated in the most radical way in Bresnan et al. (2016: 90), who state that *all* nodes (including nonbranching intermediate X′ projection nodes, heads, complements and specifiers) are optional:

(60) ECONOMY OF EXPRESSION:
All syntactic phrase structure nodes are optional and are not used unless required by independent principles (completeness, coherence, semantic expressivity). (Bresnan et al. 2016: 90)

Note that this is a *theoretical* principle whose *formal* implementation is a separate issue, partly discussed in Section 5.2.1. For example, in the standard phrase stucture rule formalism, the notions of complement and specifier crucially depend on the presence of intermediate X′ nodes, even if these are redundant in the sense of unary branching. Thus, as Dalrymple et al. (2015) observe in their detailed discussion of economy of expression, this principle leads to a proliferation of rules, such as in (61).

(61) X′ ELISION (Dalrymple et al. 2015: 384)
If an LFG grammar G_G contains an annotated rule of the form

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[29] It is also the only consistent exception from endocentricity, although, as an anonymous reviewer observes, the X′ theory elaborated in Bresnan et al. (2016) only requires endocentricity for lexical, not functional, projections (p. 137), thereby allowing, among other things, the standard treatment of mixed categories (Bresnan et al. 2016: 311ff.).

$$\begin{array}{cccccc} \mathrm{XP} & \longrightarrow & \alpha & \mathrm{X}' & \beta \\ & & & \uparrow=\downarrow & \end{array}$$

it also contains a rule of the form

$$\begin{array}{cccccc} \mathrm{XP} & \longrightarrow & \alpha & \mathrm{X} & \beta \\ & & & \uparrow=\downarrow & \end{array}$$

In general, Dalrymple et al. (2015) conclude that economy of expression is plausible as an informal principle that emerges through the interaction of other, more basic principles, and that grammars, in general, tend to obey; but it is not plausible as a formal principle to be incorporated into the theory of grammar, because it not only introduces additional complexity into the framework, but also fails to account for cases of genuine non-optionality (such as, for example, in configurational languages where certain nodes are obligatory regardless of independent principles).

Still, the degree of optionality commonly allowed in LFG grammars is rather large and certainly greater than what is assumed by most other phrase-structure-based frameworks. I will now go through each of the X′ theoretic categories and show why they can be optional (except adjuncts, because these are optional by definition, by virtue of the rules that introduce them).

4.3.6.1 Complements and specifiers

Complements and specifiers not only can but must, as a rule, be optional because the c-structure does not contain any valency information and there is no way to verify at c-structure if, for example, the verb has a direct object. Thus, the rule in (43), repeated in (62), will hold for all English sentences, but the NP complement will only be licensed in transitive clauses.

(62) $$\mathrm{VP} \longrightarrow \begin{array}{c} \mathrm{V} \\ \uparrow=\downarrow \end{array} \left(\begin{array}{c} \mathrm{NP} \\ (\uparrow \textsc{obj})=\downarrow \end{array} \right)$$

If the verb is transitive (i.e. its PRED feature has OBJ in the list of arguments), omitting the complement will result in a violation of Completeness (unless the object is introduced in another position). By contrast, if the verb is intransitive, introducing the object here will lead to a Coherence violation, because the grammatical function OBJ will not be selected by any argument.

Optionality of complement and specifier positions, and c-structure positions where arguments are introduced in general, is also required because the material that they “canonically” contain may be displaced elsewhere, for example, to a position designated for wh-movement or information structure function. In this case, only one position must be filled, otherwise conflict of PRED values will lead to a Uniqueness violation. Thus (43) may produce a single V node even in a transitive clause, provided that the direct object is introduced in another position (such as wh-movement *Whom did you see?* or topicalization *John, I saw.*).

4.3.6.2 Heads

Similarly, c-structure heads can be optional in LFG because of Completeness and Coherence. PRED features are almost always[30] introduced by head nodes, i.e. nodes carrying the unificational annotation ↑=↓. Therefore, a structure lacking a head (without its PRED features introduced elsewhere) will be PRED-less and will not be able to include any grammatical functions, because that would violate Coherence.

Headless XPs are quite widespread at clause level; their role is to account for variation in head positions in configurational languages. For example, in English lexical verbs always appear in V, but the I head can be filled or not depending on whether the verb form is periphrastic or synthetic. In German and other V2 languages, the distribution is more complex: the V head is only occupied if the verb form is periphrastic, and the auxiliary, or the finite verb in synthetic forms, stands in the I node in subordinate clauses (63) and in the C node in main clauses (64). Examples are from Bresnan et al. (2016: 448–450).

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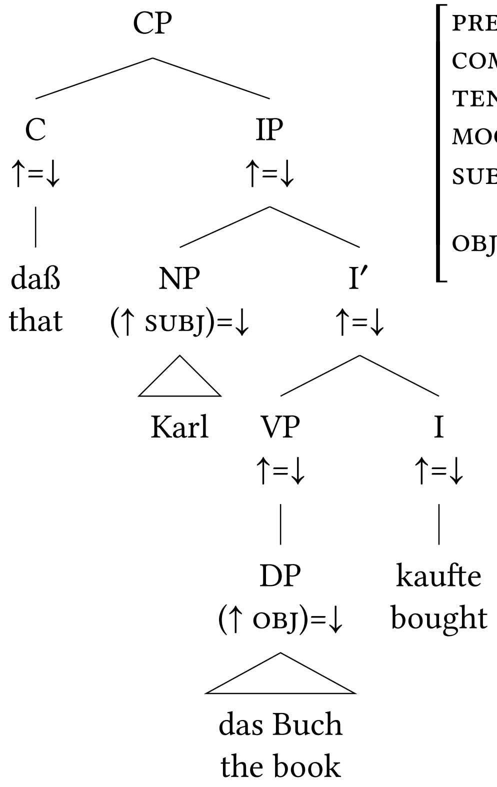
[30] It is technically possible to introduce a PRED feature in a different position. For example, the annotation of a complement or specifier might include an additional annotation like (↑ OBJ PRED)='PRO'. I am not aware of any analyses utilizing this possibility; "external" PRED assignment normally only happens in verbal heads assigning PRED features to pro-dropped subjects and in similar such structures. However, Mary Dalrymple (p.c.) points out that such annotations seem to be required in asyndetic relative clauses like *The man John saw*, where the pronominal OBJ in the relative clause has to be introduced by a phrase structure rule since there is no lexical material that could plausibly contribute its content.

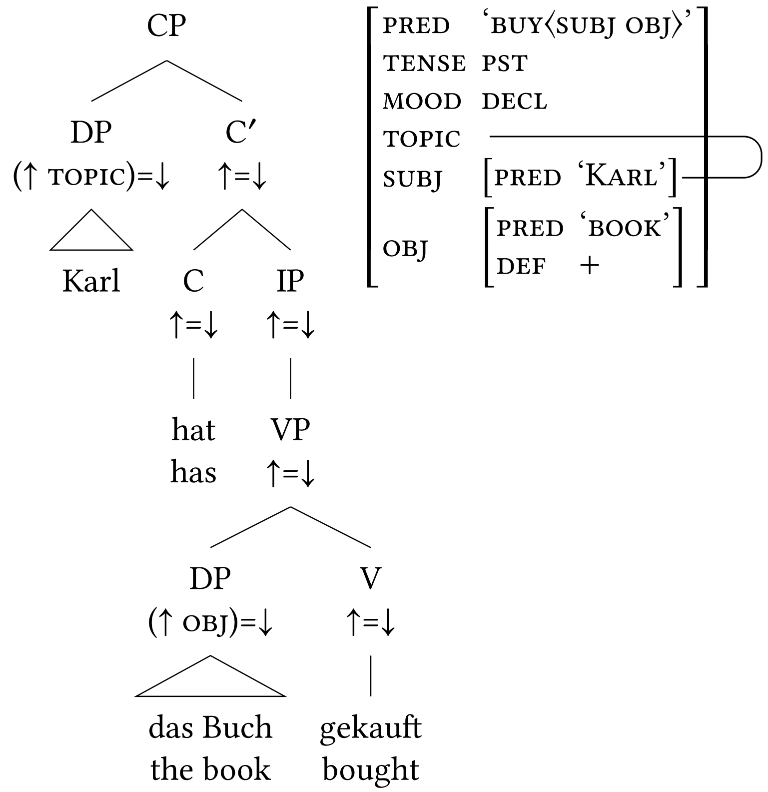
(63)



$$\left[\begin{array}{ll} \textsc{pred} & \text{‘buy}\langle\textsc{subj obj}\rangle\text{’} \\ \textsc{comptype} & \textsc{that} \\ \textsc{tense} & \textsc{past} \\ \textsc{mood} & \textsc{decl} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{Karl}\text{’} \end{array}\right] \\ \textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{book}\text{’} \\ \textsc{def} & + \end{array}\right] \end{array}\right]$$

‘that Karl bought the book’

(64)



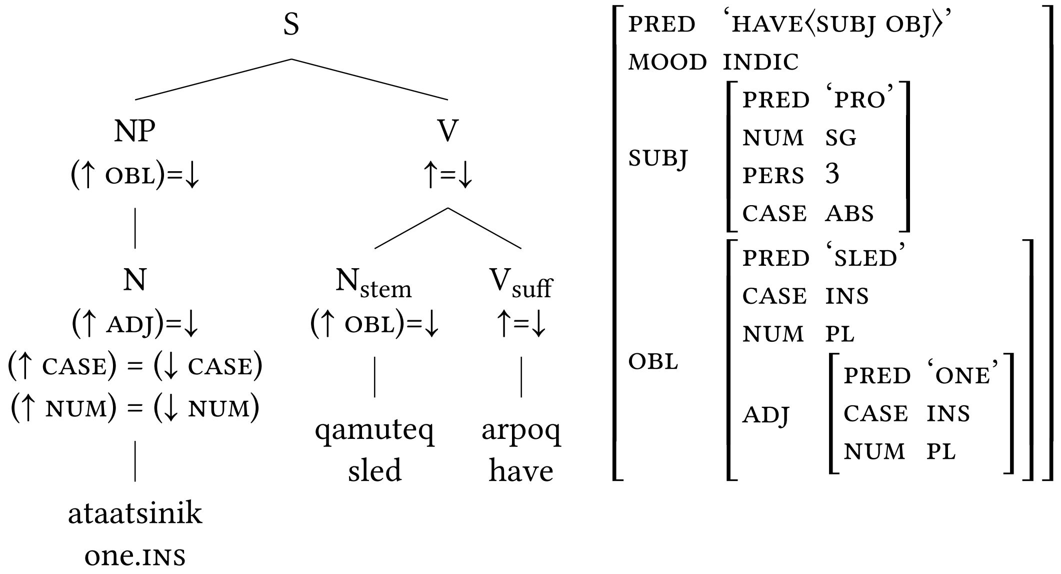
‘Karl has bought the book.’

This analysis corresponds quite closely to the standard view of German word order in GB / Minimalism, such as Vikner (1995). The key difference is that there is no verb movement in LFG; verbs and auxiliaries are always “base-generated” in C, I, or V depending on clause types and the verb form. The correct word order is ensured by feature licensing; multiple occurences of a verb form or verbless sentences are excluded at f-structure through Uniqueness and Coherence.

Another type of headless XP occurs in languages which allow freely discontinuous constituents, like the example from Warlpiri in (51) above. Non-configurational languages like Warlpiri allow freely assigning any grammatical function to Spec,IP (which is additionally interpreted as a focus) and to any NP children of S. Hence, two or more NPs might be mapped to the same grammatical function; if there is no PRED clash or case mismatch, the resulting sentences will be grammatical and these multiple NPs will be mapped to the same f-structure. For more information on non-configurational languages, see Andrews 2023 [this volume].

Finally, headless constituents appear in certain instances of incorporation, such as in West Greenlandic (65), where an incorporated noun head can have non-incorporated dependents (here, agreeing in instrumental case with the incorporated argument).

(65) Greenlandic (Bresnan et al. 2016: 446)



‘I have one sled.’

5 Extensions of the core architecture

The core architecture of LFG has remained remarkably stable since the framework was first introduced in Bresnan (1982a); the only major innovations are the introduction of various additional projections, briefly described in Belyaev 2023b: Section 5 [this volume], and functional uncertainty (earlier LFG used traces to model long-distance dependencies). Nevertheless, there have been proposals to alter and extend the core architecture, mainly from three directions: to adopt a view of c-structure different from context-free grammar; to introduce construction-based approaches to LFG using templates; to eliminate PRED values, fully relegating their work to semantics. None of these approaches have been adopted by mainstream LFG practitioners, with the exception of templates, which have gained some acceptance. Nevertheless, these proposals may represent venues in which LFG could develop in the future.

5.1 Constructions and LFG: Templates

In many ways, LFG is close in spirit to other non-transformational frameworks such as HPSG (Pollard & Sag 1994) or various versions of construction grammar (see Hoffmann & Trousdale 2013). All these frameworks, unlike mainstream generative grammar, are not committed to cross-linguistically universal structures and instead define syntactic rules on a language-by-language basis. However, LFG is crucially different from these other approaches in lacking any concept comparable to the notion of construction. The basic building blocks of syntax are phrase structure rules and lexical entries (which formally are a subtype of phrase structure rules); there is a general set of principles governing the mapping from phrase structure positions to f-structure. It is, of course, possible to define separate phrase structure rules and lexical entries to handle specific phenomena and constructions, but these will not be formally related to other rules – there is no hierarchy of phrase structure rules that would allow defining, for example, an exceptional subtype of a specifier rule. In general, most theoretical principles in LFG (such as the principles of c- to f-structure mapping described above) are formulated in such a way as to define a structure that obtains by default, but which can be overriden in individual languages. This is at odds with the main tenets of construction-based approaches, where no general or universal principles or structures are usually assumed, and each construction hierarchy is language-specific.

Furthermore, while it is possible to define rules that are specific to individual constructions or lexical items, it is impossible to directly define a construction that spans more than the scope of one phrase structure rule (e.g., a specific combination of a specifier, head and complement). Of course, the same effect may be achieved by using combinations of defining and constraining equations, as in analyses of idioms; for an example, see Falk (2001: 77). But such analyses do not treat idioms or constructions as theoretical objects in their own right; the collocation is only enforced by the combination of equations acting at different levels.

These “limitations” related to the c-structure to f-structure correspondence are not necessarily disadvantages of the LFG system: they are the result of a conscious design decision that influences the way LFG analyses are structured; in most cases, it is possible to account for “construction-based” phenomena in LFG, but the description will be different than in Construction Grammar and related frameworks. However, there are certainly genuine cases of construction-specific phenomena, such as so-called multi-word expressions (MWEs); these are difficult to describe in standard LFG. A possible, but radical, solution is the replacement of context-free grammar by Tree-Adjoining Grammar (TAG) at c-structure, as described in Findlay 2023 [this volume].

Another reason why some counterpart to the notion of construction might be useful in LFG is that f-structure equations associated with rules and lexical items are not generalized in any way. Thus, nouns may have annotations such as (↑ NUM)=SG and (↑ NUM)=PL, and verbs, (↑ TENSE)=PST, but nothing in the grammar *requires* nouns and verbs to introduce these equations, and there is no place where such generalizations are stated explicitly – in effect, they are only the result of consistency on the part of the grammar writer.[31] This limitation, again, cannot be overcome using a kind of type inheritance system common to construction-based approaches, because that would require a "hierarchy" of f-descriptions. But f-descriptions are only sets of expressions, not objects that can be manipulated or inherit information from each other.

A possible compromise between the description-based approach of LFG and constructions, explored in Asudeh et al. (2013), is based on the use of templates – bundles of grammatical descriptions extensively used in computational LFG, such as in XLE, but also in some theoretical work (Dalrymple et al. 2004, Asudeh 2012). Templates are basically symbols that serve as shorthands for f-descriptions that are substituted for the template call wherever it is invoked in an f-description. For example, the combination of third person and singular number agreement, highly relevant for English grammar, can be abbreviated as the template 3sg (66). This template can then be called as in (67). Furthermore, just like an f-description, a template can be negated; thus, as Asudeh et al. (2013: 19) propose, English unmarked present-tense forms can be naturally captured as in (68a), which resolves to (68b).[32]

(66) 3sg ≡[33] (↑ subj pers)=3
(↑ subj num)=sg

(67) *laughs* V (↑ pred) = 'laugh⟨subj⟩'
@3sg

(68) a. *laugh* V (↑ pred) = 'laugh⟨subj⟩'
¬@3sg

b. *laugh* V (↑ pred) = 'laugh⟨subj⟩'
{ (↑ subj pers) ≠ 3
| (↑ subj num) ≠ sg }

---

[31] Note that in LFG, this issue is distinct from the issue of permissible f-structure attributes and values discussed in Section 3.3. The two are, of course, related, and would have been the same issue in other frameworks, but not in LFG, where, as discussed above, structures are distinct from the descriptions that license them. An LFG grammar may not generalize over *structures* directly (unless feature declarations are used), but it may well generalize over *descriptions*.

[32] Note that such negation tacitly changes the equation type from defining to constraining, because negative statements can only be constraining. This change is not formally problematic, but care should be taken to ensure that other parts of grammar, which may depend on these defining equations, are not compromised.

[33] Asudeh et al. (2013) use := for template assignment, which is a standard assignment operator in some programming languages (e.g. Pascal), also used in computer science.

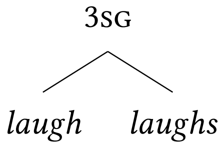
Templates can also be parametric, with parameters supplied in parentheses, as in programming languages. When a template is called, all mentions of each parameter are replaced by the string given in the parentheses. Note that this is done via simple string substitution,[34] and the parameters can be any kind of symbol; often, a reference to an f-structure, but not necessarily. For example, Asudeh et al. (2013) define the following template for intransitive verbs:

(69) INTRANS(P) ≡ (↑ PRED) = ‘P⟨SUBJ⟩’

(70) *laughs* V @INTRANS(LAUGH)
@3SG

Templates by themselves are not theoretical objects: they are a simple mechanism for reusing common parts of f-descriptions. Nevertheless, if used consistently, they can serve as a powerful mechanism for capturing generalizations in grammatical structure. In particular, a kind of hierarchy of templates can be defined if the use of a template in a lexical item, phrase structure rule, or in another template is viewed as inheritance from that template. For example, both *laugh* and *laughs* inherit from the 3SG template:[35]

(71)



Asudeh et al. (2013) use this template system to develop a detailed analysis of the traversal / result construction (*Smithy drank his way through university*, Jackendoff 1992, Goldberg 1995) in English, Swedish, and Dutch. Since this seminal work, templates have been widely used in LFG literature, although their adoption is not universal. Importantly, an advantage of the template-based approach to constructions is that they only introduce a purely notational convention; they

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[34] For this reason, if the parameter is an f-structure reference, it may be ambiguous within a template if it includes Functional Uncertainty. To ensure that the same f-structure is referred to in all expressions, the template should first assign the parameter to a local name.

[35] This may seem counterintuitive, given that *laugh* is not a third person singular form. However, inheritance in this approach is purely a matter of calling a template in the f-description: it does not matter in what context it is called (under negation, in disjunction, etc.). This graph captures the intuition that the English unmarked Present Simple form is defined with reference to the third person singular features (as opposed to, e.g., being a disjunction of all alternative person-number combinations). Note that “inheritance” here is purely a matter of visualization and metagrammatical analysis; it has no special status in the formalism itself.

do not change the architecture of LFG in any way. Thus template-based analyses are fully compatible with non-template-based ones.

This simplicity can also be perceived as a disadvantage, in that constructions are not "first class citizens" of the theory: the template mechanism is unconstrained, and its use is fully optional. However, this follows the overall spirit of LFG: As seen above, the core architecture and metalanguage are relatively unconstrained and certainly more expressive than is needed for the purposes of describing natural languages. Constraints on possible languages are meant to be captured by theoretical generalizations (such as the regularities of c- to f-structure mapping described in Section 4.3) that are not part of the formal framework itself. Likewise, templates only serve as a useful mechanism of generalizing over f-descriptions; what these templates should look like and how consistently they should be used are theoretical decisions that should be viewed as additional constraints on LFG grammars, not part of the formal architecture itself.

5.2 Modifications of c-structure

Compared to developments in other frameworks, such as Minimalism (cf. Adger 2013), there have been few advances in the development of constituent structure in LFG. Apart from the introduction of non-projecting words in Toivonen (2003), the version of X′ theory used in most LFG work is the same as the original version developed in transformational grammar. However, there have been several alternative approaches to c-structure proposed in the literature, some relatively minor while others quite radical. In this section, I will describe two approaches – minimal c-structure (Lovestrand & Lowe 2017) and lexical sharing (Wescoat 2002). Another modification (Findlay 2017, 2019), which replaces context-free grammar with tree-adjoining grammar (TAG) while preserving core features of the LFG formalism, is described in Findlay 2023 [this volume]. Several categorial grammar-based approaches have been proposed (Oehrle 1999, Muskens 2001, Kokkonidis 2007), but have not gained much traction, possibly because they are no longer compatible with standard LFG and have to be regarded as separate, though related, frameworks.

5.2.1 Minimal c-structure

Lovestrand & Lowe (2017) propose a modification of X′ theory to account for two shortcomings that they perceive in its standard LFG version. First, X′ categories and projection levels are stipulated by the theory but not actually represented as discrete features; in formal terms, c-structure node labels are just monolithic symbols, even though they are given a theoretical interpretation. Second, consistent application of X′ theoretic principles leads to many redundant nodes, e.g. unary branching X′ nodes have to be used if an XP has a complement but no specifier or adjuncts. This redundancy is sometimes eliminated by appealing to economy of expression, either by “pruning” the superfluous nodes (Bresnan et al. 2016) or by introducing additional rules into the grammar (such as XP ⟶ X ZP in addition to XP ⟶ X′ YP and X′ ⟶ X ZP). However, both solutions introduce additional complexity into LFG and could be avoided. Third, some analyses work with fewer than two levels of X′ structure: for example, Bresnan et al. (2016: 130) take Welsh IP to lack a specifier, dominating only I and S. Sells (1994, 1995) similarly assumes that all phases in Japanese and Korean have X′ as their maximal projection. This kind of “deficiency” is not formalized in traditional X′ theory.

An earlier attempt to refine X′ theory in LFG is Marcotte (2014), which, however, has been criticized in Lovestrand & Lowe (2017) for failing to account for some common syntactic structures, such as adjunction and non-projecting words. Lovestrand and Lowe propose, following Kaplan (1989), that additional categorial features are projected in a separate feature structure (l-structure) via the function λ. L-structure contains the features L (for Level) and P (for Projection) that represent the “current” bar level of the node and the maximal level that this particular phrase has in the sentence. C-structure itself only contains syntactic category information; thus X, X′, and XP are all represented as X. Lovestrand and Lowe then define a set of templates and rule schemas that describe all the positions allowed by X′ theory. For example, the template EXT in (72a) is a conjunction of the tem1lates LPM (72b) and LP (72c), which mean that the annotated node is a maximal projection (LP) that is a daughter of a maximal projection (LPM). This applies to specifiers and adjuncts. The template HEADX (73a) is used on all X′ theoretic heads and consists of the templates LDOWN (73b) and PUD (73c), which mean that, first, the bar-level of the annotated node is lower than the level of the mother by 1; (b) the maximal projection level is inherited from the head to the overall structure. These templates allow us to define the specifier rule template in (74).[36]

(72) templates for specifier

a. EXT ≡ @LPM ∧ @LP

b. LPM ≡ $(\hat{*}_{\lambda}\ \mathrm{L}) = (\hat{*}_{\lambda}\ \mathrm{P})$

c. LP ≡ $(*_{\lambda}\ \mathrm{L}) = (*_{\lambda}\ \mathrm{P})$

---

[36] For clarity, conjunction is explicitly represented as ∧ in (72a) and (73a).

(73) templates for head

a. HEADX ≡ @LDOWN ∧ @PUD

b. LDOWN ≡ $\{(*_{\lambda}\ \text{L}) = 0 \wedge (\hat{*}_{\lambda}\ \text{L}) = 1 \ \mid\ (*_{\lambda}\ \text{L}) = 1 \wedge (\hat{*}_{\lambda}\ \text{L}) = 2\,\}$

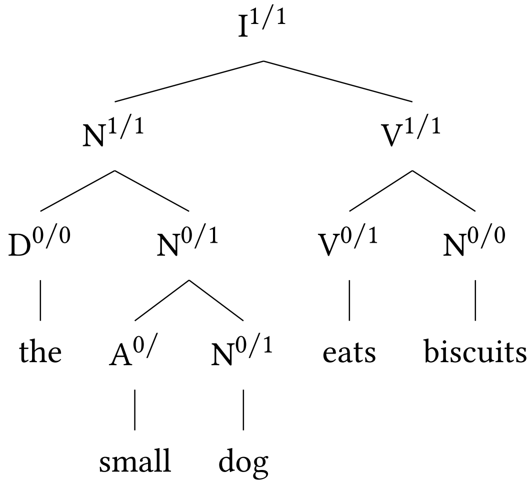
c. PUD ≡ $(\hat{*}_{\lambda}\ \text{P}) = (*_{\lambda}\ \text{P})$

(74) specifier rule

$$\text{X} \longrightarrow \underset{\text{@EXT}}{\text{Y}} \quad \underset{\text{@HEADX}}{\text{X}}$$

The application of this approach leads to c-structures notated as in (75), where the superscript numbers are shorthand for L/P feature values of the node.

(75)



In this example, prenominal A in English is treated as a non-projecting category, hence it lacks the P feature altogether.[37] It is seen from this example that the "maximal" projection level (P) is inherited bottom-up and represents the highest projection that the phrase has in this specific sentence. For example, the specifier noun phrase *the small dog* has a specifier, hence its dominating node has the category $\text{N}^{1/1}$, while the complement *biscuits* has no modifiers, and its head is only $\text{N}^{0/0}$. Thus the system results in minimal c-structures solely by using standard LFG mechanisms of templates and projections, without employing additional formal devices such as Economy of Expression.

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[37] While Lovestrand and Lowe assume no DP in English, D is not treated as a non-projecting word: in their theory, *'s* possessors can attach to D as internal arguments (complements).

5.2.2 Lexical sharing

The principle of lexical integrity, and the general idea that there is a definite boundary between morphology and syntax, has long been criticized in the generative literature (perhaps the most recent such attempt is Bruening 2018) and, recently, in typological approaches (see Haspelmath 2011). Not all of the objections to lexicalism are necessarily applicable to LFG, but one persistent problem is the putative existence of syntactic structure where one lexical item (either completely idiosyncratic or derived in the morphology) occupies two or more syntactic heads. One example are preposition-determiner contractions in languages like French and German (Wescoat 2007): Items like French *au* [o] 'to the (masculine)' (⟵ *à* + *le*) are clearly idiosyncratic, historically motivated mergers of the preposition and the article (compare *à le faire* 'to do it', where *le*, identical in form to the masculine singular definite article, is the object proclitic of *faire* 'do', and thus does not trigger merger), but syntactically, they obey all the constraints that are independently imposed on prepositions and determiners in the language.

To account for such phenomena, Wescoat (2002) proposed LEXICAL SHARING: a modification of the LFG architecture to allow a single word (supplied by the lexicon) to occupy more than one c-structure node. In Wescoat's system, lexical items are no longer part of c-structure; category nodes like N, V, I (preterminals in the standard system) are now terminal nodes that are mapped, via the projection function λ, to morphological words that comprise an ordered list at a separate level of representation, l-structure.[38] In the simplest and most common case, each terminal c-structure node corresponds to exactly one word:

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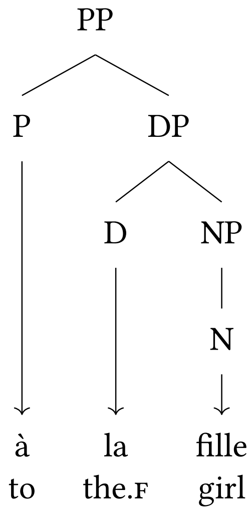
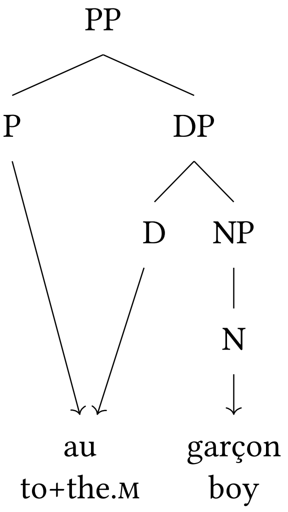
[38] It is unfortunate that the same name of the level and the projection function were independently used in Lovestrand & Lowe's (2017) proposal of minimal c-structure, which creates confusion. However, as will be shown below, Wescoat's approach can be integrated into the contemporary LFG architecture without stipulating an additional level.

(76)



Lexical sharing occurs when two or more terminal c-structure nodes are mapped to one morphological word:

(77)



To avoid excessive reorderings, Wescoat puts a constraint on the correspondence between c-structure and l-structure which he calls the *order preservation axiom*: For all n_1 and n_2 in the set of terminal nodes, if $\lambda(n_1)$ precedes $\lambda(n_2)$, then n_1 precedes n_2. This means that words cannot be reordered. It also follows from this axiom that only adjacent nodes may be shared. Thus lexical sharing is, in fact, rather constrained and does not seem to introduce much additional complexity into the system.

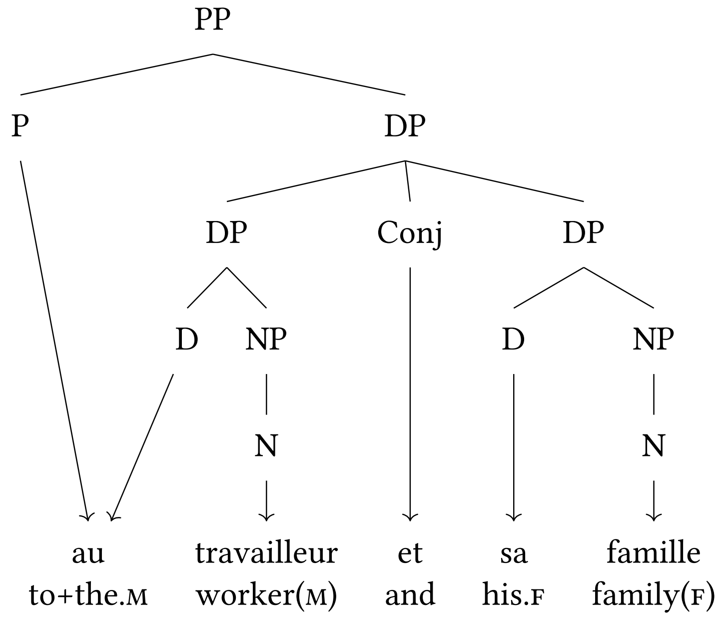
Lexical entries in lexical sharing analyses are defined as in (78), with each node having a separate f-description. The syntactic analysis then proceeds according to the standard f-structure rules defined by the grammar; lexical sharing configurations are licensed if a word is defined as coinstantiating adjacent nodes.

(78) *au* ⟵

P	D
(↓ PCASE)=TO	(↓ SPEC)=DEF
⇓=↓	(↓ GEND) $=_c$ M
	(↓ NUM) $=_c$ SG

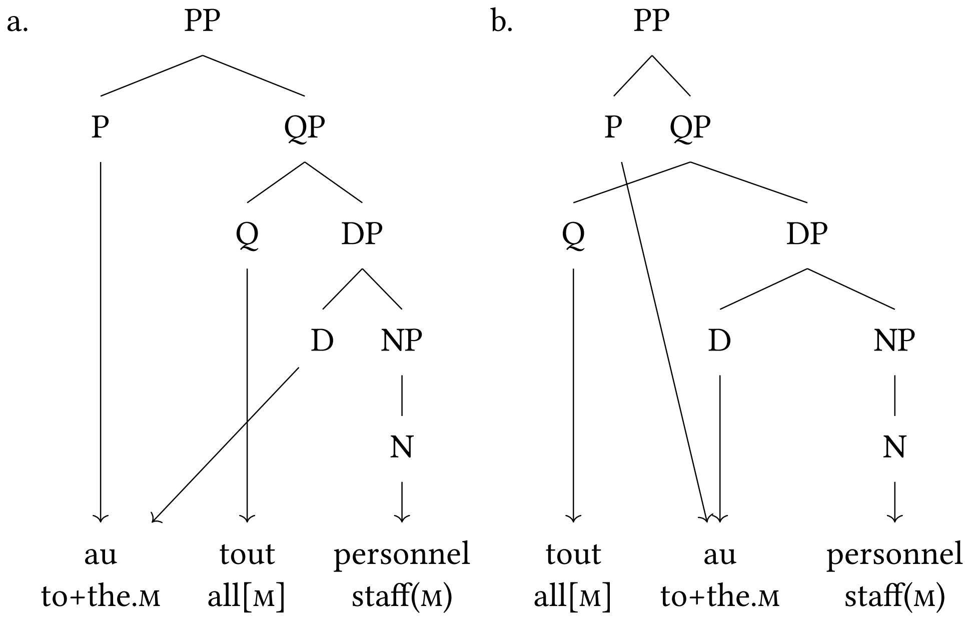
This correctly predicts the scope difference between the preposition and definite article in examples like (79). The order preservation axiom also predicts that structures like (80a) and (80b) are ungrammatical, because the shared nodes are not adjacent; the only possible word order is (81).

(79)



‘to the worker and his family’

(80) Ill-formed c-structures:



(81) á tout le personnel
to all[м] the.м staff
'to all the staff'

Note that Wescoat assumes that the correspondence function ϕ should have l-structure in its domain, hence the use of ↓ in annotations, instead of ↑ in standard LFG analyses. This assumption also motivates the symbol ⇓; this stands for the abbreviation $\phi(\lambda(\downarrow))$, i.e. "the f-structure of the lexical exponent of the current node" – this is needed to determine which of the co-instantiated f-structures the word itself maps to. However, this is not actually required, and Lowe (2016), in his analysis of the English "Saxon genitive" *'s*, proposed a modification of lexical sharing that dispenses with both these additional notations and integrates the proposal into modern mainstream LFG. Lowe observes that Wescoat's "l-structure" in fact serves the exact same function as the s-string – the set of morphosyntactic words that map to terminal c-structure nodes – in the LFG projection architecture, including the recent proposal of Dalrymple & Mycock (2011). Ordinarily, the s-string in LFG maps to terminal tree nodes that are occupied by morphosyntactic words; lexical sharing can be implemented by assuming that the c-structure tree terminates in category labels (preterminals), to which elements of the s-string are mapped. The replacement of l-structure by the s-string means that the symbol ⇓ and all the related machinery is no longer needed, because s-structure does not map to f-structure.[39] For the same reason, lexical entries use ↑, as in normal LFG, instead of ↓.[40] In Lowe's version of lexical sharing, the entry in (78) will look as follows:

(82) *au*: P D
P (↑ PCASE) = TO
D (↑ SPEC) = DEF
(↑ GEND) $=_c$ M
(↑ NUM) $=_c$ SG

While lexical sharing has been used to analyze several phenomena, including auxiliary reduction (Wescoat 2005), preposition-determiner contractions (Wescoat 2007), suspended affixation (Broadwell 2008, Belyaev 2014, 2021), endoclitics (Wescoat 2009), and morphologically bound complementation (Panova 2020), it has not been adopted as part of mainstream LFG, mainly, it seems, due to its apparent violation of lexical integrity and the potential to vastly increase the number of possible analyses. Indeed, if unconstrained, lexical sharing can be used to produce structures where every morphological category has its separate functional projection that is shared with the lexical head, reminiscent of Distributed Morphology (DM, Halle & Marantz 1993). However, as both Broadwell (2008) and Lowe (2016) observe, lexical sharing can be constrained to be used only when there is independent syntactic evidence in favour of a separate lexical head. Under this interpretation, lexical sharing analyses present an advantage over non-lexicalist analyses in that functional heads like CaseP or NumP are only stipulated as needed; for example, in Broadwell's (2008) analysis of suspended affixation, there is an empirical difference between languages where case is realized by a coinstantiated head (these allow suspended affixation) and languages where it is purely morphological (these do not); this opposition is lost in non-lexicalist approaches, where other, arguably less intuitively plausible mechanisms have to be used, such as a constraint on coordinating sub-CaseP constituents, feature deletion (Kharytonava 2012), or morphological ellipsis (Erschler 2012).

Furthermore, as mentioned in Section 2.2, lexical sharing does not really violate lexical integrity as formulated in Bresnan & Mchombo (1995), see (8), i.e. as

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[39] This seems rather harmless, because lexical sharing entries overwhelmingly just use ⇓=↓ on one of the nodes, which doesn't seem to influence anything. However, Wescoat (2007) does use constraints on the l-structure to f-structure mapping to model certain limitations on preposition-determiner contractions in German.

[40] In fact, while standard LFG allows using ↓ in lexical entries, this model does not. This means that analyses that make use of ↓ in lexical entries, such as the Italian example in (48), have to be reformulated to use ↑. In most cases, this should not influence anything, although the definition and application of f-precedence might require some modification.

the general principle that words are built from different blocks and according to different rules than syntactic units. Indeed, syntax does not have any access to internal word structure in lexical sharing analyses, and coinstantiated nodes map to words as complete units, not to morphemes, disembodied features, or anything similar.[41] This gives lexical sharing analyses a distinct flavour that separates them from both mainstream LFG analyses and from truly non-lexicalist analyses that situate morphemes or features in functional projections (which have also been proposed in LFG: see Melchin et al. 2020 for a DM-like approach to LFG morphology). Notably, it still allows an independent morphological module (usually described in LFG in terms of a lexicalist realizational framework like PFM, see Belyaev (2021) and Asudeh & Siddiqi 2023 [this volume]) to do its work.

6 Conclusion

In this article, I have tried to summarize the state of the art of the core syntactic representations of LFG – the c- and f-structures. While the understanding of various phenomena has considerably changed in almost all areas of grammar (for example, in semantics and information structure: see Asudeh 2023 [this volume] and Zaenen 2023 [this volume]), the formal underpinnings of LFG have remained remarkably stable over the years. The only fundamental innovation to the original c- and f-structure architecture of Kaplan & Bresnan (1982) is the introduction of functional uncertainty in Kaplan & Zaenen (1989b). Since then, new levels of projection were introduced, and the architecture extended in various ways, but the core mechanisms of c- and f-structure – notation, featurehood, even the basic set of GFs – have remained constant. This serves as an impressive testimony of the versatility of the architecture proposed in Kaplan & Bresnan (1982), and its remarkable suitability to describing natural languages.

The architecture of LFG is both similar to that of other constraint-based frameworks and very different from them in various ways. The main difference is the parallel architecture of LFG, and the related emphasis on the distinction between descriptions (a set of syntactic constraints) and the structures that are licensed by

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[41] In fact, from a certain perspective this might be viewed as a disadvantage of lexical sharing analyses in that they fail to capture the fact that coinstantiated material usually corresponds to a well-defined, segmental, agglutinatively attached element of the wordform. For example, Ossetic affixal case features are realized on the Case head, while stem-based ones are realized on N (Belyaev 2014, 2021). I am not aware of any analyses where coinstantiated heads encode features that are realized by stem change, suppletion, or apophony. This fact might be explained diachronically, however, since lexical sharing usually reflects an ongoing process of (de)grammaticalization.

these descriptions. While constructions and lexical entries are *structures* in most other frameworks, in LFG they are sets of *statements* that describe a range of possible structures. This architectural feature enables LFG to make use of mechanisms such as functional uncertainty and inside-out application, which are unavailable in other frameworks.

While the empirical coverage of LFG work is impressive, and a number of important developments are now taking place in several theoretical directions, not all areas of syntax have been researched to the same extent. The focus on f-structure and the view of GFs as theoretical primitives has prompted a lot of fruitful and insightful work on subjects and other core grammatical relations. Functional uncertainty and structure sharing have also proved to be efficient mechanisms for describing long-distance dependencies. The notion of sets and feature distributivity allow for elegant analyses of coordination – an area traditionally underrepresented in mainstream syntactic frameworks. In contrast, c-structure has seen much less attention,[42] although here important developments are also taking place. The notion of lexical integrity, assumed as a stipulation early in the history of LFG, has not been extensively discussed and refined, in spite of numerous challenges. These challenges will have to be dealt with if LFG is to compete with other frameworks for the originally envisaged role of "a theoretically justified representation of the native speaker's linguistic knowledge" (Kaplan & Bresnan 1982).

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[42] The reason for this might be that the range of phenomena handled by c-structure is much less than those handled by f-structure, as c-structure only directly models word order and embedding. However, as an anonymous reviewer observes, c-structure in LFG is analogous to Merge in Minimalism, being the main generative component that connects different projections together while also providing codescription for the semantics. This role can hardly be described as minor, but the existing model handles this purpose rather adequately.

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Chapter 3

Grammatical functions in LFG

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Grammatical functions (GFs) such as subject and object play a central role in the architecture of LFG, which makes it quite different from most other formal theories of grammar. In this chapter, I discuss the motivation behind this design decision and the ways in which grammatical functions are distinct from each other: their classification and the properties of certain individual GFs, namely subjects, sentential complements (COMP) and possessors. I also discuss the status of so-called overlay or discourse functions, which serve to specify the status of GFs with respect to additional syntactic constraints.

1 Introduction

One of the distinguishing features of LFG is that grammatical functions (GFs) are first-class citizens of syntactic structure. The set of available GFs is viewed as universal, and each GF is associated with a distinct set of structural properties. Some syntactic rules and generalizations refer to individual GFs directly; others refer to their relative ranking, but, unlike GB/Minimalism (Sells 2023 [this volume]) or HPSG (Przepiórkowski 2023 [this volume]), the ranking itself is directly stipulated and is secondary to grammatical function status. The list of grammatical functions used in most LFG work includes subjects (SUBJ), direct objects (OBJ), secondary objects (OBJ_θ or OBJ2), obliques (OBL_θ), and adjuncts (ADJ), which are familiar from traditional grammar but given more exact definitions in LFG. This list is not arbitrary; it is motivated by the classification of grammatical functions into ungovernable (ADJ) vs. governable functions, terms (SUBJ and OBJ) vs. non-terms, semantically restricted (OBJ_θ and OBL_θ) vs. unrestricted; each class is associated with a distinct expected pattern of behaviour. The list of basic GFs is also

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motivated by the regularity of mapping between semantic roles and their syntactic expression: the cross-classification of GFs into two binary features [±*o*] and [±*r*] and the mapping principles assumed in Lexical Mapping Theory (Bresnan & Kanerva 1989) correctly predict both the regular mappings and their possible permutations. More unusually, LFG also treats certain specialized grammatical functions – namely, clausal complements (COMP), possessors (POSS) and sometimes nonverbal predicates (PREDLINK) – as theoretical primitives on par with subjects and objects.

LFG also uses OVERLAY FUNCTIONS to represent the locus of long-distance dependencies like wh-extraction. These do not formally belong to the class of grammatical functions, but are similar in that they are occupied by the same f-structures that represent clausal participants. In earlier versions of LFG, most overlay functions were called "discourse functions" and also represented information structure notions such as topic and focus. In modern LFG, there is usually a separate level for information structure, and there is no need to duplicate it at f-structure. Instead, a single function, here called DIS, is used for all long-distance dependencies; some authors postulate additional overlay functions to model other grammatical information, such as PIVOT for "pivots" in Falk (2006). To the extent that overlay functions are related to grammatical functions, they will be discussed in this chapter; further information on overlay functions with respect to long-distance dependencies is found in Kaplan 2023 [this volume].

In this chapter, I summarize the key elements of the LFG understanding of grammatical functions. In Section 2, I briefly discuss the formal status of grammatical functions and their role as syntactic primitives in LFG. In Section 3, I describe the main mechanism through which grammatical functions obtain their distinctive properties – their hierarchical ordering and cross-classification. In Section 4, I turn to individual grammatical functions – subjects, objects, and obliques – and discuss their distinctive properties that do not follow from their classification or ranking in the hierarchy. Finally, in Section 5, I discuss overlay functions, which represent additional functions that link clausal participants to the wider sentential or discourse context.

2 General concepts

Grammatical functions in LFG represent all kinds of relations that syntactic dependents may have to their predicates. This includes both grammatical relations like subject, object, or adjunct and additional functions – so-called overlay functions – that situate the event participant in some wider cross-clausal or discourse context (e.g. dis for dislocated – usually topicalized or focalized – elements, or relpro for relative pronouns). The values of grammatical functions are normally also event participants – thus, in the words of Bresnan et al. (2016), grammatical functions can be called "the 'relators' of c-structure to a[rgument]-structure" (p. 94). However, this is not always the case: adjuncts do not appear at argument-structure, and expletive arguments, like *it* in *It rains*, are purely syntactic and do not correspond to any semantic argument.

In formal terms, a grammatical function is any f-structure attribute that has an f-structure as its value[1] and whose occurence is governed by Completeness, Coherence, and Extended Coherence. Completeness requires that features listed as arguments in a pred feature value appear within the same f-structure as this pred. Coherence prevents governable gfs (see Section 3.3) from appearing in f-structures where they are not listed in the pred value. Extended Coherence restricts the occurence of *non-governable* gfs: adjuncts and overlay functions. Adjuncts can only appear in f-structures that have a pred feature (regardless of its value), while overlay functions like dis (for dislocated constituents), relpro (relative pronouns), topic, and focus (see Section 5) must be linked to non-overlay functions through structure sharing or anaphora.

For example, (1) represents the f-structure of the sentence *Peter met Paul in Rome*. The value of the feature pred includes, in angled brackets, the list of arguments that are required by the verb *meet* – in English, this is a transitive verb that selects a subject and an object. These arguments appear as the features subj and obj that have f-structures representing the NPs *Peter* and *Paul* as their values. The PP *in Rome* is not selected by the verb (its occurrence is not obligatory) and is represented as an element of the set-valued feature adj, for adjunct. The preposition *in*, which contributes semantic content, has its own f-structure with the feature pred whose value defines a valency for obj. The nouns *Peter*, *Paul* and *Rome* do not require any syntactic arguments, and hence their pred feature values lack a list of arguments in angle brackets. For more detail on how arguments and adjuncts are licensed at f-structure, see Belyaev 2023a [this volume].

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[1] F-structures appear as values not exclusively with gfs. For example, many authors, among others Alsina & Vigo (2014) and Haug & Nikitina (2015), use the function agr as a "bundle" of agreement features that is an f-structure that never has a pred value and that is neither an argument nor an adjunct.

(1)
$$\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{meet}\langle\textsc{subj}, \textsc{obj}\rangle\text{’} \\
\textsc{tense} & \textsc{past} \\
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘Peter’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘Paul’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\
\textsc{adj} & \left\{\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{in}\langle\textsc{obj}\rangle\text{’} \\ \textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘Rome’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \end{array}\right]\right\}
\end{array}\right]$$

The fact that dependents are represented as values of f-structure *features* is not at all trivial. The term “grammatical relations” used in typology implies that arguments and clauses are viewed as *objects* literally linked to each other via *relations*. Thus, where LFG has $(f\ \textsc{subj}) = g$ (f is a function, SUBJ is an argument, g is the feature value), the intuitive tradition would rather have $\textsc{subj}(f) = g$ (SUBJ is a function, f is an argument, g is the value). The LFG view has certain interesting consequences for the handling of many syntactic phenomena. For example, the Coordinate Structure Constraint (Ross 1967) has no special status in the framework – its effects are of exactly the same nature as the scoping of grammatical features (such as mood or case) over conjuncts in coordinate structures. This is a direct consequence of the fact that grammatical functions such as SUBJ or OBJ are features in exactly the same sense as grammatical features such as CASE or MOOD; for more information, see Patejuk 2023 [this volume].

A core tenet of LFG is that grammatical functions are theoretical primitives; their set is universal and their properties are not derived from other, more fundamental principles.[2]

Viewing GFs as primitives amounts to saying that neither phrase structure relations nor semantics are sufficient to account for all the properties of individual arguments. As discussed in Belyaev 2023b [this volume] and Andrews 2023 [this volume], the mapping from c-structure to grammatical functions is relatively unconstrained. X′ Theory, in formulations like that of Bresnan (2001) and Bresnan

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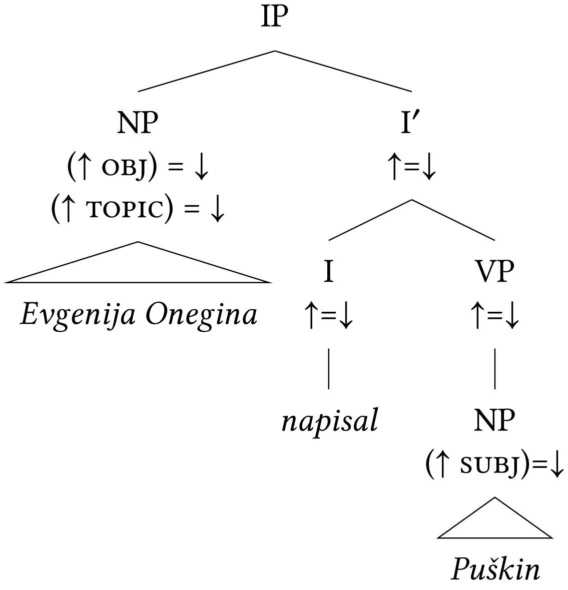
[2] Lexical Mapping Theory (Bresnan & Kanerva 1989) is sometimes interpreted as involving the decomposition of grammatical functions into bundles of two binary features: [±*r*], [±*o*], cf. e.g.: “Basic argument functions are not atomic but decomposable into features” (Kibort 2014). Under this view, it is these features that are primitives, instead of GFs. But lexical mapping theory can also be interpreted as a classification rather than an actual decomposition; this is the position taken, for example, in the Oxford Reference Guide to LFG (Dalrymple et al. 2019).

et al. (2016), does impose certain restrictions, but these are very general and do not impose any specific mapping. For example, it is assumed that complements of lexical projections map to grammatical functions, but no specific mapping is enforced: the complement of VP does not have to map to obj, but can map to any grammatical function, even subj. Thus in King (1995), all postverbal (contrastive) foci in Russian, including subjects (2), are analyzed as VP complements.

(2) Russian (Slavic > Indo-European)
Evgenija Onegina napisal **Puškin**
E.:acc O.:acc wrote P.:nom
'It was **Pushkin** who wrote "Eugene Onegin".'



In fact, a consistent mapping cannot be assumed even in so-called configurational languages like English: while in English declarative sentences, objects appear in Comp of VP, the arrangement changes in interrogative sentences, where objects occupy the clause-initial position (Spec of CP or CP adjunct) but the Comp of VP is left empty. Since LFG uses no transformations or any similar mechanism, this has to be accounted for by positing a notion of grammatical function independent from c-structure position.

Grammatical functions are also distinct from semantic roles. A patient, for example, may map to either obj (in the active voice) or subj (in the passive), as evidenced by its syntactic properties (e.g. control of verb agreement, reflexive binding). In LFG, these two sentence types are defined as two different *lexical mappings* between semantic roles and gfs. While in terms of argument structure, i.e. the mapping from semantic roles to gfs, the passive is treated as derivative to the active, at f-structure passive subjects are genuine, first-class subjects that are not derived from objects in any sense.

Finally, grammatical functions cannot be equated to case marking or another argument encoding mechanism, such as verb agreement. First of all, there are many languages which completely lack both agreement and case marking, but which nevertheless display evidence for grammatical functions. Thus Mandinka (Mande > Niger-Congo), which lacks both case marking and verbal indexing, nevertheless displays a distinction between the subject (sole argument of intransitive verbs, i.e. S in typological terminology, and the agent of transitive verbs, i.e. A) and all other arguments in a number of different constructions (Creissels 2019). For instance, pronominal resumption in relative clauses is only available for non-subject arguments. In (3a) and (3b), subjects (S and A arguments, respectively) are relativized, and the resumptive pronoun *à* cannot appear in the subordinate clause in the normal subject position; the subject is represented by a gap. In contrast, in (3c), it is the object that is relativized, and the pronoun *à* may (optionally) appear in the object position after the verb.

(3) Mandinka (Mande > Niger-Congo: Creissels 2019: 339)

a. S relativized: resumption ungrammatical
mùs-ôo **míŋ** (***à**) táa-tá fàr-ôo tó
woman-DET REL 3SG go-COMPL.POS rice.field-DET LOC
'the woman **who** went to the rice field'

b. A relativized: resumption ungrammatical
mùs-ôo **míŋ** (***à**) yè fǎaŋ-ó tǎa
woman-DET REL 3SG COMPL.POS cutlass-DET take
'the woman who took the cutlass'

c. P relativized: resumption possible
fǎaŋ-ò **míŋ** mùs-ôo yè **à** tǎa
cutlass-DET REL woman-DET COMPL.POS 3SG take
'the cutlass that the woman took'

Furthermore, case marking or agreement do not always consistently identify specific grammatical functions. For example, in Icelandic (Andrews 1982) agreement is always with the nominative argument, but subjects can be non-nominative. Many languages with differential object marking (DOM) allow nominative objects (Dalrymple & Nikolaeva 2011). For example, in Ossetic, human objects are normally genitive-marked (4a) and inanimate objects are nominative-marked (4b), i.e. the case marking of subjects and objects can be identical.

(4) Ossetic (Iranian > Indo-European)

a. Human P: genitive
alan **šošlan-ə** fet:-a
S.-GEN see.PFV-PST.3SG
'Alan saw **Soslan**.'

b. Inanimate P: nominative
alan **št'ol** fet:-a
table see.PFV-PST.3SG
'Alan saw **a/the table**.'

Of course, this is not to say that grammatical functions never systematically correspond to any syntactic or morphological marking; if they did not, there would be no means of identifying them. The point of treating grammatical functions as primitives is that we *cannot*, as a general rule, reduce them to any other linguistic phenomena such as case marking or word order. This logic is in line with the general spirit of LFG, which can be termed "anti-reductionist" in that it strives to factorize grammatical phenomena into distinct notions responsible for distinct patterns of behaviour, which may or may not correlate systematically across languages. Thus, in the LFG treatment of argument encoding, constituent structure, semantic roles, and case marking are all formally independent from each other. The framework itself puts no constraints on their relationship; it is the task of the theorist to establish how exactly they can or cannot correlate, both cross-linguistically and within individual languages.

We also have to assume, as a working hypothesis, that individual grammatical functions are associated with core sets of syntactic properties that are relatively stable across languages. If this is not the case, then using such terms as "subject" or "direct object" as anything more than convenient language-internal labels is not justified. This issue is still at the centre of much typological discussion, cf. the overview in Bickel (2010). In many syntactic frameworks, grammatical functions only exist, at best, in the form of an ordering relation among arguments – this is true at least for most variants of HPSG (Pollard & Sag 1994, Müller et al. 2021) and Simpler Syntax (Culicover & Jackendoff 2005, Varaschin 2023 [this volume]). Thus, in recent versions of HPSG there is a list ARG-ST (or DEPS) containing all verbal arguments; the subject is the first element of this list, the direct object, the second, and so on, generally according to the Keenan–Comrie hierarchy (Keenan & Comrie 1977). In many instances, both approaches make the same predictions, because in LFG the GF hierarchy also plays a major role (see Section 3.2); for example, in both LFG (Rákosi 2023 [this volume]) and HPSG (Müller 2021), anaphoric relations are licensed by the relative ranking of verbal arguments. But the key practical difference is that in HPSG or Simpler Syntax, distinctive properties are not associated with individual grammatical functions. For example, in LFG it is possible to analyze sentences as having only a subject (SUBJ) and a secondary object (OBJ_θ, without a primary OBJ) when the "second-ranking" argument is deemed to lack features commonly associated with direct objects. This is done, for example, for certain classes of predicates in Plains Cree (Dahlstrom 2009) and for unmarked direct objects in differential object marking systems in the analysis of Dalrymple & Nikolaeva (2011). Even subjectless sentences are possible if the highest-ranking argument lacks properties that are associated with subjecthood (Kibort 2006). The standard LFG analysis of complementation (Section 4.3) also relies on the grammatical functions COMP and XCOMP (for clausal complements) being distinct from OBJ (Dalrymple & Lødrup 2000, Alsina et al. 2005). All of this would be impossible if grammatical functions were just an issue of ranking.

While GFs have been a cornerstone of LFG since its inception, a variant of this framework without the traditional notion of GF is also conceivable. Such an attempt was made in Patejuk & Przepiórkowski (2016), who propose replacing features such as SUBJ, OBJ and ADJUNCT with an ordered set DEPS in the style of HPSG. A detailed counterargument to this proposal can be found in Kaplan (2017).

In the following sections, I will describe the standard view of grammatical functions in current LFG: their inventory, their classification, and the properties of the core grammatical functions.

3 The classification of grammatical functions

3.1 General remarks

LFG generally operates with the following set of grammatical functions (with the addition of overlay functions, which will be discussed in Section 5):

(5)	SUBJ	subject
	OBJ	object
	OBJ_θ	secondary object
	OBL_θ	oblique
	COMP (XCOMP)	complement (closed/open)
	PREDLINK	nonverbal predicate in copular constructions
	ADJ (XADJ)	adjunct (closed/open)
	POSS	possessor

The θ in OBJ$_\theta$ and OBL$_\theta$ represents the particular semantic role that is filled by the argument. For example, a secondary object and an oblique with the semantic role Goal will be called OBJ$_{\text{GOAL}}$ and OBL$_{\text{GOAL}}$, respectively. Thus OBJ$_\theta$ and OBL$_\theta$ are not individual GFs but "families" of GFs associated with particular semantic roles, but sharing some common properties. The main motivation for this will be discussed in Section 3.5.

As discussed above, GFs in LFG are theoretical primitives on a par with such entities as constituents, or morphosyntactic or phonological features. Such primitives are never given definitions or identified on the basis of a fixed set of tests or criteria; rather, they are associated with a set of properties and used as building blocks for hypotheses whose predictions are to be tested. But this does not mean that the list of GFs in (5) is completely arbitrary. On the contrary, in the following sections I will show how the core GFs (SUBJ, OBJ, OBJ$_\theta$, OBL$_\theta$, ADJ) are mostly distinguished on the basis of three classifications: ungovernable (ADJ) vs. governable, term (SUBJ, OBJ, OBJ$_\theta$) vs. non-term, semantically unrestricted (SUBJ, OBJ) vs. restricted. This only leaves the distinction between SUBJ and OBJ – two semantically unrestricted terms – unspecified, but these can be distinguished on the basis of the subject having a higher structural priority.

This classification is complemented by a different but related cross-classification from the Lexical Mapping Theory (LMT, Bresnan & Kanerva 1989) based on two features: [$\pm r$] (for "(semantically) restricted") and [$\pm o$] (for "objective"), seen in (6).

(6)

	$-r$	$+r$
$-o$	SUBJ	OBL$_\theta$
$+o$	OBJ	OBJ$_\theta$

This classification produces a markedness hierarchy of grammatical functions: SUBJ [$-r$, $-o$] < OBJ [$-r$, $+o$], OBL$_\theta$ [$+r$, $-o$] < OBJ$_\theta$ [$+r$, $+o$] (Bresnan & Moshi 1990). This hierarchy, together with the mapping principles, ensures the correct default mapping of semantic roles to grammatical functions. It also predicts the possible ways of remapping grammatical functions in passives, causatives and applicatives, although the details differ across variants (e.g. some versions of LMT allow mapping agents to OBJ and some do not). It should be stressed that LMT does not *directly* provide evidence for the set of grammatical functions, because in LFG the theory of f-structure and the theory of the mapping from semantic roles to f-structure are formally independent: one can analyze GFs without adopting any particular theory of how they are mapped to semantic roles. But indirectly, the cross-classification of core GFs can serve as an independent justification for their inventory. For more information on mapping principles in LFG, see Findlay et al. 2023 [this volume].

3.2 Functional hierarchy

The most fundamental distinction between grammatical functions is the universal functional hierarchy in (7), which is the LFG version of the Keenan-Comrie Hierarchy (Keenan & Comrie 1977).[3]

(7) SUBJ > OBJ > OBJ_θ > COMP, XCOMP > OBL_θ > ADJ, XADJ

The Keenan-Comrie Hierarchy was originally devised as a typological hierarchy that constrains the range of possible grammatical functions that the relativized argument can occupy in the relative clause. It is now widely acknowledged that the same hierarchy can determine a number of grammatical processes within a single language. Phrase-structure-based frameworks try to account for such generalizations by reducing the hierarchy to differences in phrase structure configuration. For example, asymmetries in anaphoric binding are typically described in terms of c-command (Chomsky 1982). In LFG, most such constraints, if they are indeed syntactic,[4] are described in terms of f-structure.[5] Thus, the relation of c-command is replaced by the relation of outranking in the hierarchy in (7): see Rákosi 2023 [this volume].

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[3] The difference from Keenan and Comrie is mainly in the terminology (OBJ_θ for what they call indirect object), but also in the split between OBJ and (X)COMP and the addition of adjuncts at the bottom of the hierarchy. Objects of comparison are not viewed as a special grammatical function in LFG and are therefore not included. Also, while Keenan and Comrie include genitive possessors, this is not done in LFG because possessors do not directly compete with clausal arguments and are somewhat special; they are discussed in Section 4.4.

[4] For many phenomena, it is not easy to decide whether the constraints should be formulated in terms of syntax, semantics, or both; in many ways this rests on the particular theories of the two and the syntax–semantics interface. For example, while mainstream generative grammar is notoriously syntactocentric, Simpler Syntax represents another extreme, where syntactic structure includes only a very basic notion of grammatical relations, and most of the work that is done by f-structure is assigned to a (very elaborate) semantic structure. As an illustration of the relationship between Culicover and Jackendoff's approach and LFG, Belyaev (2015) shows that the criteria that Culicover & Jackendoff (1997) consider to be semantic are captured at the f-structure level in LFG.

[5] It has been argued that anaphora is sometimes directly constrained by linear precedence, e.g. for Malayalam in Mohanan (1982). In LFG, this has been modeled using the f-precedence relation (Kaplan & Zaenen 1989, also see Belyaev 2023a [this volume]) by essentially stating that the c-structure nodes that map to the f-structure of the antecedent must precede the c-structure nodes that map to the f-structure of the anaphoric expression. Notably, the starting point is still the f-structure and the c-structure is only accessed through inverse mapping.

3.3 Governable and ungovernable GFs

As stated above, most GFs are GOVERNABLE: that is, in LFG terms, they must appear in the list of arguments in the PRED value of their f-structure in order to be licensed. The PRED value is usually that of a verb or other clausal predicate, as in (8), which is the f-structure of the sentence *Mary ran quickly*.

(8)

$$\left[\begin{array}{ll} \text{PRED} & \text{‘RUN}\langle\text{SUBJ}\rangle\text{’} \\ \text{TENSE} & \text{PAST} \\ \text{SUBJ} & \left[\begin{array}{ll}\text{PRED} & \text{‘Mary’}\\ \text{PERS} & 3 \\ \text{NUM} & \text{SG}\end{array}\right] \\ \text{ADJ} & \left\{\left[\begin{array}{ll}\text{PRED} & \text{‘QUICKLY’}\end{array}\right]\right\}\end{array}\right]$$

In this sentence, SUBJ is a governable GF that appears in the argument list in PRED. The f-structure for *quickly* appears as the value of the GF ADJ, which is ungovernable and is not licensed by the PRED value.

If a governable GF is included in the list of arguments in PRED but has no value, Completeness is violated; conversely, if a governable GF is present but not included in the list, Coherence is violated. Modifiers (ADJ and XADJ) are the only GFs which are ungovernable. The only condition on their occurence is that the f-structure in which they appear should have *some* PRED value.[6]

Determining the status of the dependents of a given predicate is not trivial in general, but especially in LFG because of its rigid separation between levels. Two distinctions are especially important for LFG: between semantic and syntactic argumenthood, because semantic arguments are not necessarily expressed as arguments in syntax, and vice versa (Section 3.3.1), and between arguments and adjuncts in syntax, whose status does not necessarily correlate with semantic argumenthood and adjuncthood (3.3.2).

3.3.1 Semantic and syntactic arguments

First of all, one must clearly differentiate between *semantic* argumenthood and *syntactic* argumenthood. Syntactic arguments may have no semantic counter-

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[6] This constraint is part of *extended coherence* (Bresnan et al. 2016), which is not accepted by all LFG practitioners as a universal well-formedness condition. While the notion that only f-structures with PRED values can have modifiers is intuitively plausible, it is difficult to find empirical justification for this condition on adjuncts, since PRED-less f-structures normally correspond either to expletive pronouns or heads of categories like P, which both tend not to attach any modifiers at c-structure. Violation of extended coherence might be relevant for languages where some adpositions have PRED values and some do not; only the former would then be able to have adjuncts.

parts; such is the case of subjects of verbs like *rain*, or “raised” subjects and objects like *John* in *John seemed to come* or *David* in *I saw David come* (functionally controlled in LFG terms). In LFG, such “non-arguments” are notated as being outside the angled brackets in the argument list of the PRED feature value, e.g. ‘RAIN⟨ ⟩SUBJ’ or ‘BELIEVE⟨SUBJ XCOMP⟩OBJ’. This effectively makes f-structure include semantic information. As discussed in Belyaev 2023a [this volume], in modern Glue Semantics-based approaches, it is possible to either completely eliminate PRED features from the syntax or at least remove semantic role information, which would make the separation between syntax and semantics more clear-cut.

Conversely, a semantic argument might have no syntactic expression. For example, unspecified object deletion or antipassivization can turn a transitive verb into an intransitive one that only has a single argument, the agent (*We ate a meal.* ⟶ *We ate.*). The semantic predicate ‘eat’, and the corresponding real-life event, clearly have a patient participant regardless of whether it is syntactically expressed, and this omitted participant will be interpreted in some way. But there is broad consensus in the literature (see Melchin 2019) that unspecified objects are not present in syntax in any form. In LFG, this means that they are both absent as constituents in c-structure, and as GFs in f-structure, because f-structure is a syntactic level that does not directly reflect the thematic roles of the arguments.[7]

It is important to distinguish such cases of true omission of semantic arguments at f-structure from cases where arguments do not overtly appear at c-structure but are still present at f-structure. Two widespread cases when this occurs are pro-drop (like in Italian *ha vinto* lit. ‘has won’ = ‘s/he has won’) and raising (*John seems to have won*, where *to have won* appears to lack a subject). The “little *pro*” analysis of null subjects in languages like Italian has been assumed at least since Perlmutter (1971) and is supported by much empirical evidence, such as the possibility of controlling PRO, serving as the antecedent of anaphors, controlling agreement etc. that is well-known from basic syntax textbooks and need not be repeated here. This evidence is also valid in LFG and leads one to conclude that while *pro* is not needed at c-structure, it has to be present at f-structure in subject position. Similarly, “raised” (functionally controlled) arguments overtly appear in main clauses but still have to satisfy the subcategorization constraints of the embedded clause. In the LFG analysis of raising, one f-structure is shared

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[7] The mapping from semantic roles to GFs is handled in LFG by a separate component, Linking Theory. In the most widespread variant of Linking Theory, Lexical Mapping Theory, unspecified object deletion is captured by suppressing the realization of the patient argument, i.e. preventing it from being mapped to any GF. See Findlay et al. 2023 [this volume] for further explanation.

between the main clause subject or object and the subject of the embedded clause. Therefore, both components of the functional control relation are present in the syntax as arguments of their respective clauses; see Section 4.3.2 and Vincent 2023 [this volume] for more detail.

3.3.2 Arguments and adjuncts

In one form or another, the problem of arguments vs. adjuncts is relevant for all grammatical frameworks, but LFG is special in that it treats the syntactic distinction between arguments and adjuncts as fully separate from the homonymous semantic distinction. The syntactic distinction between arguments and adjuncts also does not exist in other frameworks in the same form; for example, the HPSG approach is typically to include all verbal dependents in an ordered list DEPS. This means that semantic subcategorization and semantic obligatoriness cannot be used as reliable criteria by themselves: it was shown above that semantic arguments might not correspond to any GF in syntax. Similarly, some analyses treat passive agents as adjuncts, in spite of their semantic argumenthood. The issue is further complicated by the fact that additional, derived arguments that are not present in the lexical entry of the predicate can be introduced in the syntax (Needham & Toivonen 2011). Hence, criteria for distinguishing between arguments and adjuncts must be purely syntactic.

The main empirical difference between arguments and adjuncts can be formulated in terms of Dowty's (1982) *subcategorization test*: modifiers, but not arguments, can be omitted. In a theory like LFG which uses no empty heads (see Belyaev 2023a [this volume]), this criterion is clearly not general enough, because grammatical functions that are present at f-structure may lack a realization at c-structure, e.g. under pro-drop (see Section 3.3.1 above). Normally, the presence of such "null" elements like *pro* and their features is reflected in the morphology through agreement or argument incorporation, although some languages, like Japanese, are notorious for allowing almost unrestricted pro-drop — for these languages, distinguishing between arguments and adjuncts using the subcategorization test is especially problematic.

Another truly syntactic criterion is that adjuncts can be freely multiplied in any number, whereas arguments cannot (Kaplan & Bresnan 1982: 40):

(9) The girl handed the baby a toy **on Tuesday**$_{\text{ADJ}}$ **in the morning**$_{\text{ADJ}}$.

(10) * The girl saw **the baby**$_{\text{OBJ}}$ **the boy**$_{\text{OBJ}}$.

Crucially, the multiplication test is only relevant for adjuncts *of the same type*. While a clause may have at most one subject and object, it may have several obliques or indirect objects (as elaborated in sections 3.5.2 and 3.5.3 below). But there can still be only one indirect object or oblique with the same semantic role:

(11) * John went to Moscow to Red Square.

Other criteria have to do with the specific understanding of grammatical functions in LFG, their relative ordering and the licensing of long-distance dependencies. For example, some pronouns, such as the reflexive pronoun *seg selv* in Norwegian, are specifically limited in their coreference to coarguments (Hellan 1988), and therefore cannot occur in adjunct position. The examples in (12) are cited from Dalrymple et al. (2019). In (12a) this reflexive is a direct object that is coreferent to the subject – both are arguments. Similarly, in (12b), the reflexive is used in a PP that is an oblique argument selected by the verb 'tell'. But in (12c), the prepositional phrase containing the reflexive is not an argument of the predicate and thus it cannot have the subject as its antecedent. Thus the cut-off point in the hierarchy in (7) for *seg selv* is just to the left of ADJ, XADJ.

(12) Norwegian (Germanic > Indo-European)

a. Jon forakter **seg selv**.
Jon despises self
'Jon$_i$ despises **himself**$_i$.'

b. Jon fortalte meg **om** **seg selv**.
Jon told me about self
'Jon$_i$ told me **about himself**$_i$.'

c. * Hun kastet meg **fra** **seg selv**.
she threw me from self
('She$_i$ threw me away **from herself**$_i$.')

It is also widely assumed in the literature that wh-extraction from adjuncts is impossible (Pollard & Sag 1987, Huang 1982, Rizzi 1990). However, this constraint does not seem to be cross-linguistically universal, or at least it does not apply to all types of modifiers. For example, while in English extraction from clausal adjuncts is prohibited (13), extraction from PPs is allowed (14).

(13) * **Which man** did John leave when he saw __?

(14) **Which bed** did David sleep **in** __?

3.4 Terms and non-terms

Another distinction is between core arguments, or terms, and non-core arguments, or non-terms.

(15) $\underbrace{\textsc{subj} > \textsc{obj} > \textsc{obj}_\theta}_{\text{terms}} > \textsc{comp}, \textsc{xcomp} > \textsc{obl}_\theta > \textsc{adj}, \textsc{xadj}$

There is no universal set of tests that distinguishes between terms and non-terms, but a number of constructions in different languages are systematically sensitive to this distinction; see Alsina (1993) for a detailed discussion of termhood. Some of these constraints are discussed in the following sections.

3.4.1 Agreement

In many languages, verb agreement seems to be only possible with terms, that is, subjects, objects or secondary objects. The idea goes back at least to Johnson (1977: 157), where it is called the Agreement Law. It has the same status in Relational Grammar (Frantz 1981). Agreement with subjects is very widespread; many languages also have (obligatory or optional) agreement with direct objects; the map in WALS (Siewierska 2013) cites 193 languages with both subject (A/S) and object (P) agreement out of a sample of 378. Object-only (or rather, P/S) agreement is considerably less common, exhibited by only 24 languages in the above-mentioned sample. Indexing other arguments is even more rare, but some languages, like Basque (isolate), also agree with secondary objects. As seen in (16), finite ditransitive verbs in Basque agree with the ergative (SUBJ), absolutive (OBJ) and dative ($\textsc{obj}_\theta$) arguments in person and number.

(16) Basque (isolate)
d-a-kar-ki-da-zu
3SG.ABS-PRS-bring-DAT-1SG.DAT-2SG.ERG
'you bring it to me' (Hualde et al. 2003: 209)

From current LFG literature, it is unclear whether the restriction of agreement to terms is a theoretical postulate or an empirical observation, since the termhood of agreement controllers is usually confirmed by independent syntactic evidence.

3.4.2 Control

Cross-linguistically, only terms tend to be controllers or controllees in control constructions, both lexically determined (clausal complements) and not (clausal adjuncts). For instance, Kroeger (1993) shows that in Tagalog, only terms can be anaphoric controllees[8] in participial complement constructions and controllers in adjunct constructions. According to Kroeger, voice suffixes in Tagalog promote any argument to subject status, and the erstwhile subject (the agent) becomes an obj$_\theta$ (see an illustration in (23) below).[9] Thus, (17) illustrates the verb 'read' in the active voice; the controller is the subject. In (18), the verb 'read' is marked by the "object voice" suffix: the Patient is promoted to subject status and carries the nominative proclitic *ang=*. The controllee is still the Agent, which in this example is demoted to obj$_{\text{AG}}$. Finally, (19) shows that obliques, i.e. arguments that are not subjects, direct objects or demoted agent-like arguments in voice constructions, cannot be controllees, even if they have the same semantic role Agent.

(17) Tagalog (Malayo-Polynesian > Austronesian)
In-abut-an ko siya=ng [nagbabasa ___$_{\text{subj}}$ ng=komiks
pfv-find-dv 1sg.gen 3sg.nom=comp av.ipfv.read gen=comics
sa=eskwela].
dat=school
'I caught him reading a comic book in school.' (Kroeger 1993, via Dalrymple et al. 2019: 16)

(18) In-iwan-an ko siya=ng [sinusulat ___$_{\text{obj}_{\text{AG}}}$ ang=liham].
pfv-leave-dv 1sg.gen 3sg.nom=comp ipfv.write.ov nom=letter
'I left him writing the letter.' (Kroeger 1993, via Dalrymple et al. 2019: 16)

(19) *In-abut-an ko si=Luz na [ibinigay ni=Juan
pfv-find-dv 1sg.gen nom=Luz link iv.ipfv.give gen=Juan
ang=pera ___$_{\text{obl}_{\text{GOAL}}}$].
nom=money
('I caught Luz being given money by Juan.') (Kroeger 1993, via Dalrymple et al. 2019: 16)

Similarly, Kibrik (2000) argues that in Archi (Lezgic > East Caucasian), any of the core arguments / terms (subject or direct object) can be the controllee in control constructions.

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[8] On the distinction between anaphoric and functional control ("raising") in LFG, see Section 4.3.2 below and Vincent 2023 [this volume].

[9] Such arguments must be treated as secondary objects because they are marked by the same genitive proclitic *ng=* that marks direct objects, which do not change their mapping when an agent is demoted.

3.4.3 Reflexivization

Kibrik (2000) in fact claims that not only control constructions, but most constructions in Archi do not single out any argument beyond the term vs. non-term distinction. He shows that possessive reflexives can be controlled by the subject or direct object (i.e. A, S or P), in any direction (20a), but not by non-core-arguments (21).

(20) Archi (Lezgic > East Caucasian)

a. tow-mu$_i$ žu-n-a-ru$_i$ łːonnol a<r>č-u
he-ERG self-GEN-EMPH-CL2 wife(CL2) ⟨CL2⟩kill-PRF
'He$_i$ (pron., erg.) killed his (refl.) wife$_i$ (abs.).' (A > P)

b. tor$_i$ že-n-a-w$_i$ bošor-mu a<r>č-u
she self-GEN-EMPH-CL1 husband(CL1)-ERG ⟨CL2⟩kill-PRF
'Her$_i$ (refl.) husband (erg.) killed her (pron., abs.).' (P > A)
(Kibrik 2000: 62)

(21) a. tow$_i$ žu-n-a-bu$_i$ abej.me-tːi-š k'olma-ši
he self-GEN-EMPH-CL1.PL parents(CL1.PL)-SUPER-EL separate-ADV
w-i
CL1-be.PRS
'He$_i$ (pron., abs.) lives apart from his$_i$ (refl.) parents.' (SUBJ > OBL) (ibid.)

b. *tow.mu-tːi-š$_i$ žu-n-a-bu abaj k'olma-ši
he-SUPER-EL self-GEN-EMPH-CL1.PL parents(CL1.PL) separate-ADV
b-i
CL1-be.PRS
('His$_i$ (refl.) parents (abs.) live apart from him$_i$ (pron., abs.).') (OBL > ABS) (ibid.)

Therefore, while subject-oriented reflexives are found in many languages (see Dalrymple 1993 and Rákosi 2023 [this volume]), Archi is different in having subject *and* object, i.e. term-oriented, reflexives.

3.5 Semantically restricted and unrestricted arguments

The classification of GFs into terms and non-terms allows us to distinguish between subjects, objects and all other grammatical functions. But the difference between "primary" and "secondary" objects (OBJ and OBJ$_\theta$) remains undefined.

This distinction is captured by another classification of GFs into semantically restricted and unrestricted arguments:

(22) $$\underbrace{\text{SUBJ} > \text{OBJ}}_{\text{semantically unrestricted}} > \text{OBJ}_\theta > \text{COMP}, \text{XCOMP} > \text{OBL}_\theta > \text{ADJ}, \text{XADJ}$$

As mentioned above, θ in the GF names OBJ_θ and OBL_θ stands for a particular thematic role that is filled by this argument. Thus they are families of GFs, each of which is associated with a particular semantic role: OBL_{GOAL}, $\text{OBJ}_{\text{THEME}}$, etc. In this, they are contrasted with subjects (SUBJ) and direct objects (OBJ), which do not have this additional qualifier attached to them.

The specific list of thematic roles is not agreed upon in LFG. In the case of OBJ_θ and OBL_θ, it is not even clear whether the roles that appear in θ are universal or language-specific (the fact that θ is often equivalent to the PCASE value supplied by an adposition suggests the latter). For more information on the mapping from thematic roles to GFs, see Findlay et al. 2023 [this volume].

A consequence of the distinction between semantically restricted and semantically unrestricted GFs is the fact that only the latter can be non-arguments at the semantic level; the former must be assigned some thematic role. This, in turn, predicts that, first, arguments lacking any semantic role (expletives or dummy arguments) like English *it* or *there* (such as in *It rained*) can only appear in subject or direct object position; second, that "raising" (functional control in LFG terms) is only possible when the matrix clause position is SUBJ or OBJ.

In what follows, I will discuss the motivation for treating each of these GFs as semantically restricted or unrestricted in detail.

3.5.1 Unrestricted GFs

3.5.1.1 Subjects One of the key features of subjects is that they are not restricted to one semantic role (Fillmore 1968). The semantic unrestrictedness of subjects is perfectly illustrated by the existence of passive constructions: the same lexical verb can have either the Agent (in the active voice) or the Patient (in the passive voice) as its subject. Some languages go even further and allow promoting any argument to subject status if it has discourse prominence, or for syntactic reasons. One such language is Tagalog, where the voice suffix on the verb determines which argument bears the SUBJ GF, according to the analysis in Kroeger (1993):

(23) Tagalog (Greater Central Philippine > Austronesian)

a. active voice
B<um>ili **ang=lalake** ng=isda sa=tindahan.
<PRF.AV>buy NOM=man GEN=fish DAT=store
'**The man** bought fish at the store.'

b. objective voice
B<in>ili-∅ ng=lalake **ang=isda** sa=tindahan.
<PRF>buy-OV GEN=man NOM=fish DAT=store
'The man bought **the fish** at the store.'

c. dative voice
B<in>ilih-an ng=lalake ng=isda **ang=tindahan**.
<PRF>buy-DV GEN=man GEN=fish NOM=store
'The man bought the fish **at the store**.'

d. instrumental voice
Ip<in>am-bili ng=lalake ng=isda **ang=pera**.
<PFV>IV-buy GEN=man GEN=fish NOM=money
'The man bought fish **with the money**.'

e. benefactive voice
I-b<in>ili ng=lalake ng=isda **ang=bata**.
BV-<PRF>buy GEN=man GEN=fish NOM=child
'The man bought fish **for the child**.'

The formal marking of the subject is also not usually directly derived from its semantic role. We saw above that in Tagalog, the subject always receives the nominative preposition *ang*. In languages where non-canonical subject marking is possible, there is still no consistent association between case marking and the semantic role of the subject. For example, Icelandic oblique subjects are never agent-like, but the choice of the case marker does not otherwise consistently correlate with particular semantic roles (Jónsson 2003). Even among Daghestanian (East Caucasian) languages, where experiencer subjects are regularly marked by dative instead of ergative, there is some variation as to which case is selected by which verb; for example, in Gubden Dargwa, the verb 'see' selects ergative case and the verb 'want' selects dative case, while in the closely related Khuduts Dargwa both verbs have dative subjects (Ganenkov 2013: 246).[10] In short, sub-

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[10] It is worth mentioning that some Daghestanian languages have been argued to lack the subject grammatical function. As mentioned above, Kibrik (2000) argued that in Archi, only core arguments (terms in LFG) can be distinguished, but there is no evidence for the privileged status of either of the core arguments. The universality of subjects is discussed in Section 4.2.4.

jects are usually consistently encoded regardless of their semantic role, and when there is variation in marking, it is usually lexical and idiosyncratic.

3.5.1.2 Direct Objects Direct objects, too, are not associated with specific semantic roles. While direct objects are never agents in English, they can still have a range of semantic roles: Patient (*John ate* ***the cookie***), Stimulus (*John saw* ***David***), Experiencer (*It surprised* ***me***), Theme (*I gave* ***the book*** *to John*). Just like Tagalog can promote various arguments to subjects, some languages allow promoting arguments to direct objects via so-called applicative constructions. One such language is Hakha Lai (Tibeto-Burman > Sino-Tibetan), which I describe following Peterson (2007: 15ff.). In Hakha Lai, verbs agree with two core arguments – subjects and objects – of transitive verbs, as in (24).

(24) Hakha Lai (Tibeto-Burman > Sino-Tibetan)
ʔan-kan-thoʔŋ
subj.3pl-obj.1pl-hit
'They hit us.' (Peterson 2007: 16)

It can be reasonably assumed that, in LFG terms, the argument indexed by the first prefix is subj, while the argument indexed by the second prefix is obj.

Hakha Lai also has a range of applicative suffixes that introduce additional morphologically unmarked arguments into the verb's argument structure. One such marker is the benefactive / malefactive suffix *-piak*. When this suffix is used, it is the newly introduced argument that occupies the obj position, as seen from the agreement pattern in (25). The verb agrees with the first person singular benefactive argument ('on me') and not with the third person singular patient ('wood slab').

(25) ʔaa! tleem-pii khaa maʔ-tii tsun taar-nuu=niʔ
interj wood.slab-aug deic dem-do deic old-woman=erg
ʔa-**ka**-khaʔŋ-piak=ʔii…
subj.3sg-obj.1sg-burn-mal=conn
'Ah, the old woman burned the big slab of wood on me, and…'
(Peterson 2007: 17)

3.5.2 Obliques

The reason for treating obliques as semantically restricted and a family of functions is that, unlike subjects and objects, their marking will always vary depending on their semantic role. For example, Goals in English use the preposition *to* (as in *Mary went to London*), while Sources use the preposition *from* (*David came from Paris*). This justifies treating OBL as a family of functions rather than a single GF.

Another reason for this architectural decision is that there may be multiple obliques in one clause. In English, this can be illustrated by sentences like *John moved from London to Paris*, where *from London* can be analyzed as $\text{OBL}_{\text{SOURCE}}$ and *to Paris* as OBL_{GOAL}. This can be disputed, however, because either of the obliques, or both, can be omitted; thus Zaenen & Crouch (2009) propose doing away with OBL altogether, replacing OBL with set-valued ADJ. In other languages, however, the evidence for multiple OBL arguments can be more compelling. Dahlstrom (2014) shows that in the Algonquian language Meskwaki, obliques are strictly positioned immediately before the verb (26), while other arguments (subjects, objects, secondary objects and complement clauses) appear postverbally, as illustrated in (27), where 'Wisahkeha' is analyzed as a direct object by Dahlstrom.

(26) Meskwaki (Algonquian > Algic)
aˑkwi **nekotahi** wiˑh-nahi-ihaˑ-yanini
not anywhere FUT-be.in.habit.of-go(thither)-2/NEG
'You will never go **anywhere**.' (Dahlstrom 2014: 57)

(27) iˑni=keˑhi=ipi=meko eˑh-awataw-aˑči wiˑsahkeˑh-ani
then=and=HRSY=EMPH AOR-take.OBJ2.to-3>3′/AOR W.-SG
metemoˑh-eˑh-a
old.woman-DIM-SG
'And right then, it's said, the old woman took it to Wisahkeha.'
(Dahlstrom 2014: 58)

In Meskwaki, obliques are not optional but required by verbal stems or preverbs. For example, all verbs of quotation require an oblique argument. Therefore, the participants that Dahlstrom terms "obliques" cannot be analyzed as adjuncts in terms of LFG.

Dahlstrom further demonstrates that additional oblique arguments may be associated with preverbs (which can be viewed as a kind of applicative marker) or compounded verb stems. When more than one oblique appears in a clause, all must precede the verb, and each oblique argument must be adjacent to the associated root or preverb.

(28) awitameko **keˑkoˑhi** iši– **ateškaˑwi** –išawihkapa
not.POT=EMPH any.way thus– with.delays –thus.happen.to.S-2/POT
'You would not have experienced delays in any way.' (Dahlstrom 2014: 64)

In (28), *ateška·wi* is associated with the verb stem, while *ke·ko·hi* satisfies the valency introduced by the preverb *iši-*. The special position of each of these obliques seems to present compelling evidence for treating them as separate (though related) semantically restricted GFs.

3.5.3 Secondary objects

Among all the main GFs, secondary objects are perhaps the most difficult to characterize. They are similar to objects in being terms, and to obliques in being semantically restricted. But these classifications are not easily translatable into specific empirical properties. We have seen above that arguments analysed as secondary objects are similar to direct objects in being terms, which allows them to trigger verbal agreement and act as controllees. But these criteria do not always serve to distinguish OBJ$_\theta$; for example, neither applies to English. Another property of secondary objects, which likens them to obliques, is their semantic restrictedness.

Secondary objects were originally thought of as occupying a single GF OBJ2 (Kaplan & Bresnan 1982) and identified on the basis of constructions like (29) in English and other Germanic languages like Icelandic. In English, the identification of OBJ2 is straightforward due to the fact that it is the only argument apart from subject and direct object that is not marked by a preposition (which is a feature of obliques) and also due to the alternation of the double object construction in (29) with the oblique dative construction in (30). Thus, the same thematic roles map to two constructions that differ both in word order and case / preposition marking. This means that at least three different GFs must be distinguished: OBJ, OBL$_\theta$ and OBJ$_\theta$.

(29) John gave [Mary]$_{\text{OBJ1}}$ [a book]$_{\text{OBJ2}}$.

(30) John gave [a book]$_{\text{OBJ1}}$ [to Mary]$_{\text{OBL}}$.

The fact that *Mary* is indeed the direct object in (29), even though it is called an “indirect object” in traditional grammar (due to its dative semantics), can be seen from the fact that in the passive version of (29), it is the recipient that is promoted to subject status (31).

(31) a. Mary was given a book.
     b. * A book was given Mary.

Passivization is not a *direct* criterion for objecthood, because in LFG the passive is a lexical process and not a syntactic transformation (Dalrymple et al. 2019: 28).

But indirectly, lexical mapping constraints do determine which arguments can be passivized. Objects can be passivized because they are inherently classified as [−*r*], and, in the absence of a higher-ranking argument, fill the subj gf which is defined as [−*o*, −*r*]. Secondary objects, in contrast, cannot be passivized because they are inherently defined as [+*o*]. This is one of the key features of secondary objects as opposed to direct objects.

In English, the label obj2 may indeed be appropriate, because there can be only one secondary object, and this object is connected to only one semantic role (Theme). But other languages make much wider use of secondary object functions, such that there may be several obj$_\theta$s, each of which is restricted to a different semantic role. For example, Bresnan & Moshi (1990) analyze Kichaga (Bantu) as having verbal indexing of multiple thematically restricted objects, each of which has its own slot in the verb form:

(32) Kichaga (Bantu)
n-ä-lꜝé-kú-shí-kí-kóṛ-í-à
focus-1subj-pst-17obj-8obj-7obj-cook-appl-fv
‘She/he cooked it with them there.’ (Bresnan & Moshi 1990: 151)

Of the three object prefixes in this example, only the instrumental object (8obj-) is unrestricted; the other two are thematically objects that occupy the grammatical functions obj$_{\text{loc}}$ (17obj-) and obj$_{\text{patient}}$ (7obj-).

Another use of obj2 / obj$_\theta$ is to capture the difference between case-marked (topical) and unmarked objects in languages with Differential Object Marking (DOM), where the direct object can either be marked by a special (accusative) case or left unmarked (as discussed in Section 2; also see Butt 2023 [this volume]). According to Dalrymple & Nikolaeva (2011), in many such systems, accusative-marked direct objects have the gf obj, while unmarked objects are obj$_\theta$. The same distinction may be reflected in agreement patterns: Dalrymple & Nikolaeva (2011) show that in Ostyak (Ob-Ugric > Uralic), objects that trigger agreement are obj while objects that do not are obj$_\theta$. With respect to case marking, an opposite viewpoint is taken by Butt & King (1996), who treat focal, unmarked objects as obj. It may be that different patterns are observed in different languages. It is also possible that in some languages, the distinction is not reflected by any overt case marking or agreement; the theory itself does not constrain this in any way.

3.5.4 Universality

From these examples it is clear that secondary objects are very similar to obliques in being semantically restricted and covering a similar set of semantic roles. Secondary objects have to be recognized only in those languages where there is evidence that some arguments are more prominent than obliques (e.g. in case marking, verb morphology, or anaphora) but less prominent than direct objects. Not all grammars involve such fine-grained distinctions, and in this sense $\textsc{obj}_\theta$ is probably not universal.

In contrast, $\textsc{obl}_\theta$ as it is understood and used in LFG is, in effect, architecturally necessary,[11] because subj and obj provide only two positions, which is not enough to map all possible thematic roles that verbs may have.

Finally, it is theoretically possible that some languages do not make use of the gf obj. Such a language would have only one semantically unrestricted function, subj; all other arguments would be $\textsc{obj}_\theta$s or $\textsc{obl}_\theta$s with various semantic roles. It would also lack a passive, because, under Lexical Mapping Theory, passivization depends on the presence of a second $[-r]$ argument that is promoted to subject status. In effect, this would be a language where most semantic roles are directly encoded in the syntax, i.e. there is a one-to-one correspondence between gfs and thematic roles, except for one unrestricted argument. This idea has been discussed in two distinct flavours. Börjars & Vincent (2008) consider whether the obj vs. $\textsc{obj}_\theta$ distinction should be abandoned as such (i.e. all objects in all languages are $\textsc{obj}_\theta$s). In contrast, Lander et al. (2021) make this proposal for the specific case of West Circassian (West Caucasian). West Circassian, a polysynthetic language, has a rather unusual system of applicative prefixes that is unlike the more typologically common system discussed above for Hakha Lai: see (25) above. In Hakha Lai, additional arguments introduced by applicative morphology are promoted to obj status, while the erstwhile object is demoted to $\textsc{obj}_\theta$. In West Circassian, applicative prefixes simply introduce additional arguments without altering the status of existing arguments. The absolutive argument is not indexed on the verb and the corresponding full NP (if present) bears Absolutive case. All other arguments are introduced by prefixes and their full NP counterparts bear Oblique case. For example, in (33) the Absolutive Patient is ‘dishes’ (*laʁe-xe-r*) and has no corresponding verbal prefix. The three other arguments bear Oblique case: ‘boy’ (*č̣’ale-m*) corresponds to the prefix *jə-*, ‘girl’ (*pŝaŝe-m*) corresponds to *∅-r-* and ‘you’ is expressed only by the prefix *b-də-*.[12]

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[11] Assuming that $\textsc{obj}_\theta$ is not universal. Logically speaking, if the language only draws a distinction between subj, obj, and all other arguments, it does not matter whether the latter are called $\textsc{obj}_\theta$ or $\textsc{obl}_\theta$.

[12] The colours represent the morphemes and f-structures associated with the arguments of the clause, for easier comprehension. The ergative subject (‘boy’) is in red, the oblique-marked recipient (’to the girl’) is in brown, and the caseless comitative pronoun (’with thee’) is in blue.

(33) West Circassian (West Caucasian)
č̣’ale-m$_i$ pŝaŝe-m$_j$ laʁe-xe-r we$_k$
boy-OBL girl-OBL dish-PL-ABS you.SG
qə-b-$_k$də-∅-$_j$r-jə-$_i$tə-ʁe-x
DIR-2SG.IO-COM-3SG.IO-DAT-3SG.ERG-give-PST-PL
‘The boy gave the dishes to the girl with you (sg.).’ (Lander et al. 2021: 226)

Lander et al. (2021) argue for a syntactically ergative analysis of West Circassian, showing that the Absolutive argument has privileged status in certain constructions; it is assigned the grammatical function SUBJ. In contrast, they find no evidence for a distinction between different types of indexed arguments and analyze them all as OBJ$_\theta$: ergative agents are OBJ$_{\text{AGENT}}$, recipients are OBJ$_{\text{RECIP}}$, instrumentals are OBJ$_{\text{INSTR}}$ etc. Thus the sentence (33) gets the f-structure (34) in their analysis.

(34)
$$\left[\begin{array}{ll}
\text{PRED} & \text{‘GIVE}\langle\text{SUBJ, OBJ}_{\text{AG}}\text{, OBJ}_{\text{GOAL}}\text{, OBJ}_{\text{COM}}\rangle\text{’} \\
\text{TENSE} & \text{PAST} \\
\text{DIR} & \textit{Qə} \\
\text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘DISH’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{PL} \end{array}\right] \\
\text{OBJ}_{\text{AG}} & \left[\begin{array}{ll} \text{PRED} & \text{‘BOY’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{array}\right] i \\
\text{OBJ}_{\text{GOAL}} & \left[\begin{array}{ll} \text{PRED} & \text{‘GIRL’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{array}\right] j \\
\text{OBJ}_{\text{COM}} & \left[\begin{array}{ll} \text{PRED} & \text{‘PRO’} \\ \text{PERS} & 2 \\ \text{NUM} & \text{SG} \end{array}\right] k
\end{array}\right]$$

According to Lander et al., West Circassian does make use of the grammatical function OBL$_\theta$ for those arguments that are not indexed and are marked by postpositions, but there is no need for the grammatical function OBJ in this language.

4 Individual GFs

4.1 General remarks

In the preceding section, I described the cross-classification of grammatical functions according to three parameters: governability, termhood and semantic restrictedness. This subdivides the main GFS into four classes: (1) SUBJ and OBJ (governable semantically unrestricted terms); (2) OBJ_θ (governable semantically restricted term); (3) OBL_θ (governable semantically unrestricted non-term); (4) ADJ (ungovernable). However, this is not enough to characterize all the grammatical functions for the following reasons. First, (X)COMP and POSS, being restricted to rather specific syntactic configurations, do not readily fit into this picture: while (X)COMP is certainly governable, it is not clear whether it is a term; as for POSS, while it is certainly semantically unrestricted, it is not clear whether it is a term and whether it is, in fact, governable. Secondly, the distinction between SUBJ and OBJ remains unspecified.[13] Thirdly, the cross-classification of grammatical functions is not meant to explain all of their properties: even grammatical functions like OBJ_θ, whose existence is predicted by the cross-classification itself, may have individual properties that do not follow from their class membership.

Therefore, in this section, I will proceed from the "big picture" drawn above towards characterizing the unique properties of some of the more distinct grammatical functions in LFG, sometimes together with other GFS in order to provide a better contrast. Subjects are opposed to all other grammatical functions and will be discussed separately in Section 4.2. Many LFG approaches treat clausal complementation and nonverbal predication similarly, and both are discussed in Section 4.3. The treatment of possessors in LFG is rather special: in many ways they are like subjects, but they are also sometimes viewed as being ungovernable, likening them to adjuncts instead. Accordingly, they are given a separate treatment in Section 4.4.

4.2 Subjects

All grammatical frameworks that have any notion of grammatical function assign a special status to the subject. Its properties are mainly derived from its position at the top of the functional hierarchy, and are discussed in Section 4.2.1. The centrality of the subject also raises the question of its universality, which can be approached from three different perspectives. First, is the subject universal across sentences within a single language, i.e. do all sentences have to have a subject (Section 4.2.2)? Secondly, do all languages map semantic arguments to subjects in the same way? For example, do ergative languages employ the same mapping as accusative languages? This is discussed in Section 4.2.3. Finally, is

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[13] As mentioned above, Lexical Mapping Theory classifies them both as semantically unrestricted [$-r$], but OBJ is "objective" [$+o$] while SUBJ is not [$-o$]. But this distinction only plays a role in mapping thematic roles to grammatical functions; it is not relevant for the actual syntactic properties of subjects and objects, which is the focus of this chapter.

the notion of subject universal at all – are there languages where no single argument can be identified as the priority target of most syntactic relations and processes (Section 4.2.4)?

4.2.1 Core properties

The subject can be characterized as the most prominent argument in the clause, both in terms of the hierarchy in (7) and in that it is usually the sentence topic (at least in syntactically accusative languages). As with all other GFs, there is no specific set of tests that would define subjects cross-linguistically. Rather, being highest-ranking in the Keenan-Comrie hierarchy, they are expected to always participate in processes that are dependent on this hierarchy. More specifically, if a syntactic construction always targets only one argument of a clause, this argument is likely to be identified as the subject. Many tests for subjecthood have been proposed in the literature (for one summary, see Andrews 2007);[14] in the end, the particular set of diagnostics should be identified on a language-by-language basis.

One diagnostic is agreement. We have seen above that cross-linguistically, only terms can control agreement. But if any one term is the sole agreement controller in a language, this has to be the subject. Moravcsik (1978: 364) proposes a typological universal: if a language has agreement with anything other than an intransitive subject, it also has to exhibit agreement with the intransitive subject. Note that this universal is carefully formulated to include ergative languages (which only show S/P agreement) and does not automatically identify the subject in the "accusative" sense (A/S). I will return to the question of subjecthood in non-accusative languages below.

It also seems that only subjects can be "raised",[15] i.e. in LFG terms, shared (functionally controlled) with a term argument in the main clause. English only has subject-to-subject (35) and subject-to-object (36) raising.[16]

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[14] Subject criteria that are commonly proposed in the literature include: case marking and agreement; ellipsis under coordination; binding of reflexive pronouns; control of null subjects (PRO) of infinitives and gerunds; selection in switch reference systems (same-subject / different-subject). Many more language-specific tests have been proposed as well.

[15] Based on cross-linguistic data, Falk (2006: 155-161) argues that only arguments bearing the grammatical function PIVOT (in accusative languages equal to SUBJ, see Section 4.2.3) can be controllees in functional control (raising) constructions, with the only exception being certain Polynesian languages. For the latter, he allows the possiblity of inside-out licensing of functional control, which does not obey his generalization on PIVOT.

[16] A reviewer proposes English sentences like *This book is tough to read* as potential counterexamples; however, Dalrymple & King (2000) argue that this construction involves anaphoric control rather than raising/functional control (see Section 3.4.2 above for a termhood constraint on anaphoric controllees in certain languages).

(35) **John** seemed [__ to agree].

(36) John believed **David** [__ to be crossing the street].

In Icelandic, the raising rule also applies to non-nominative ("quirky") subjects (Andrews 1982). Thus, in (37a–c) the verbs select accusative, dative and genitive subjects, respectively.

(37) Icelandic (Germanic > Indo-European)

a. **Drengina** vantar mat.
boys.DEF.ACC lacks food.ACC
'**The boys** lack food.'

b. **Barninu** batnaði veikin.
child.DEF.DAT recovered.from disease.DEF.NOM
'**The child** recovered from the disease.'

c. **Verkjanna** gætir ekki.
pains.DEF.GEN is.noticeable not
'**The pains** are not noticeable.'

This case marking is retained under raising in the main clause (38). These examples also illustrate how subjecthood is independent not only from semantic role, but also from case marking.

(38) a. Hann telur **mig** (í barnaskap sínum) [vanta peninga].
he believes me.ACC in foolishness his to.lack money.ACC
'He believes **me** (in his foolishness) to lack money.'

b. Hann telur **barninu** (í barnaskap sínum) [hafa
he believes child.DEF.DAT in foolishness his to.have
batnað veikin].
recovered.from disease.DEF.NOM
'He believes **the child** (in his foolishness) to have recovered from the disease.'

c. Hann telur **verkjanna** (í barnaskap sínum) [ekki gæta].
he believes pains.DEF.GEN in foolishness his not noticeable
'He believes **the pains** (in his foolishness) not to be noticeable.'

4.2.2 Subjectless sentences?

A persistent question in theoretical linguistics is whether subjects are universal — that is, if subjectless sentences exist. Note that the very fact that this is a valid question follows from the LFG assumption that GFs like SUBJ are theoretical primitives (even if they tend to be associated with a set of typical empirical diagnostics). Were the subject only defined as the highest-ranking argument in a list of ARGS (as in Simpler Syntax and some variants of HPSG), each clause would automatically have a "subject" as long as its predicate had any syntactic arguments. In LFG, subjects are also assumed to be, by and large, prominent in different senses (more on this below), but this does not entail that subjectless sentences cannot exist, if only at the periphery of grammar.

That being said, the Subject Condition in (39) is widely assumed to hold in LFG (Bresnan & Kanerva 1989) — as a theoretical stipulation, not as a consequence of the framework's architecture. Most versions of the Lexical Mapping Theory also predict that one of the arguments will always be mapped to SUBJ.

(39) Subject Condition:
Every verbal predicate must have a subject.

The Subject Condition certainly holds in English, as well as in many other languages. But is it universal? Examples like (40) from German and (41) from Russian at first sight seem to be exceptions to the Subject Condition.

(40) German (Germanic > Indo-European)
… weil getanzt wird
because danced become.PRS.3SG
'because there is dancing'

(41) Russian (Slavic > Indo-European)
menja tošnit
I.ACC nauseate.PRS.3SG
'I feel sick.'

The German example in (40) has an intransitive verb with no overt arguments, even though German is generally not a pro-drop language. The Russian verb in (41) only has an accusative experiencer argument; while Russian does allow null subjects, it does so in a limited number of contexts and always optionally, while here no nominative argument can be expressed. However, Berman (1999, 2003) argues that the agreement morphology indicates that German examples contain a null expletive subject with only pers and num features, and no pred value. The same analysis can be extended to the Russian data.

A more convincing case for subjectless sentences is found in the Polish examples like (42), discussed in Kibort (2006). In this construction, the verb stands in the infinitive form, thus having no agreement morphology. To Kibort, this indicates that such sentences are truly subjectless. The agent may be optionally expressed, but as an oblique prepositional argument — not as a subject.

(42) Polish (Slavic > Indo-European)
Słychać ją / jakieś mruczenie.
hear.inf her.acc some.n.acc murmuring(n).acc
'One can hear her/some murmuring.'

Subjectless sentences also appear in Lowe et al.'s (2021) analysis of the Sanskrit raising verb *śak* 'can'. When this verb is passivized, one of the possible outcomes is for the raised subject of the subordinate clause to stand in the instrumental case, while the object remains in the accusative:

(43) Sanskrit (Indo-Aryan > Indo-European)
rājabhī rāmaṃ hantuṃ na śakyate
kings.ins R.acc slay.inf not can.pass.3sg
'Rāma cannot be slain by the kings.'

Lowe et al. argue that in this construction the matrix clause has two arguments: the instrumental as obl$_\theta$ and the subordinate clause as xcomp, and thus it has no overt subject.[17]

Thus, the Subject Condition may not be universal as a general rule — although it does hold as an overall tendency, since subjectless constructions, if there are any, are usually found only at the periphery of grammar.

4.2.3 Subjects in non-accusative languages

The universality of subjects can also be questioned in a different way: Does the same mapping between thematic roles and gfs obtain in all languages? This has long been debated in the literature concerning ergative and other non-accusative types of alignment. Most ergative languages are in fact only morphologically ergative, that is, have ergative case marking while syntactically behaving in the

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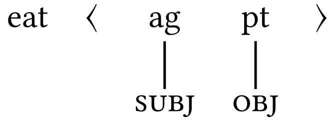
[17] Lowe et al. acknowledge that, if (x)comp is assumed not to exist as a separate gf (see Section 4.3.1), the clause itself will have to be treated as subj.

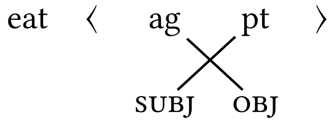
same way as accusative languages. But there are a few languages that have been claimed to be consistently syntactically ergative, e.g. Dyirbal (Dixon 1979), although this analysis is disputed, see Legate (2012); less common syntactic alignment types are attested as well. These facts call for an adjustment to the standard approach to argument mapping.

There are two basic proposals for treating non-accusative languages in LFG. One, developed in Manning (1996), is to preserve the standard set of gfs but map subj and obj to thematic roles in different languages in different ways. Thus, while intransitive verbs always have a single subj argument, transitive verbs in accusative languages map agents to subj and patients to obj (44a); in ergative languages, the mapping is reversed (44b).

(44) a. accusative



b. ergative



Thus, in ergative languages, the transitive agent (A) is obj while the transitive patient (P) is subj. This explains why the patient has subject-like properties in various constructions. Calling the agent a “direct object” is unfamiliar and confusing from a traditional perspective, which is why Manning proposes an alternative nomenclature of pivot (= subj) and core (= obj, for core argument) instead.

This approach works well for languages where one of the arguments fully “takes over” all syntactic properties of subjecthood. However, such languages are an exception rather than the norm. More commonly, subject properties are distributed between the transitive agent (A) and the absolutive argument (P): some constructions are aligned in the ergative way, while others are still oriented towards A. For example, in Ashti Dargwa (field data), gender agreement on the verb follows the ergative pattern (S/P), and can even be long-distance (45), which suggests syntactic ergativity. But reflexive binding still prefers the A argment, as in accusative languages (46).

(45) Ashti (Dargwa > East Caucasian)

di-l	[šin	**d**-eč:-ib]	ha<**d**>eχʷ-i
I(m)-erg	water(npl)	npl-drink.pfv-pcvb	<npl>finish.pfv-pret

‘I finished drinking water.’

(46) a. rasul-li **sin-na** **sa-w** w-aˁqˁ.aqˁ-ipːi
R.-ERG self-GEN self-M(ABS) M-hurt.PFV-PRF.3
'Rasul (erg.) hurt **himself** (abs.).'

b. * **sin-na** **sin-dil** rasul w-aˁqˁ.aqˁ-ipːi
self-GEN self-ERG R.(ABS) M-hurt.PFV-PRF.3
(intended translation: 'Rasul hurt himself.'; lit. 'Himself (erg.) hurt Rasul (abs.).')

Falk (2006) observes that cross-linguistically, subject properties tend to fall into two classes exactly along these lines: anaphoric prominence, switch-reference, null expression, control of PRO (anaphoric control) and some other properties such as the ability to serve as the imperative subject are almost always tied to A/S, even in ergative languages. At the same time, properties related to cross-clausal continuity – functional control, extraction properties, long-distance agreement – and certain secondary properties (external structural position in non-configurational languages, agreement) may be tied to different arguments of the clause in different languages.

Accordingly, Falk proposes to recast the traditional LFG grammatical function SUBJ as $\widehat{\text{GF}}$, which is the most prominent argument (A/S), while introducing the additional clausal continuity function PIVOT, which can be identified with either $\widehat{\text{GF}}$ or OBJ. Subjecthood properties are distributed between these two functions along the lines in (47).

(47) Subject properties according to Falk (2006)

$\widehat{\text{GF}}$	PIVOT
anaphoric prominence	extraction
anaphoric control	functional control
switch-reference	long-distance agreement
null expression	obligatory element
imperative subject	"external" structural position

Of these two functions, only $\widehat{\text{GF}}$ can be properly called a grammatical function: it replaces SUBJ in the argument lists of PRED feature values; in terms of Lexical Mapping Theory, it is this function that the most prominent argument on the semantic role hierarchy is mapped to. PIVOT always has to be structure-shared with one of the verbal arguments and is thus more correctly characterized as an overlay function (see Section 5).

All the diverse surface manifestations of pivot can be generalized in what Falk calls the Pivot Condition, informally summarized in (48). This condition means that all cross-clausal dependencies, if they are not stated in terms of special overlay functions for long-distance dependencies such as dis (for “dislocated”, or topic and focus in earlier approaches: see Section 5 and Kaplan 2023 [this volume]) must be tied to pivot. Thus pivot is the locus through which argument information is shared across clauses.

(48) Pivot Condition:
A path inward through f-structure into another predicate-argument domain or sideways into a coordinate f-structure must terminate in the function pivot. (Falk 2006: 78)

In English, and in other purely accusative languages, $\widehat{\text{gf}}$ and pivot are always occupied by the same f-structure. Falk calls such systems “uniform-subject”. In other languages, these do not always coincide — this class of languages is called “mixed-subject”. The mixed-subject class is not uniform. Its most widespread members are ergative languages, where pivot is identified with $\widehat{\text{gf}}$ in intransitive clauses and with obj in transitive clauses.

Given the facts in (45)–(46), Ashti Dargwa can be analyzed as a mixed-subject, ergative language, with the f-structure of a transitive sentence ‘the girl drank water’ as in (49).

(49)
$$\left[\begin{array}{ll} \text{PRED} & \text{‘DRINK}\langle\widehat{\text{GF}}\ \text{OBJ}\rangle\text{’} \\ \widehat{\text{GF}} & \left[\begin{array}{ll} \text{PRED} & \text{‘GIRL’} \\ \text{NUM} & \text{SG} \\ \text{GEND} & \text{F} \\ \text{CASE} & \text{ERG} \end{array}\right] \\ \text{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘WATER’} \\ \text{NUM} & \text{PL} \\ \text{GEND} & \text{N} \\ \text{CASE} & \text{ABS} \end{array}\right] \\ \text{PIVOT} & \rule{3cm}{0.4pt} \end{array}\right]$$

The Philippine type of alignment, illustrated in (23) above, where any argument can become the “subject” through voice morphology, is interpreted by Falk as promotion to pivot, as in (50); the most prominent argument, $\widehat{\text{gf}}$, does not change its mapping.

(50)	“Active voice”:	$(\uparrow \text{PIVOT})=(\uparrow \widehat{\text{GF}})$
	“Direct object voice”:	$(\uparrow \text{PIVOT})=(\uparrow \text{OBJ})$
	“Indirect object / locative voice”:	$(\uparrow \text{PIVOT})=(\uparrow \text{OBJ}_{\theta})$
	“Instrumental voice”:	$(\uparrow \text{PIVOT})=(\uparrow \text{OBL}_{\text{INS}})$
	…	

Some languages do not entirely fit the uniform- vs. mixed-subject distinction. In topic prominent languages like Acehnese, PIVOT is identified with any of the core arguments ($\widehat{\text{GF}}$ and OBJ) provided that it bears the information structure function TOPIC, according to Falk’s (2006: 172) interpretation of the data in Durie (1985). Thus Falk’s approach does not require PIVOT to be necessarily tied to particular argument functions.

4.2.4 Universality

Since Falk’s framework splits the traditional SUBJ into two grammatical functions that may be identified with different arguments in different languages and constructions, it follows that the subject in the traditional sense – i.e. a single highest-ranking grammatical function that dominates all syntactic rules and processes – is not universal. But we may also ask whether $\widehat{\text{GF}}$ and PIVOT are universal. There are two ways in which a language may be said to lack $\widehat{\text{GF}}$. One is that this language encodes thematic roles directly in the syntax. Such claims have been made for different languages in the literature, especially in the typological tradition. Falk (2006: 169) observes that in LFG terms, this amounts to saying that the language only has oblique GFS: OBL_{AGT}, OBL_{PAT}, etc. This, in turn, entails that the language would have no distinction between core and non-core arguments — a prediction that has empirical consequences. Evaluating such a possibility for Acehnese, one language that has been claimed to lack reference to grammatical relations in its grammar (Van Valin & LaPolla 1997), Falk concludes that its syntax does distinguish core functions from non-core functions and thus requires reference to $\widehat{\text{GF}}$. Similarly, Kibrik (2000), as mentioned in Section 3.4.3, argues that most constructions in Archi (Lezgic > East Caucasian) are only sensitive to the term (core argument) vs. non-term distinction. But there is one construction in Archi that is oriented towards A/S arguments (i.e. in Falk’s terms, $\widehat{\text{GF}}$): clausemate reflexivization. Nevertheless, the theoretical possibility of languages only having oblique arguments still exists and deserves to be investigated in more detail, although, based on the current state of our understanding, their existence does not seem likely.

Another sense in which a language may lack $\widehat{\text{GF}}$ is, conversely, if it draws a more fine-grained distinction between core arguments, i.e. does not unify the transitive agent (A) and the sole intransitive argument (S) in any way.[18] Again, this approach is widespread in the typological / functionalist tradition, a prominent example being Dixon (1994), who treats A, S and P as syntactic primitives. This is useful for purposes of typology and cross-linguistic comparison: A, S and P serve as valid comparative concepts in the sense of Haspelmath (2009). But applied to individual grammars, this distinction seems too fine-grained, failing to capture important generalizations. It is well-known, for example, that $\widehat{\textsc{gf}}$ outranks other arguments in anaphoric constructions in the overwhelming majority of languages, regardless of their other alignment patterns. Nor do “syntactically tripartite” languages with S, A and P having distinct, non-intersecting sets of properties seem to be attested.[19]

Thus, $\widehat{\textsc{gf}}$ is likely to be universal. A separate question is what a pivotless language could look like, and whether such languages exist. A pivotless language is *not* a language where the pivot cannot be readily identified with any grammatical function; it could be identified with the topic, as in Acehnese, or with the highest-ranking argument on the person hierarchy, as in some analyses of Ojibwe (Algonquian > Algic, Rhodes 1994). A pivotless language would rather lack constructions of the kind that are predicted to be pivot-sensitive by the Pivot Condition (48). For example, there would be no cross-clausal extraction, with all interrogatives and relatives being localized in their local domains; coreference in coordination and in other multiclausal constructions would similarly involve no pivot sensitivity. Falk argues that at least two languages, Choctaw and Warlpiri, qualify for pivotless status. Thus, unlike $\widehat{\textsc{gf}}$, pivot is not universal according to Falk.

Falk’s approach is insightful and makes a number of strong claims that deserve more thorough cross-linguistic investigation. It is widely accepted as the most

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[18] Another possible complication for Falk’s theory, and the LFG view of grammatical relations in general, are so-called split-S languages, cf. Van Valin (1990), sometimes described as languages with active alignment, a view that goes back at least to Sapir (1911). In such languages, the marking of S depends on the properties of the clause or the predicate, such as agentivity, control, and telicity. Unaccusativity (Perlmutter 1978) is a related phenomenon inasmuch as it amounts to a difference between classes of intransitive verbs or intransitive subjects. It is not obvious that this difference in marking requires distinguishing between two different gfs. LFG work has tended to describe split intransitivity in terms of argument structure (cf. Bresnan & Zaenen 1990 on unaccusativity in English) or semantics (cf. Belyaev 2020 on split S marking on the verb in Ashti Dargwa). However, split intransitivity / active alignment still requires a more thorough and systematic treatment in LFG.

[19] Kibrik (1997: 323-326) claims that syntactically tripartite alignment is observed in Jacaltec (Mayan), based on the analysis in Van Valin (1981), who identifies multiple pivots in the language. However, Falk (2006: 93-94) interprets Jacaltec as syntactically ergative in terms of his LFG anlaysis instead.

adequate solution for ergativity and other syntactic alignments within LFG, although many authors still continue using the SUBJ-OBJ distinction for languages where Falk's fine-grained analysis is irrelevant, i.e. mainly in syntactically accusative languages. Falk's notion of $\widehat{\text{GF}}$ and PIVOT also has yet to be fully integrated with the recent developments in the relevant areas of LFG, such as Lexical Mapping Theory and semantic composition.

4.3 Complementation and nonverbal predication

In the preceding sections, I have mostly avoided discussing sentential complements, because their specialized grammatical function COMP stands apart from other grammatical functions in LFG. COMP is not readily classifiable in terms of termhood and semantic restrictedness, and its limitation to a single semantic type (clauses / states of affairs) is unusual for LFG. In fact, the very existence of (X)COMP as a separate GF has been questioned in the theoretical literature, as discussed in Section 4.3.1. In Section 4.3.2, I discuss the difference between closed (COMP) and open (XCOMP) complements. Nonverbal predication is also sometimes analysed using the grammatical function XCOMP, and therefore it is discussed under the same umbrella in Section 4.3.3.

4.3.1 The status of COMP

The status of COMP as a specialized grammatical function in LFG is controversial. From the beginning, it was assumed that *all* clausal complements are classified as COMP (Kaplan & Zaenen 1989, Bresnan et al. 2016). As a formal assumption, this idea is suspect: the spirit of LFG is generally to separate categorial and functional information, such that f-structure should not draw a distinction between NP and CP complements. For this reason, the very existence of COMP has been questioned, first in Alsina et al. (1996), who proposed that COMP can be replaced by OBJ.

One argument in favour of COMP is the fact that it can coexist with OBJ and OBJ_θ, as in (51).

(51) David bet $[\text{Chris}]_{\text{OBJ}}$ $[\text{five dollars}]_{\text{OBJ}_{\text{GOAL}}}$ $[\text{that he would win}]_{\text{COMP}}$.

As a further argument, Dalrymple & Lødrup (2000) show that while many clausal complements in English, German and Swedish do, indeed, behave like objects, others do not. For example, in German the complement of the verb 'believe' can be replaced by a pronoun and moved to clause-initial position (52); the latter option is also available for ordinary object NPs (53). In contrast, neither option is possible for complements of 'be happy' (54).

(52) German (Germanic > Indo-European)
a. Ich glaube [**dass** die Erde rund ist].
I believe that the earth round is
'I believe **that** the earth is round.'
b. Ich glaube es.
'I believe **it**.'
c. [**Dass** Hans krank ist] glaube ich.
that Hans sick is believe I
'**That** Hans is sick, I believe.'

(53) Einen Hund habe ich gesehen.
a dog have I seen
'A dog, I have seen.'

(54) a. Ich freue mich [**dass** Hans krank ist]
I gladden myself that Hans sick is
'I am happy that Hans is sick.'
b. * Ich freue mich **das** / **es**.
('I am happy it.')
c. * [**Dass** Hans krank ist] freue ich mich.
('**That** Hans is sick, I am happy.')

Dalrymple & Lødrup (2000) conclude that while clausal arguments of verbs like 'believe' do indeed bear the function OBJ in German, complements of verbs like 'be happy' should be recognized as genuine COMPs. However, Alsina et al. (2005) contest this conclusion by appealing to the data of Catalan and Spanish. They claim that both examples like (51) and the data cited by Dalrymple and Lødrup only show that OBJ alone is not enough to capture the behaviour of all types of clausal complements. But if some complements are treated as OBJ$_\theta$ and OBL$_\theta$, they can coexist with direct objects, and their syntactic properties can be adequately captured. A similar conclusion is reached in Forst (2006) for the German data.

This debate still continues in the LFG literature. Thus Belyaev et al. (2017) conclude that the syntax of complementation in Moksha Mordvin requires appealing to COMP in addition to OBJ and OBL$_\theta$. Moksha has object agreement morphology on transitive verbs. As discussed in Section 3.4 above, agreement is a feature of terms; clausal complements controlling agreement may thus be viewed as OBJ. In Moksha, there is a split according to this criterion. Factives control agreement, and they can also be replaced by pro-forms (55), like OBJ-complements in German, passivized, coordinated with nouns, and replaced by quantificational expressions.

(55) Moksha Mordvin (Mordvinic > Uralic)
factive complements

a. object agreement
učit'əl'-s' **sodas-in'ə /** *soda-s' [**što**
teacher-DEF.SG[NOM] know-NPST.3PL.O.3SG.S know-NPST.3SG COMP
pet'ɛ er' mejn'ɛ vor'g-əčn'-i urok-stə]
Peter every what.TMPR run.away-IPFV-NPST.3SG class-EL
'The teacher **knows** (SUBJ-OBJ) **that** Peter always misses classes.'

b. pronominalization
mon kunarə soda-jn'ə [što vas'ɛ
I[NOM] for.a.long.time know-PST.3.O.1SG.S COMP Basil[NOM]
ašč-əl' t'ur'ma-sə] — də mon-gə **t'ɛ-n'** soda-sa
be-PQP.3SG prison-IN yes I-ADD this-GEN know-NPST.3SG.O.1SG.S
'I have known (SUBJ-OBJ) for a long time that Basil had been in prison. – Yes, I know (SUBJ-OBJ) **it** too.'

Other complement clauses do not control matrix verb agreement, i.e. the verb only agrees with the subject. However, this class is not homogeneous. Some non-factive complements, such as the complement of 'fear', can be replaced by pronominal postpositional phrases or oblique case-marked pronouns — these can uncontroversially be classified as obliques (56). But complements of other non-factives, such as the verb 'say', cannot be replaced by a pronoun — an adverbial 'so' should be used instead (57). They also cannot be replaced by quantificational expressions or coordinated with a nominal argument. Belyaev et al. (2017) conclude that this latter class of complements, being distinct from both OBJ and OBL$_\theta$, should be assigned the grammatical function COMP.[20]

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[20] Another option is available: these non-agreeing complements can be OBJ$_\theta$. This idea is appealing because Dalrymple & Nikolaeva (2011) analyze some unmarked direct objects in DOM systems as OBJ$_\theta$. In Moksha, which displays DOM, direct objects can be nominative (unmarked) or genitive. Indeed, it is unmarked direct objects in Moksha that are similar to complements of verbs like 'say': they do not trigger agreement, cannot be used with quantifiers; pronominal objects are always case-marked, etc. However, it is not clear whether unmarked and genitive direct objects in Moksha should be assigned to different grammatical functions: for instance, a marked and an unmarked direct object can be coordinated (Natalia Serdobolskaya, p.c.). In contrast, complements of verbs like 'say' cannot be coordinated with a noun phrase (Belyaev et al. 2017). Thus for Moksha the answer depends on whether unmarked direct objects in this language are OBJ$_\theta$s and on whether the coordination facts can be given an alternative explanation.

(56) Moksha Mordvin (Mordvinic > Uralic)
non-factive ‘fear’: pronominalization
mon dumand-an [što vas’ɛ af pastupanda-v-i]
I[NOM] think-NPST.1SG COMP Basil[NOM] NEG enter-PASS-NPST.3SG
institut-u — mon tožə **t’a-də** pel’-an
institute-LAT I[NOM] also that-ABL fear-NPST.1SG
‘I think (SUBJ) that Basil will not enter the university. — I am afraid (SUBJ) **of that** as well.’

(57) non-factive ‘say’: no pronominalization
nu mon **t’aftə** / *t’ɛ-n’ af dumand-an
well I[NOM] thus this-GEN NEG think-NPST.1SG
{Context: ‘Basil is so smart, he will surely pass the exams with excellent marks!’ —} ‘Well, I do not think (SUBJ) **so** / *that.’

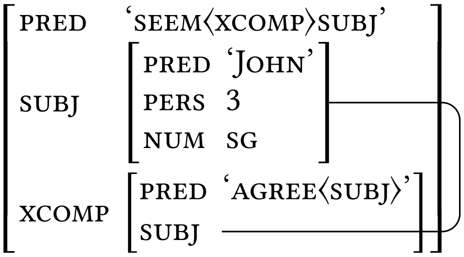
Not all languages with object agreement or indexing draw such a sharp distinction between different complement types, however. West Circassian (West Caucasian, polysynthetic), for example, treats most clausal complements in the same way as NP arguments, which is consistent with this language’s weak distinction between nouns and verbs (Letuchiy 2016).

Significant differences between clausal complements and “nominal” grammatical functions such as SUBJ and OBJ have also been described for Russian in Letuchiy (2012). Overall, the data strongly suggest that COMP should at least be recognized as a possible GF for clausal complements, although the extent to which languages use this possibility seems to vary. The semantic differences between OBJ and COMP complement clauses should also be investigated in more detail.

4.3.2 Open and closed complements

We mentioned above that clausal complements in LFG are split into two grammatical functions: COMP and XCOMP. The former is called ‘closed’, the latter ‘open’. Closed clausal complements are, in principle, fully self-contained and have their own subjects (e.g. finite complement clauses); the latter do not have a subject, which has to be structure shared with an argument of another clause. Open complements (XCOMP) appear in structures called FUNCTIONAL CONTROL, which involves structure sharing of an argument of the matrix clause and an argument (usually the subject) of the subordinate clause. Functional control is generally used to represent so-called raising constructions, as in (35), repeated here, with the f-structure in (58).

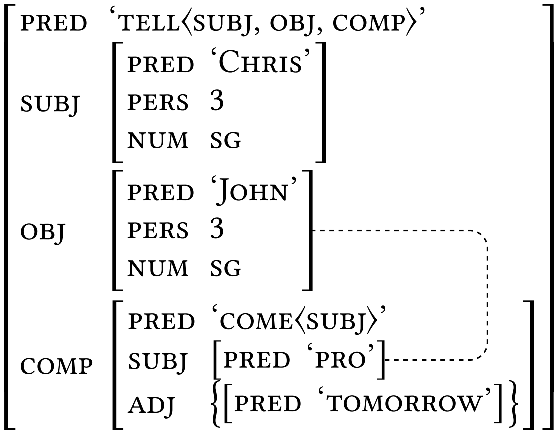
(35) **John** seemed [__ to agree].

(58)


Functional control in LFG is opposed to anaphoric control, which is often employed to analyse the construction known as Equi or simply control in English, see (59).[21]

(59) Chris told John$_i$ [(PRO$_i$) to come tomorrow].

Anaphoric control involves no structure sharing but only a covert pronominal subject in the subordinate clause (PRO); accordingly, complements whose subject is anaphorically controlled are treated as closed (COMP). The f-structure of (59) is shown in (60), where the dashed line indicates coreference.

(60)


It is not clear if the distinction between COMP and XCOMP is really needed to account for the behaviour of control constructions. After all, equations that enforce structure sharing automatically ensure that the subject of the complement clause is overtly expressed only once: double expression would cause a PRED conflict. F-structure does not take the linear order or c-structure position of elements

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[21] The discussion here presents a simplified view of the issue. In some LFG work, functional control is not limited to raising constructions but is also used in the analysis of some or all of the constructions traditionally called Equi or control. See Vincent 2023 [this volume] for detailed information on control and raising in LFG.

into account, therefore it does not matter, in principle, *where* the argument is expressed. This means that LFG allows Backward Raising constructions as in the West Circassian (61) by default (Sells 2006). In (61), the “raised” NP is overtly expressed only in the subordinate clause, which is seen in its case marking: the ergative is selected by the verb ‘lead’. The main clause subject, if it were overt, would have been in the absolutive (as seen in the crossed out pronoun).

(61) West Circassian (West Caucasian)

~~a-xe-r~~	[a-xe-me	se	s-a-š’e-new]
dem-pl-abs	dem-pl-erg.pl	1sg.abs	1sg.abs-3pl.erg-lead-inf

∅-fjež’a-ʁe-x
3abs-begin-pst-3pl.abs
‘They began to lead me.’ (Potsdam & Polinsky 2012: 76)

The English counterpart to this example would be **Began* [*they to lead me*] (or, to provide an uncontroversial example of raising, **Seem they to come*). The ungrammaticality of such examples requires independent explanation (for example, English xcomps are expressed by VPs at c-structure, which do not have a subject position). See Vincent 2023: §7 [this volume] for further discussion of LFG analyses of backwards raising.

Similarly, anaphoric control is typically analyzed as coreference that is syntactically enforced through equations like (↑ subj index) = (↑ comp subj index)[22] and, possibly, (↑ comp subj pred)=‘pro’. If the latter equation is present, an overt subject in the complement clause is precluded due to pred conflict. If it is not, argument expression is only constrained by general anaphoric requirements, which is why Backward Control (Polinsky & Potsdam 2002) is impossible in most languages due to Principle C violations (see Rákosi 2023 [this volume] for details on Principle C).

Crucially, such constraints follow from universal considerations, functional equations and general principles of individual grammars, but not from complements being xcomp rather than comp. Thus, it is not clear whether the traditional distinction between comp and xcomp is anything more than a useful notational convention; both could be said to refer to the same GF.

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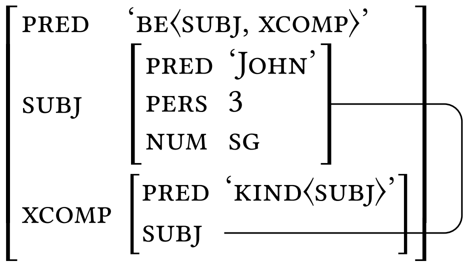
[22] In an approach where coreference is a semantic relation, such as Haug (2013), it cannot be enforced directly in the f-structure, but it can be done via a Glue meaning constructor (Haug 2014, Asudeh 2023 [this volume]).

4.3.3 Nonverbal predication

Traditionally, XCOMP was used in LFG to represent nonverbal predicates, treating them as arguments of copular verbs such as *be*, as in (62).

(62) a. John is kind.

b.



$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{be}\langle\textsc{subj, xcomp}\rangle\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`John'} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \textsc{xcomp} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{kind}\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \end{array}\right] \end{array}\right]$$

This effectively makes the nonverbal predicate into a kind of small clause. The main problem with this approach is that all lexical items that can serve as predicates must have two subcategorization frames, because in normal contexts at least nouns, and possibly adjectives (if they are not assumed to be predicated of their head noun), do not have a valency for SUBJ. As observed in Dalrymple et al. (2004), another problem for this approach is that clauses that already have subjects may function as predicates, as in the sentence *The problem is that John came.* Such clauses have no open subject position to share with the matrix subject.

The main alternative is to replace XCOMP with a special grammatical function PREDLINK (Butt et al. 1999), which is not an open complement GF and therefore does not have to share a subject valency, see (63) for *John is kind* and (64) for *The problem is that John came.*

(63)

$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{be}\langle\textsc{subj, predlink}\rangle\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`John'} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \textsc{predlink} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{kind}\text{'} \end{array}\right] \end{array}\right]$$

(64)

$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{be}\langle\textsc{subj, predlink}\rangle\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{problem}\text{'} \\ \textsc{det} & \textsc{def} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \textsc{predlink} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{come}\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`John'} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \end{array}\right] \end{array}\right]$$

One drawback of the PREDLINK approach compared to the XCOMP approach is related to the fact that in languages with adjective agreement, such as Russian (65), the predicative adjectives agree in gender with the subject. In (65a), the word *komnata* 'room' is feminine, and therefore the predicative adjective *malen'kaja* is feminine. In (65b) *dom* 'house' is masculine, and the adjective is also masculine.

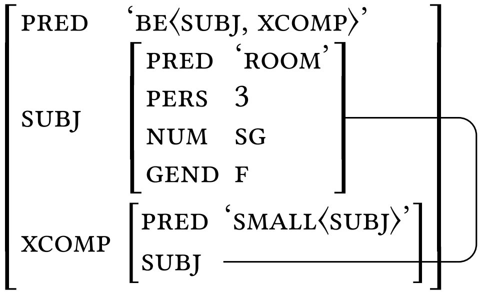
(65) Russian (Slavic > Indo-European)

a. Komnata byla malen'kaja.
room(F).SG.NOM was.F.SG small.F.SG.NOM
'The room was small (f.).'

b. Dom byl malen'kij.
house(M).SG.NOM was.M.SG small.M.SG.NOM
'The house was small (m.).'

This is straightforward to capture in the XCOMP approach, because the adjective has its own local subject with which it can agree: see (66).

(66)

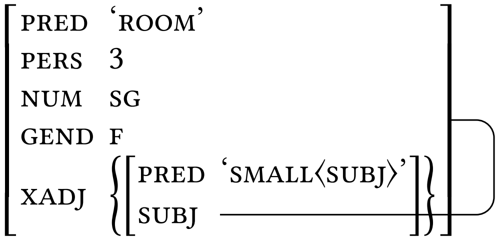


Adnominal adjectives like in (67a) can be treated in the same way by using a cyclic f-structure (67b) (see Haug & Nikitina 2012), requiring only one agreement pattern in the lexical entry (68).

(67) Russian (Slavic > Indo-European)

a. malen'kaja komnata
small(F).SG.NOM room(F).SG.NOM
'small room'

b.



(68) *malen'kaja* A (↑PRED) = 'SMALL⟨SUBJ⟩'
(↑ SUBJ NUM) = SG
(↑ SUBJ GEND) = F

In the PREDLINK approach, agreement rules will have to be more complex, utilizing inside-out functional expressions as in (69a) for adnominal adjectives and (69b) for predicative adjectives.

(69) a. ((ADJ ∈ ↑) NUM) = SG
b. ((PREDLINK ↑) SUBJ NUM) = SG

Yet another approach is to unify the f-structure of the nonverbal predicate with the f-structure of the clause (via ↑=↓); this is proposed in Dalrymple et al. (2004) for languages like Japanese, where predicative adjectives do not require a copula (70).

(70) Japanese (Japonic)
a. hon wa akai
book TOPIC red
'The book is red.'
b. $\left[\begin{array}{ll} \text{PRED} & \text{`RED}\langle\text{SUBJ}\rangle\text{'} \\ \text{SUBJ} & \left[\text{PRED `BOOK'}\right] \end{array}\right]$

In Japanese, this analysis is quite reasonable because adjectives are morphologically a subclass of verbs. It is plausible to assume that even adnominal adjectives have subjects, and thus always have PRED values like 'RED⟨SUBJ⟩'. But for languages like Russian, where adjectives inflect like nouns, there is less evidence in favour of treating each adjective as having a subject. Therefore, this analysis suffers from the same disadvantage as the XCOMP approach, in requiring two lexical definitions for each adjective or noun. Apart from this, it is structurally quite distinct from both the XCOMP and the PREDLINK approaches in being monostratal. Overall, as Dalrymple et al. (2004) conclude, it is likely that all three approaches are required to account for different constructions in different languages. For more information on copular constructions in LFG, see Dalrymple et al. (2019: 189–197).

4.3.4 The classification of comp

4.3.4.1 Termhood The termhood of sentential complements has not been frequently discussed in the literature. In no small part this is due to the unclear status of the grammatical function comp itself (see Section 4.3.1 above). A number of arguments in favour of treating comp as a non-term gf are given in Dalrymple et al. (2019). If this view is combined with the idea that clausal complements are split between comp and obj (Dalrymple & Lødrup 2000), one can predict that in languages with object agreement, obj-like complements may trigger agreement on the verb while comps may not. This prediction is confirmed in languages like Moksha Mordvin (Mordvinic > Uralic), where, as Belyaev et al. (2017) argue, the verb agrees with obj-like complements (mainly those of factive verbs like ‘know’) but does not agree with comp-like complements (mainly propositional complements of verbs like ‘promise’):

(71) Moksha Mordvin (Mordvinic > Uralic)
učit’əl’-s’ **soda-si-n’ə** / *soda-s’ [**što**
teacher-def.sg[nom] know-npst.3pl.o.3sg.s know-npst.3sg comp
pet’ɛ er’ mejn’ɛ vor’g-əčn’-i urok-stə]
Peter every what.tmpr run.away-ipfv-npst.3sg class-el
‘The teacher **knows** (subj +obj) **that** Peter always misses classes.’

(72) paša **abəščanda-s’** / *abəščanda-z’ə [**što**
Paul[nom] promise-pst.3sg promise-pst.3sg.o.3sg.s comp
il̥’caman’ kud-u]
accompany.npst.1sg.o.3sg.s house-lat
‘Paul **promised** (subj) **that** he would accompany me home.’

4.3.4.2 Semantic restrictedness The status of (x)comp as semantically restricted is less clear. Certainly, sentential complements are semantically diverse: at least factives and non-factives have been distinguished since Kiparsky & Kiparsky (1970), and other distinctions since then have been discussed in the literature, such as between fact, proposition, event (Peterson 1997) and other abstract objects (Asher 1993). However, this is a difference in the semantic type of the argument and its entailments/presuppositions, which is not directly related to semantic roles; it might be more properly compared to the distinction between definite and indefinite NPs — given that definites, like factives, presuppose the existence of their referents, and have other similar properties (see Melvold 1991).

The range of semantic roles that clausal arguments can be associated with is difficult to resolve because these arguments are rather restricted in their distribution. There are very few verbs with two clausal arguments (exceptions being verbs like *prove*, *entail*, etc.), and these all have only subj and comp arguments; I am not aware of any verbs that have two sentential non-subjects (comp, obj or obl). Clausal arguments often cannot have the markings characteristic of NP arguments and hardly ever undergo valency-changing processes (even clausal complements classified as obj can be difficult to passivize). Hence, there is little distributional evidence that could help distinguish between the semantic roles of comp. On a purely speculative basis, one may say that most comps are Themes, some are Stimuli (mental predicates), and some could be classified as Goals (e.g. verbs like *try*). In terms of Dowty (1991), these all fall under the proto-role Patient; thus it is an open question whether these fine-grained distinctions are grammatically relevant. Zaenen & Engdahl (1994) believe that they are not, and that (x)comp is, in fact, semantically restricted, since this gf can only be occupied by clausal arguments. Similarly, Dalrymple & Lødrup (2000), who distinguish between comp and obj (see Section 4.3.1), assume that comp is semantically restricted and that this is what distinguishes comp from obj.

The alternative is simply to avoid definitively classifying comp and xcomp as either semantically restricted or semantically unrestricted. Falk (2001) proposes that comp and xcomp are different from all other gfs in having the positive value for a special feature [c] (for complement). In practical terms, this is equivalent to the position of Zaenen & Engdahl (1994). Another approach is to treat comp as underspecified for being semantically restricted or unrestricted, depending on the context, as in Berman's (2007) analysis of German.

The difficulties in resolving this question only serve to illustrate that comp and xcomp are really apart from all other gfs and require a special analysis – if they are to be distinguished at all, as discussed in detail in Section 4.3.1 above.

4.4 Possessors

The discussion of grammatical functions has so far avoided mentioning possessors. This is because, being nominal dependents, they are not easily comparable to other, clause-level gfs.

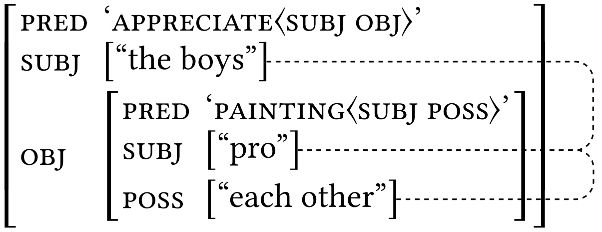
In LFG, possessors are standardly assumed to bear the grammatical function poss. Among clausal gfs, it is most similar to subj in two ways. First, it is the most prominent argument, as, apart from possessors, nouns may only have oblique dependents. Second, it is semantically unrestricted. It is well-known that possessors (in the syntactic sense, i.e. genitive dependents) can have a very wide range of relations to their heads. The semantic non-restrictiveness of possessors is also evident from the fact that in many languages, genitive marks the same arguments in non-finite clauses that are mapped to subj in finite clauses (73).

(73) a. **The enemy** destroyed the city.
b. **the enemy's** destruction of the city

Therefore, some authors propose reducing poss to subj (Sulger 2015). This solution seems too radical, however — at least for some languages. Chisarik & Payne (2003) were the first to introduce a hybrid approach that uses both subj and poss in noun phrases. They analyse English and Hungarian, which both allow two types of possessor expression: English has the "Saxon Genitive" *'s* and *of*-possessors, while Hungarian has nominative and dative possessors. Chisarik and Payne argue that English *'s*-possessors and Hungarian nominative possessors are subjs, while the other two types of possessors are adnoms, which correspond to poss. Laczkó (2004), critical of their analysis of the Hungarian data, also maintains that Hungarian possessors can be either subj or poss, but argues that the gf of the possessor is independent of its marking pattern. Laczkó further develops this analysis of Hungarian in a series of papers, in particular Laczkó (2009, 2017). Laczkó & Rákosi (2019) further argue that in some Hungarian examples such as (74), both subj and poss are present in the f-structure of the nominalization. In this case, the possessor is the reciprocal which triggers 3rd person singular agreement on the nominalized verb, while the subject is the null pronominal coreferent with 'boys' in the main clause (75).

(74) A fiúk$_i$ dijazzák [$_{\text{DP}}$ az egymás$_i$ lefest-és-é-t].
the boys appreciate.3pl the each.other paint-nmlz-poss.3sg-acc
'The boys appreciate the painting of each other.' (Laczkó & Rákosi 2019: 163)

(75)



If poss is a governable gf like subj, all nouns with optional possessors must be assumed to have two variant pred values: with and without a possessor valency, e.g. 'book' and 'book-of⟨poss⟩' (Bresnan 2001, Bresnan et al. 2016: 315 et passim). This seems undesirable, so Dalrymple et al. (2019) propose to treat poss as being ungovernable, like adj, but positioned at the top of the gf hierarchy, like subj. This means that poss is licensed in any f-structure having a pred value, including clausal f-structures; thus, additional care must be taken to ensure that poss is constrained not to appear in inappropriate positions.

5 Overlay and discourse functions

F-structures occupying gf feature values may have additional functions in the clause that link the f-structure to the wider syntactic or discourse context. Following Falk (2001: 59), who took the term from Johnson & Postal (1981), these can be called overlay functions because they must always be connected to arguments or adjuncts by either anaphora or structure sharing (according to Extended Coherence, see Fassi Fehri 1988, Zaenen 1985, Bresnan & Mchombo 1987, Bresnan et al. 2016: 62–63). One overlay function, pivot, serves to capture some of the subject properties of core arguments and has been discussed in Section 4.2.3. Two other important classes of functions are so-called grammaticalized discourse functions, which traditionally included topic and focus but are now increasingly replaced by a single function called dis or udf (discussed in Section 5.1), and functions like q or relpro that are intended to mark elements relativized, questioned, or otherwise selected to serve as input to other syntactic or semantic processes (discussed in Section 5.2).

5.1 topic, focus and dis

Since the earliest work in LFG, "grammatic(al)ized discourse functions" topic and focus have been used at f-structure to represent simultaneously the information structure status of participants and their role in establishing long-distance dependencies such as wh-extraction. It is also often assumed, e.g. in Bresnan (2001) and Bresnan et al. (2016), that subj is unique in being both a grammatical function and a discourse function. This is meant to represent the discourse prominence of subjects and capture some generalizations in the c- to f-structure mapping, but it also means that discourse functions in this understanding are not necessarily overlay functions.[23]

Under this view, f-structure combines morphosyntactic and information-structure features, which is against LFG's tendency for localizing different aspects of language structure at different projections or levels (see Belyaev 2023b [this volume] and Belyaev 2023a [this volume]). This, with other formal and empirical considerations, has caused recent work, notably King & Zaenen (2004) and Dalrymple & Nikolaeva (2011), to promote information structure to a separate projection (see Zaenen 2023 [this volume]), which has removed the need to represent notions such as topic and focus at f-structure. Therefore, many authors feel that only one overlay function is now sufficient for all topicalized, focalized or otherwise displaced material. This function has been variously called UDF for "unbounded dependency function" (Asudeh 2012), OP for "operator" (Alsina 2008), or DIS for "dislocated" (Dalrymple et al. 2019) in the literature.[24]

Regardless of whether DIS or TOPIC / FOCUS are used, these attributes have to be set-valued because there may be multiple dislocated elements in one sentence, whether in the same position, like in (76) from French, where two phrases are right-dislocated (with clitic resumption), or in different positions, as in (77) from English, where *Mary* and *me* are dislocated to the left and right edges of the clause, respectively.

(76) a. French (Romance > Indo-European)

Je	le	lui	ai	donné,	**le livre**,	**à Jean**.
I.CL	it.CL	to.him.CL	have	given	the book	to J.

'I gave it to him, the book, to Jean.'

---

[23] Falk (2006), whose approach was discussed in Section 4.2.3 above, introduces the overlay function PIVOT to account for those subject properties that are associated with syntactic prominence. Therefore, the properties that Bresnan et al. associate with SUBJ as a discourse function can instead be associated with PIVOT in Falk's approach, resolving the ambiguous status of subjects. I am grateful for this observation to an anonymous reviewer.

[24] The treatment of long-distance dependencies in LFG is described in detail in Kaplan 2023 [this volume]; here, I will only discuss issues related to the role overlay functions play in their analysis.

b.

$$\begin{bmatrix}
\text{PRED} & \text{‘GIVE}\langle\text{SUBJ, OBJ, OBJ}_{\text{RECIP}}\rangle\text{’} \\
\text{TENSE} & \text{PAST} \\
\text{DIS} & \left\{ \begin{matrix}
\begin{bmatrix} \text{PRED} & \text{‘BOOK’} \\ \text{DEF} & + \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{GEND} & \text{M} \end{bmatrix} \\
\begin{bmatrix} \text{PRED} & \text{‘JEAN’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{GEND} & \text{M} \\ \text{PCASE} & \text{A} \end{bmatrix}
\end{matrix} \right\} \\
\text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{‘PRO’} \\ \text{PERS} & 1 \\ \text{NUM} & \text{SG} \end{bmatrix} \\
\text{OBJ} & \begin{bmatrix} \text{PRED} & \text{‘PRO’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{GEND} & \text{M} \\ \text{CASE} & \text{ACC} \end{bmatrix} \\
\text{OBJ}_{\text{RECIP}} & \begin{bmatrix} \text{PRED} & \text{‘PRO’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{GEND} & \text{M} \\ \text{CASE} & \text{DAT} \end{bmatrix}
\end{bmatrix}$$

(77) a. **Mary**, I saw her yesterday, **me**.

b. $$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{see}\langle\textsc{subj,obj}\rangle\text{’} \\ \textsc{tense} & \textsc{past} \\ \textsc{dis} & \left\{\begin{array}{l} \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{Mary}\text{’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \\ \textsc{case} & \textsc{acc} \end{array}\right] \end{array}\right\} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \\ \textsc{case} & \textsc{nom} \end{array}\right] \\ \textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{case} & \textsc{acc} \end{array}\right] \\ \textsc{adj} & \left\{\left[\textsc{pred}\ \ \text{‘}\textsc{yesterday}\text{’}\right]\right\} \end{array}\right]$$

Notice that the f-structures do not distinguish between two types of dislocation: in the DIS approach, all dislocated elements are members of the same set, while in the TOPIC / FOCUS approach, both would be TOPICs due to their information structure status. Presumably, a distinction at f-structure is not required because the difference between types of dislocation is captured at other levels, such as information structure (i-structure) or prosody (p-structure).

In fact, when so much has been delegated to other levels, it is not clear whether it is really necessary to indicate the dislocated status of a constituent by any f-structure feature. Indeed, in all the analyses of long-distance dependencies that I am aware of, DIS is locally introduced in the rule that defines the dislocated position by the equation $\downarrow \in (\uparrow \textsc{dis})$, and no other rules reference the value of DIS directly. The symbol GF used in paths constraining long-distance dependencies usually includes only non-overlay GFs (Dalrymple et al. 2019: 206), so the dislocation of a phrase from one clause to another does not influence its availability for further extraction. When the dislocated phrase *is* relevant for other processes, such as in relativisation and constituent questions, it occupies the special overlay functions RELPRO and Q. It thus appears that the feature DIS duplicates the information already present at c-structure – that the element is in some dislocated position – and is therefore redundant. This question is discussed in detail in Snijders (2015: section 4.6).

5.2 RELPRO and Q

In some constructions, elements that are dislocated to designated structural positions serve as input to other syntactic or semantic rules and constraints. For example, in relative clauses, the relative pronoun must be linked to the head of the relative phrase, both in syntax (e.g. to ensure agreement in gender and/or number) and in semantics (in order to correctly restrict the reference of the head noun). Similarly, the semantic interpretation of constituent questions must be able to identify the f-structure of the interrogative.

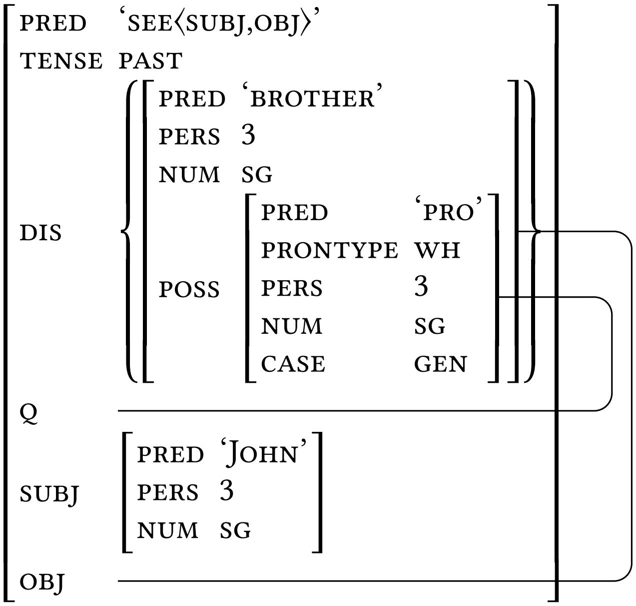
It is not enough to use only DIS in such constructions because DIS is not specific enough. A sentence may have another dislocated element in addition to the relative pronoun or interrogative: for example, in the sentence *John, who saw him?* the f-structures of both *John* and *who* will be elements of DIS, but only *who* must be correctly identified as the question word. The traditional distinction between TOPIC and FOCUS will not help either, because relativization or questioning of a phrase often leads to the extraction of a larger constituent in which it occurs (pied piping), as in the sentence *Whose brother did John see?*, where the dislocated element occupying FOCUS is *whose brother*, but only *whose* is the interrogative element.

For these reasons, LFG analyses of relativisation and constituent questions make use of the additional overlay features RELPRO and Q, respectively, that specifically include the f-structure of the element that is relativized or questioned.[25] For example, the sentence *Whose brother did John see?* will have the f-structure in (78).

---

[25] Similar effects could be achieved by using off-path constraints (see Belyaev 2023a [this volume] on the notion) but this seems to be in essence equivalent to using the overlay functions but results in a more cumbersome analysis (Tracy Holloway King, p. c.). This possibility is explored in Kaplan 2023: Section 5 [this volume].

(78)



In this example, the question word is the possessor *whose*, but English does not allow extraction of just the possessor, so the whole object phrase *whose brother* is dislocated to the left periphery and, consequently, appears in DIS at f-structure. The wh-word itself occupies the value of the special overlay function Q, which represents the element being questioned. For more information on the handling of long-distance dependencies in LFG, see Kaplan 2023 [this volume].

6 Conclusions

In this chapter, I have described the key properties of the LFG view of grammatical functions. An important aspect of LFG is assigning to grammatical functions a central role in grammar, without reducing them to more basic phenomena such as semantic roles, constituent structure position or relative syntactic rank. The inventory of grammatical functions is assumed to be universal, and each grammatical function is supposed to be associated with a distinct pattern of syntactic behaviour. The optimal inventory and the syntactic status of its members are based on three generalizations: (1) the functional hierarchy, which determines constraints on anaphoric binding and semantic role mapping; (2) the classification of grammatical functions into governable vs. ungovernable, semantically restricted vs. unrestricted GFs and terms vs. non-terms, as well as the related cross-classification of GFs in lexical mapping theory; (3) individual properties of specific grammatical functions, primarily subjects. This defines the core five-way distinction between SUBJ, OBJ, OBJ_θ, OBL_θ and ADJ. Four grammatical functions – POSS, COMP, XCOMP and PREDLINK – stand somewhat apart due to being uniquely associated with very specific argument types: nominal possessors, clausal complements and nonverbal predicates. This has resulted in attempts to eliminate PREDLINK and assimilate POSS to SUBJ and (X)COMP to non-clausal other grammatical functions, but there are compelling independent arguments in favour of preserving their distinct status. In addition to these GFs, LFG makes use of so-called overlay functions, which represent positions additionally occupied by GFs that are required for cross-clausal or discourse continuity.

This approach aligns LFG very well with typological and functional approaches to language, where *grammatical relations* are direct counterparts to the LFG *grammatical functions*. In spite of the superficial similarity, however, there is a crucial difference between the two approaches: typology does not generally assume one specific system of grammatical relations to be universal, while LFG is concerned with universality, at least in theory. This focus on universality implies that the LFG notions of grammatical functions are quite removed from their traditional definitions. In particular, there have been interesting developments in the treatment of subjects: Manning (1996) replaces subject and object with more abstract functions PIVOT and CORE that receive an inverse mapping in ergative languages, while Falk (2006) retains the traditional SUBJ as the most prominent argument ($\widehat{\text{GF}}$) while adding the overlay function PIVOT to account for those subjecthood properties that can be associated with other arguments in syntactically non-accusative languages. The distinction between OBJ and OBJ$_\theta$ has also been extended beyond its traditional understanding, with OBJ$_\theta$ being used for unmarked direct objects in differential object marking languages (Dalrymple & Nikolaeva 2011) and for coindexed arguments in polysynthetic languages (see Lander et al. 2021 for a rather radical approach). Finally, the LFG use of a distinct GF (X)COMP for clausal complements is unique in theoretical and typological literature and allows a wide range of intriguing generalizations.

Grammatical functions are a cornerstone of LFG, and their analysis is in line with the general spirit of this framework, which avoids reductionism to the extent of sometimes being overtly redundant in splitting linguistic phenomena into several mechanisms operating at different levels. The framework itself puts no constraint on the relationship betwen these levels; determining to what extent the mapping is regular becomes an empirical question. There is no formal obstacle to eliminating grammatical functions from LFG if it can be demonstrated that they can be reduced to other mechanisms. However, all such attempts to date have been unsuccessful, which demonstrates the viability of the LFG approach to grammatical functions.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

ADD	additive
AOR	aorist
AUG	augmentative (Hakha Lai)
AV	active voice (Tagalog)
BV	benefactive voice (Tagalog)
CL	clitic
CL1	first agreement class (East Caucasian languages)
CL2	second agreement class (East Caucasian languages)
CONN	connective (Hakha Lai)
COMPL	completive
DIM	diminutive
DIR	directive
DV	dative/locative voice (Tagalog)
EL	elative
EMPH	emphatic
FV	final vowel (Kichaga)
HRSY	hearsay evidential (Meskwaki)
INTERJ	interjection
IN	inessive
IO	indirect object
IV	instrumental voice (Tagalog)
LAT	lative
LNK	linker
MAL	malefactive
OV	objective voice (Tagalog)
PCVB	participle-converb (Ashti)
POS	positive
POT	potential
PQP	pluperfect (Moksha Mordvin)
PRET	preterite
SUPER	location above landmark
TMPR	temporal (Moksha Mordvin)

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Part II

Grammatical phenomena

Chapter 4

Anaphora

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The LFG approach to anaphora explicitly recognizes the substantial amount of variation that we see attested in the grammar of anaphoric elements, and it offers a lexicalist account that captures this diversity. This chapter provides an overview of the major tenets of this approach. We discuss how LFG captures prominence relations between anaphors and antecedents, as well as the inventory of further constraints that determine the size of the binding domain and the search for an antecedent. The chapter includes a brief commentary on logophoric elements and on how the anaphoric dependency itself is represented in LFG accounts, and it concludes with an outlook on other pertinent issues addressed in the LFG literature.

1 Introduction

In the broader sense of the term, anaphora is a referential dependency relation between an ANTECEDENT and an ANAPHORIC ELEMENT, with the latter being dependent on the former for its interpretation. In (1), for example, the embedded subject *he* is in principle free to refer to any available singular discourse participant that matches the gender of the pronoun, but assuming topic continuity between the matrix and the subordinate clauses, the most likely interpretation is that the subordinate subject is anaphorically linked to the matrix subject.[1]

(1) He thought that *he* would catch a train up to London.

(2) My mother, *she* just entered a mysterious decline.

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[1] Examples (1), (2) and (4) are from the British National Corpus (Davies 2004).

György Rákosi. 2023. Anaphora. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 165–192. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185940

In (2), the anaphoric link between the subject pronoun *she* and the left-dislocated noun phrase *my mother* is obligatory. But this is a property of the construction itself (see Haug 2023 [this volume] on ANAPHORIC AGREEMENT of this sort), since the personal pronoun *she* is not constrained elsewhere to occur in the company of a linguistically expressed antecedent. Personal pronouns can in fact establish reference to discourse participants through a deictic pointing gesture, as happens in (3):

(3) Who did you mean? *Him* or *her* over there?

Thus personal pronouns are born free, even if they often end up bound to antecedents under particular linguistic circumstances.

Personal pronouns are unlike reciprocals or reflexives in this respect, which do normally require the presence of a linguistic antecedent. In the small discourse universe of (4), the subject pronoun *he* refers back to Graham, and the object pronoun *them* to the group of Slater and Sarah. This is a very likely interpretation, but one that is in principle not obligatory. The reciprocal *each other*, however, must be in a strict dependency with an antecedent, which is the object pronoun *them* in (4).

(4) Graham didn't mind Slater knowing about Sara – he had introduced them to *each other*, after all.

Likewise, the object reflexive *themselves* requires the availability of a local antecedent, the subject *these animals* in the case of (5).

(5) These animals protect *themselves* against being eaten by secreting poisonous substances.

Following the accepted practice of generative grammars, I will refer to reflexives and reciprocals as ANAPHORS in this chapter. The term ANAPHORIC ELEMENT is used here as a cover for anaphors and anaphorically interpreted personal pronouns.

An anaphor in this narrow, categorial sense is a referentially dependent type of pronominal expression, which cannot be used deictically and which requires the presence of a linguistically expressed antecedent. The primary aim of this chapter is to give an overview of what anaphoric phenomena have attracted attention in LFG-based research, and what discussions these phenomena have generated. The standard LFG approach to the grammar of anaphors has two major descriptive tenets. First, in line with the lexicalist nature of LFG, the constraints that govern the grammar of anaphoric elements are stated in their lexical entries. Whether these lexical constraints are comprehensive, and thus more or less fully specify the grammar of anaphors, or they are to be supplemented by what Belyaev 2023 [this volume] calls GRAMMAR-WIDE CONSTRAINTS, is an issue where particular approaches may vary. Dalrymple (1993, 2001) and Dalrymple et al. (2019) postulate lexical entries that are rich enough in themselves, while Bresnan (2001) and Bresnan et al. (2016) emphasize the role of pertinent constraints that form part of the inventory of the universal design features of grammar. But this is partly a matter of perspective and emphasis, and in the lexicalist nature of LFG architecture, everything can be stated in the lexicon (evoking redundancy rules or templates where generalisations need to be captured). This chapter takes a comprehensive descriptive approach in presenting pertinent LFG research.

The second major tenet of the LFG approach to anaphora is the recognition that the distinction between anaphors and personal pronouns is not necessarily pronounced: neither empirical reasons, nor general theoretical concerns necessitate an approach in which anaphors and pronouns are considered to be two entirely distinct and discrete categories of grammar. Particular LFG descriptions may make use of a PRONTYPE attribute with values PERSONAL, REFLEXIVE or RECIPROCAL (as well as other pronominal types not relevant for us), but such features tend to play relatively little theoretical role in the actual analysis itself. Therefore, the term ANAPHOR is used here mostly for expository purposes only, with no specific theoretical commitment attached. One reason why the study of anaphoric systems has become a favourite topic of many researchers is exactly their versatile nature, and a major aim of this chapter is to demonstrate how the LFG architecture can be employed to describe this rich landscape adequately.

The structure of this chapter is as follows. In Section 2 and Section 3, I provide an overview of the standard LFG-theoretic approach to the binding of anaphors, discussing first the prominence relations between anaphors and their potential antecedents (Section 2), and then the constraints that determine the binding domain and the search for the antecedent (Section 3). In Section 4, I briefly discuss the LFG approach to discourse-dependent or logophoric elements. In Section 5, I make some comments on anaphor interpretation and on how the anaphoric dependency itself is represented in LFG accounts. Section 6 concludes this chapter.

2 Prominence relations and anaphora

2.1 Syntactic rank

One core property of anaphoric dependencies is that the antecedent needs to be more prominent than the anaphor *at some level of representation*. In Chomskyan generative approaches, the anaphor is required to have a c-commanding antecedent. The relation c-command is defined over hierarchical structures represented as trees, but LFG employs f-structure as the primary locus for capturing generalizations about abstract syntactic relations.[2] Thus, syntactic prominence relations are primarily described in terms of f-structure. This allows us to abstract away from attested variation in the surface coding of anaphoric dependencies in case such variation does not seem to correlate with grammatically relevant differences in how these dependencies are constructed. I illustrate the motivation for the LFG approach with parallel English and Hungarian data involving the reciprocal anaphor.

The triadic predicate *introduce* projects onto a syntactic structure in which the reciprocal anaphor may assume two syntactic functions: it is either the oblique PP argument (6a) or the object (6b), and it is ungrammatical as a subject (6c). The antecedent may either be the object or the subject argument in (6a), but if the reciprocal is the object, then only the subject can antecede it (6c):

(6) a. They$_i$ introduced the children$_k$ to *each other*$_{i/k}$.
b. They$_i$ introduced *each other*$_{i/*k}$ to the children$_k$.
c. **Each other* introduced them to the children.

This observed syntactic asymmetry between the anaphor and the antecedent is described as a difference in syntactic rank as defined by the Functional Hierarchy, which is independently needed in the description of other grammatical phenomena:[3]

(7) a. Functional Hierarchy (Bresnan et al. 2016: 229)

SUBJ > OBJ > OBJ$_\theta$ > OBL$_\theta$ > COMP, XCOMP > ADJ

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[2] Several definitions of c-command exist; here we simply assume the textbook variety.

[3] This hierarchy has played an important role in LFG, and it has its predecessors and analogues in other frameworks; see, for example, the accessibility hierarchy of Keenan & Comrie (1977), or Pollard & Sag (1992).

b. Syntactic rank (Bresnan et al. 2016: 230)

A locally outranks *B* if *A* and *B* belong to the same f-structure and *A* is more prominent than *B* on the functional hierarchy. *A* outranks *B* if *A* locally outranks some *C* which contains *B*.

An anaphor requires an antecedent which outranks it. Applying (7) to the data in (6), *B* is the anaphor *each other* and *A* is the antecedent, which is either the subject *they* or the object *the children* in (6a), or only the former in (6b). (6c) is out because, among other things, the reciprocal anaphor *each other* is the subject, and since the subject function is at the topmost position of the hierarchy, no outranking antecedent is available in the clause.[4]

The advantages of the f-structure-centered LFG approach to binding are especially apparent if we compare the English data in (6) to their counterparts in other languages, where clausal syntax is different. Hungarian is one such language. In particular, it allows for the pro-drop of subjects (treated as pronoun incorporation in LFG, see Toivonen 2023 [this volume]), and it has a non-configurational VP.[5] Consequently, the Hungarian versions of (6a) may lack an overt subject, and the linear ordering of the constituents is also relatively free within the VP. (8a–8b) represent two discourse neutral configurations, and each has the same ambiguity in terms of antecedent choice that we have seen in the case of the English (6a).

(8) Hungarian

a. Bemutat-ták a gyerekek-et egymás-nak.
introduce-PST.3PL the children-ACC each.other-DAT
'They$_i$ introduced the children$_k$ to each other$_{i/k}$.'

---

[4] This does not necessarily mean that *each other* cannot be a SUBJ, since it can be the subject of a subordinate clause under certain circumstances (see Lebeaux (1983: 724) for pertinent discussion). The following examples are from the British National Corpus (Davies 2004):

(i) We all read what *each other* had written, anyway.

(ii) One wonders how on earth they speak to each other, or if indeed they even know who *each other* is.

(iii) We all know how *each other* plays and that's why things are ticking.

The matrix antecedent outranks *each other* in these cases, too, according to (7), since the matrix SUBJ antecedent locally outranks the COMP that contains the subject anaphor.

[5] See Laczkó 2023 [this volume] and Laczkó 2021 on the non-configurational nature of the Hungarian VP, and on pro-drop phenomena in Hungarian.

b. Bemutat-ták egymás-nak a gyerekek-et.
introduce-PST.3PL each.other-DAT the children-ACC
'They$_i$ introduced the children$_k$ to each other$_{i/k}$.'

Disregarding empirical details that are irrelevant for the purposes of the current discussion (such as the fact that Hungarian employs dative case on the oblique anaphor instead of an adposition), the divergent English and Hungarian c-structures all map onto the same f-structure in (9).[6]

(9) f-structure of (6a) and (8a–8b)

$$
{}_{f}\left[\begin{array}{ll}
\text{PRED} & \text{`INTRODUCE}\langle\text{SUBJ, OBJ, OBL}_{\text{TO}}\rangle\text{'}\\
\text{TENSE} & \text{PST}\\
\text{SUBJ} & {}_{g}\left[\begin{array}{ll}
\text{PRED} & \text{`PRO}_{i}\text{'}\\
\text{PRONTYPE} & \text{PERS}\\
\text{PERS} & 3\\
\text{NUM} & \text{PL}
\end{array}\right]\\
\text{OBJ} & {}_{h}\left[\begin{array}{ll}
\text{PRED} & \text{`CHILDREN}_{k}\text{'}\\
\text{NUM} & \text{PL}
\end{array}\right]\\
\text{OBL}_{\text{TO}} & {}_{j}\left[\begin{array}{ll}
\text{PRED} & \text{`PRO}_{i/k}\text{'}\\
\text{PRONTYPE} & \text{RECIP}
\end{array}\right]
\end{array}\right]
$$

Syntatic rank is a device that is used to describe variation in syntactic prominence as stated at the level of f-structure, and it is primarily at this level where elegant and universally relevant generalisations can be made about anaphoric phenomena. One such generalisation is that an anaphor needs an antecedent that outranks it in the sense of (7).[7]

Syntactic rank captures the most salient aspect of c-command, the arrangement of constituents along a hierarchy. Embedding configurations may create issues which may scope beyond what reference to syntactic rank transparently solves. For example, the potential antecedent cannot be embedded too deeply within the search domain of the anaphor, hence the ungrammaticality of (10).

(10) *The children$_i$'s mother washed themselves$_i$.

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[6] No INDEX features (PERS and NUM) are specified for the reciprocal anaphor in the f-structure *j* in (9). We provide an overview of the LFG treatment of the feature content of anaphoric elements in Section 5.

[7] Note that the antecedent in (9) locally outranks the anaphor since both are members of the same f-structure *f*. By (7b), this relation need not be local, and it is not always local in the case of other types of anaphors that we discuss in Section 3. See also footnote 4.

(11)
$$
{}_{f}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{wash}\langle\textsc{subj}, \textsc{obj}\rangle\text{’} \\
\textsc{tense} & \textsc{pst} \\
\textsc{subj} & {}_{g}\left[\begin{array}{ll}
\textsc{poss} & {}_{i}\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{child}\text{’} \\ \textsc{num} & \textsc{pl}\end{array}\right] \\
\textsc{pred} & \text{‘}\textsc{mother}\text{’} \\
\textsc{num} & \textsc{sg}
\end{array}\right] \\
\textsc{obj} & {}_{j}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{pro}\text{’} \\
\textsc{prontype} & \textsc{refl} \\
\textsc{index} & {}_{k}\left[\begin{array}{ll}\textsc{pers} & 3 \\ \textsc{num} & \textsc{pl}\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

The plural reflexive anaphor *themselves* can only take a plural antecedent. The plural possessor *the children* could in principle act as one, but since it is properly contained within the possessive structure of the subject (f-structure *i* is in f-structure *g*), it cannot license the anaphor and therefore sentence (10) fails. LFG employs the notion of f-command to constrain such scenarios.[8]

(12) F-command (Dalrymple et al. 2019: 238)

f f-commands *g* if and only if *f* does not contain *g*, and all f-structures that contain *f* also contain *g*.

The English reflexive anaphor *themselves* needs an f-commanding antecedent that outranks it. F-structure *g* f-commands f-structure *j* in (11), but since *g* is a singular noun phrase, it does not match the INDEX features of the anaphor (see Section 5). F-structure *i* is plural and could thus be a potential antecedent for the reflexive, but it does not f-command it: one f-structure that contains *i*, namely f-structure *g*, does not contain the f-structure of the anaphor, *j*. Therefore the noun phrase *the children* does not f-command the reflexive anaphor *themselves*, and (10) is ungrammatical.

While f-command is a universal requirement on anaphor licensing, there still are anaphors in some languages that may take non-f-commanding antecedents under certain circumstances. We discuss here two reflexives to illustrate this phenomena. The antecedent of the Icelandic reflexive *sig* or the Mandarin reflexive *ziji*, for example, can be an embedded human possessor under the right discourse conditions. The Icelandic example (13a) describes Sigga's opinion, and the embedded clause, which includes the anaphor, is interpreted in her model of the

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[8] As Dalrymple et al. (2019: 239) discuss, a more complex definition of f-command is required to cover constructions that involve structure-sharing dependencies. Those concerns are not directly relevant for us now, and (12) suffices for our purposes.

world. The anaphor is thus tied to an antecedent who is a perspective holder, and this saves the configuration even if f-command is not satisfied (and even if the antecedent and the anaphor are not in the same clause). Since the embedded possessor (*Olaf*) is not a perspective holder in the case of (13b), the reflexive is unacceptable there.

(13) Icelandic (Maling 1984: 220–222)

a. Skoðun Siggui er að *sig* vanti hæfileika.
opinion Sigga's is that self.ACC lacks.SBJV talent
'Sigga$_i$'s opinion is that she$_i$ lacks talent.'

b. *Trú Ólafs á guð bjargaði *sér*.
belief Olaf$_i$'s in god saved self.DAT
'Olaf's$_i$ belief in god saved him$_i$.'

As is expected, the possessor cannot be an inanimate noun phrase in examples of this kind, since inanimate entities do not have mental states. Charnavel & Huang (2018) explicitly show that inanimate possessors are degraded in this construction in Mandarin (14b), even if they are claimed to be able to antecede *ziji* elsewhere (see Lam 2021 for a discussion and for further data on *ziji* with an antecedent embedded in the subject). But (14a) is a description of the mental state of the antecedent, Zhangsan, and this is apparently enough to license the anaphor even in the absence of f-command.

(14) Mandarin (a: Tang 1989: 100, b: Charnavel & Huang 2018: 140)

a. Zhangsan de jiaoao hai-le ziji.
Zhangsan DE pride hurt.ASP self
'Zhangsan$_i$'s pride harmed him$_i$.'

b. *Zhe ke shu de guoshi ya wan le ziji.
this CL tree DE fruit press bent ASP self
'The fruits of this tree$_i$ bent it$_i$.'

We discuss the role of point of view in the licensing of certain types of anaphora in Section 4. What the above data in (13) and (14) illustrate is that human or animate possessors in some languages can gain the kind of prominence that allows them to license anaphors even when the f-command relation between antecedent and anaphor is not satisfied.[9]

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[9] Bresnan et al. (2016: 268) offer an LFG analysis of the Icelandic construction in (13a) that includes the postulation of an f-command relation between the possessor and the embedded reflexive subject. For a recent LFG approach to the Mandarin data, see Lam (2021).

I discuss the LFG approach to domain restrictions on anaphora in Section 3. But before we turn to that, I briefly review anaphoric data where syntactic rank in the sense as we have discussed this notion here, does not seem to be the dominant factor in the search for a prominent antecedent.

2.2 Thematic prominence

Certain anaphors or anaphoric dependencies are constrained by factors that are at least partially independent of syntactic rank. Argument structure relations represent one such factor. If, for example, both the antecedent and the anaphor are oblique arguments of the same predicate, then they are indistinguishable with respect to the Functional Hierarchy in (7a). Dalrymple (1993: 154) discusses the following minimal pair, where the complement of the *to*-PP can antecede the complement of the *about*-PP, but not vice versa (see also Pollard & Sag 1992: 266):

(15) a. Mary talked to John$_i$ about *himself*$_i$.
b. *Mary talked about John$_i$ to *himself*$_i$.

This binding asymmetry can be described with reference to a hierarchy among argument roles, like that of the Thematic Hierarchy of Bresnan & Kanerva (1989) in (17), under the assumption that the *to*-PP bears a type of recipient role in (15), while the *about*-PP is a theme.

(16) Thematic Hierarchy (Bresnan & Kanerva 1989)

AGENT > BENEFACTIVE > RECIPIENT/EXPERIENCER > INSTRUMENT > THEME/PATIENT > LOCATIVE

What rules (15b) out is that the antecedent PP *about John* is less prominent thematically than the anaphoric PP *to himself*. This is because THEME is lower on the hierarchy than RECIPIENT. The Functional Hierarchy, in and of itself, cannot capture this difference, since both PP's are obliques in the f-structure of the sentence.

One potential counterargument to this understanding of the data in (15) is to deny the argumenthood of the *about*-PP. If it is an adjunct, as Reinhart & Reuland (1993: 715) argue, then syntactic rank suffices to explain the ungrammaticality of (15b), since an adjunct PP is less prominent than an oblique on the Functional Hierarchy, and therefore the former cannot antecede the latter. Similar concerns may arise with other predicates that take two PP dependents, since it is often the case that one can find reasons to assume that one of the two PP's is less argument-like than the other.[10]

But reference to the thematic hierarchy may still be necessary elsewhere. Dalrymple (1993: 153) discusses the following Norwegian data set (citing Hellan 1988) as a relevant case. Norwegian ditransitive verbs allow either of their two VP-internal objects to become subjects in the passive construction. (17b) illustrates the version where the recipient is the passive subject, and (17c) has the theme in the same function.

(17) Norwegian (Hellan 1988: 162)

a. Vi overlot Jon pengene.
we gave Jon money
'We gave John the money.'

b. Jon ble overlatt pengene.
Jon was given money
'John was given the money.'

c. Pengene ble overlatt Jon.
money was given Jon
'The money was given to John.'

Norwegian has a dedicated reflexive possessor, *sin*. Interestingly, when the object contains this reflexive, as in (18), then only one of the two potential readings of the passive sentence is acceptable. It is reading (i) below, which includes the malefactive subject argument binding the reflexive in the theme object. We assume that malefactives and benefactives occupy the same position on the Thematic Hierarchy.

(18) Norwegian (Hellan 1988)
Barnet ble fratatt sine foreldre.
child was taken self parents
(i) 'The child was deprived of self's parents.' MALEFACTIVE > THEME
(ii) *'The child was taken away from self's parents.' THEME > MALEFACTIVE

Reading (ii) would have the theme subject binding into the malefactive object, or in other words, a thematically less prominent antecedent binding into a more prominent one. Reference to the Thematic Hierarchy is thus essential here to be able to distinguish between the acceptable and the unacceptable reading of (18).

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[10] Zaenen & Crouch (2009) argue on the basis of computational efficiency that semantically marked optional PPs are best treated as adjuncts.

2.3 Linear order

Anaphoric relations are sometimes constrained by linear order, inasmuch as the anaphor may be required to have an antecedent that precedes it linearly. Linear order thus represents another dimension of prominence relations relevant in the description of binding phenomena. Facts concerning the linear order of constituents are captured at the level of c-structure in the LFG architecture, and given the f-structure centered nature of LFG, such facts need to be addressed separately.

Consider the following Hungarian data set for the purposes of illustration (É. Kiss 2008). Binding among co-arguments is primarily constrained by the Functional Hierarchy in Hungarian, so the object can bind the oblique argument (19a), but the oblique cannot bind the object (19b).

(19) Hungarian (É. Kiss 2008: 451)
a. Meg-kérdeztem a fiúk-at egymás-ról.
PFV-asked.1SG the boys-ACC each.other-about
'I asked the boys about each other.'
b. *Meg-kérdeztem a fiúk-ról egymás-t.
PFV-asked.1SG the boys-about each.other-ACC
('I asked each other$_i$ about the boys$_i$.')

É. Kiss notes, however, that linear order plays an important role in the case of non-coargument binding: when the antecedent precedes the anaphor embedded in another argument of the verb, then the acceptability of the anaphor improves significantly, even if the antecedent ranks lower on the Functional Hierarchy.

In (20a), the object locally outranks the oblique antecedent, and therefore the reciprocal possessor embedded in the object cannot be bound. But when the oblique antecedent linearly precedes the object, as happens in (20b-20d), then the sentence becomes much less degraded (and in fact, many speakers find these examples fully acceptable).

(20) Hungarian (É. Kiss 2008: 452)
a. *Meg-kérdeztem egymás szülei-t a fiúk-ról.
PFV-asked.1SG each.other parents.POSS-ACC the boys-about
('I asked each other$_i$'s parents about the boys$_i$.')
b. ?A fiúk-ról egymás szülei-t kérdeztem meg.
the boys-about each.other parents.POSS-ACC asked.1SG PFV
'About the boys$_i$, I asked each other$_i$'s parents.'

c. ?A fiúk-ról meg-kérdeztem egymás szülei-t.
the boys-about PFV-asked.1SG each.other parents.POSS-ACC

d. ?Meg-kérdeztem a fiúk-ról egymás szülei-t
PFV-asked.1SG the boys-about each.other parents.POSS-ACC

Thus changes in the linear order save this sort of binding dependency. In other words, both syntactic rank and linear order play a role in constraining non-coargument binding in Hungarian, but the linear order constraint apparently outranks the syntactic rank constraint imposed on the antecedent.[11]

In the LFG literature, Bresnan et al. (2016) provide a comprehensive discussion of the role of linear precedence in conditioning pronominal anaphoric dependencies (see also Belyaev 2023 [this volume]). Mohanan (1982) shows that overt pronouns cannot precede their antecedent in Malayalam, and Kameyama (1985) discusses pertinent Japanese data. In order to be able to capture these and other phenomena sensitive to linear order, LFG relies on the notion of f-precedence, which Kaplan & Zaenen (1989) define as follows:

(21) f f-precedes g ($f <_f g$) if and only if for all $n1 \in \phi^{-1}(f)$ and for all $n2 \in \phi^{-1}(g)$, $n1$ c-precedes $n2$.

The usual flow of information in the correspondence architecture of LFG is from c-structure to f-structure. The relation ϕ^{-1} provides for the inverse correspondence from f-structure to c-structure: it associates f-structures with the c-structures nodes they correspond to. The term $n1 \in \phi^{-1}(f)$ identifies the set of c-structure nodes that correspond to the f-structure f. The definition in (21) thus states that f-structure f f-precedes f-structure g if and only if all the c-structure nodes corresponding to f c-precede all the c-structure nodes corresponding to g. The relation C-PRECEDENCE can be defined as follows:[12]

(22) C-precedence

A c-structure node $n1$ c-precedes a node $n2$ if and only if $n1$ does not dominate $n2$, $n2$ does not dominate $n1$, and the string that $n1$ dominates (or $n1$ if $n1$ is itself a terminal) precedes the string that $n2$ dominates (or $n2$ if $n2$ is itself a terminal).

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[11] In addition, the antecedent must also f-command the anaphor. This requirement is satisfied in each example in (20).

[12] I thank an anonymous reviewer of this paper and Mary Dalrymple for their help in constructing the definition in (22). By *precede* we simply mean 'be to the left of' in the string.

F-precedence allows us to make reference to linear ordering facts at the level of f-structure, the locus where binding dependencies are primarily constrained in LFG. It relies on the notion of the inverse correspondence from f-structure to c-structure, which is evoked as a somewhat marked feature of the grammatical model. But this only reflects the fact that while conditioning anaphoric dependencies by linear order is an existing pattern in languages, it is not the dominant mode of licensing anaphors.

3 Constraining binding domains

The comprehensive description of a binding relation includes several components, which are stated in terms of f-structural properties in LFG. Anaphors require an antecedent that is available within a particular binding domain. The antecedent and the anaphor need to have matching agreement features, and antecedents are often constrained to be of specific types. For example, some anaphors require a subject antecedent, while others may need an antecedent that is a perspective holder. And, as we have seen in Section 2, the antecedent must be more prominent than the anaphor, which, by default, means that the antecedent f-commands the anaphor as well as outranks it on the Functional Hierarchy. Dalrymple (1993) proposed that these binding constraints are lexically specified on the anaphors, and there is a universally available inventory of them. Dalrymple (2001), Dalrymple et al. (2019), Bresnan (2001), and Bresnan et al. (2016), among others, extend this line of research, which I briefly overview in this section, adding some complementary remarks in Section 4 and Section 5. What lies at the heart of the LFG approach is that the grammatical space that anaphors occupy is too rich to be described in terms of generalizations of the type that classical Principle A represents. Anaphors vary along the parameters summarized above both across languages, and possibly within a single language. This versatility must be captured in any adequate description of anaphoric phenomena.

The core underlying assumption is that anaphors find or search for an antecedent within a specified domain. Inside-out functional uncertainty is used to model this search, since it allows reference to enclosing structures.[13] (23) is the general formula employed in the lexical description of binding dependencies:

---

[13] See Belyaev 2023 [this volume] for an overview discussion of inside-out function application and functional uncertainty, as well as for references to pertinent LFG literature. Strahan (2009, 2011) develops a proposal in which the search is inverted: the antecedent searches for the anaphor using outside-in functional uncertainty.

(23) $((\textsc{gf}^{*}\ \textsc{gf}_{\textsc{pro}} \uparrow)\ \textsc{gf}_{\textsc{ant}})$

$\textsc{gf}_{\textsc{ant}}$ is the grammatical function of the antecedent, and $\textsc{gf}_{\textsc{pro}}$ is the grammatical function of the anaphoric element.[14] The expression $\textsc{gf}^{*}\ \textsc{gf}_{\textsc{pro}} \uparrow$ defines a path from the f-structure of the anaphoric element to an f-structure that contains the antecedent.[15] In terms of a schematic f-structure, (23) describes the following scenario:

(24)
$$ {}_{f}\left[\begin{array}{ll} \textsc{gf}_{\textsc{ant}} & {}_{g}\left[\textsc{antecedent}\right] \\ \ldots\textsc{gf}^{*}\ldots & \left[\begin{array}{ll}\textsc{gf}_{\textsc{pro}} & {}_{j}\left[\textsc{anaphor}\right]\end{array}\right] \end{array}\right] $$

Here $\textsc{gf}^{*}\ \textsc{gf}_{\textsc{pro}} \uparrow$ defines a path from f-structure j to f-structure f, which contains the antecedent (f-structure g).

(23) requires the f-structure of the antecedent to f-command the anaphor (compare 12 and 23). In addition, further prominence relations can be stated in terms of off-path constraints on the f-structure of the antecedent. These include the prominence relations we have surveyed in Section 2: relations defined over the Functional Hierarchy or the Thematic Hierarchy, or linear order constraints. Dalrymple et al. (2019: 516–517) offer a discussion of how such constraints can be implemented, here I simply indicate the availability of this tool by adding a generic prominence template as an off-path constraint, which is meant to represent different types of prominence descriptions as is relevant for the anaphor.

(25) $((\textsc{gf}^{*}\ \textsc{gf}_{\textsc{pro}} \uparrow)\ \underset{@\textsc{prominent}}{\textsc{gf}_{\textsc{ant}}}\ )$

Such an off-path constraint requires the antecedent to be more prominent than the anaphor along one or more of the dimensions discussed here.

Anaphors may also impose further specific requirements on their antecedents. They may require them, for example, to be subjects (see Bresnan et al. 2016 and Dalrymple et al. 2019 for pertinent discussions). The Norwegian reflexive possessor *sin* can only be bound by the subject (26a), but not by the object (26b):

(26) Norwegian (Dalrymple et al. 2019: 510, citing Hellan 1988: 75)

a. Jon ble arrestert i sin kjøkkenhave.
Jon was arrested in self's kitchen.garden
'Jon$_i$ was arrested in his$_i$ kitchen garden.'

---

[14] (23) is in fact applicable to any anaphoric element, be it a reflexive or a reciprocal anaphor proper, or an anaphorically used personal pronoun.

[15] This path may consist of a single attribute only.

b. *Vi arresterte Jon i sin kjøkkenhave.
We arrested Jon in self's kitchen.garden
'We arrested Jon$_i$ in his$_i$ kitchen garden.'

This can be stated simply by constraining the antecedent to be a SUBJ in the (partial) lexical specification of the reflexive possessor *sin*:

(27) $((\text{GF}^{*}\ \text{GF}_{\text{PRO}}\ \uparrow)\ \text{SUBJ})$

The Mandarin Chinese anaphor *ziji* has also been claimed to show subject orientation, and thus (27) is part of its lexical specification (see Lam 2021 for further details):[16]

(28) Mandarin Chinese (Pollard & Xue 1998: 296)
Zhangsan gei-le Lisi yi-zhang ziji de xiangpian.
Zhangsan give-ASP Lisi one-CL self DE picture
'Zhangsan$_i$ gave Lisi$_k$ a picture of himself$_{i/*k}$.'

In contrast, the Norwegian anaphor *ham selv* can only be bound by a non-subject argument, compare (29a) with (29b).

(29) Norwegian (Dalrymple 1993: 29–30)
a. Jeg ga Jon en bok om ham selv.
I gave Jon a book about him self
'I gave Jon$_i$ a book about himself$_i$.'
b. *Jon snakker om ham selv.
Jon talks about him self.
'Jon$_i$ talks about himself$_i$.'

The anti-subject orientation of *ham selv* can be stated as a negative constraint in the lexical entry of this anaphor: the antecedent cannot be a SUBJ.

The final component of the description of anaphoric dependencies, and the one that has received most attention in LFG since the seminal work of Dalrymple (1993), is the delimitation of the binding domain. Four such domains have been found to be relevant in the description of anaphoric binding, which are listed in (30). These domains can be defined with the help of inside-out functional designators and appropriate off-path constraints, which are also added in (30) below (Dalrymple et al. 2019: 507).

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[16] In addition, *ziji* can also be bound by an antecedent properly contained in the subject, and it is sensitive to logophoricity (see Lam 2021, as well as example (14) above). We discuss logophoricity in Section 4.

(30) a. Coargument Domain: minimal domain defined by a PRED and the grammatical functions it governs

$$(\underset{\neg(\rightarrow\ \mathrm{PRED})}{\mathrm{GF}^*}\ \ \mathrm{GF}_{\mathrm{PRO}}\uparrow)$$

b. Minimal Complete Nucleus: minimal domain with a SUBJ function

$$(\underset{\neg(\rightarrow\ \mathrm{SUBJ})}{\mathrm{GF}^*}\ \ \mathrm{GF}_{\mathrm{PRO}}\uparrow)$$

c. Minimal Finite Domain: minimal domain with a TENSE attribute

$$(\underset{\neg(\rightarrow\ \mathrm{TENSE})}{\mathrm{GF}^*}\ \ \mathrm{GF}_{\mathrm{PRO}}\uparrow)$$

d. Root domain: f-structure of the entire sentence

$$(\mathrm{GF}^*\ \mathrm{GF}_{\mathrm{PRO}}\uparrow)$$

These domain specifications are stated in the lexical entries of anaphors as either POSITIVE or NEGATIVE binding requirements. A positive binding constraint requires the anaphor to be in a binding relation with some entry within the domain described (subject to further constraints, as discussed above), whereas a negative binding constraint states that the anaphor must not be bound to any element within that domain. Positive and negative binding constraints take the following general forms:[17]

(31) a. Positive binding constraint

$$(\uparrow \mathrm{ANTECEDENT})_\sigma = ((\mathrm{GF}^*\ \mathrm{GF}_{\mathrm{PRO}}\uparrow)\ \mathrm{GF}_{\mathrm{ANT}})_\sigma$$

b. Negative binding constraint

$$(\uparrow \mathrm{ANTECEDENT})_\sigma \neq ((\mathrm{GF}^*\ \mathrm{GF}_{\mathrm{PRO}}\uparrow)\ \mathrm{GF}_{\mathrm{ANT}})_\sigma$$

In what follows, we discuss some examples to show how this system of lexical specifications works. Further and more comprehensive discussions can be found in Dalrymple (1993), Dalrymple et al. (2019) and Bresnan (2001).

The Norwegian complex anaphor *seg selv* is described in Hellan (1988) and Dalrymple (1993) as a subject oriented anaphor that requires a co-argument binder. And while Lødrup 2023 [this volume] shows that speakers may also accept object binders in some cases, the co-argument binder requirement seems to be strong. The contrast between the following two examples illustrates this:

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[17] Identity is stated between the semantic representations of the antecedent and the anaphor. The σ-projection provides the mapping from f-structure to the LFG-type s(emantic)-structure; see Section 5 for more on this.

(32) Norwegian (Dalrymple et al. 2019: 505–506, citing Hellan 1988: 67, 69)

a. Jon fortalte meg om *seg* *selv*.
Jon told me about REFL self.
‘Jon$_i$ talks about himself$_i$.’

b. **Hun* kastet meg fra *seg* *selv*.
she threw me from REFL self.
‘She$_i$ threw me away from self$_i$.’

The difference between the two constructions is that (32b) contains a semantic preposition with a PRED feature, while the oblique PP in (32a) does not.

Consider the f-structure of the grammatical (32a) first. The Coargument Domain constraint (30a) requires a path from f-structure *j* to the f-structure that contains the SUBJ antecedent. Since this is a short path, no PRED feature occurs on the way, and therefore the off-path constraint ¬(→ PRED) is satisfied. (33) is the (simplified) f-structure of (32a):

(33) f-structure of (32a)

$$
{}_f\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{tell}\langle\textsc{subj}, \textsc{obj}, \textsc{obl}_{\textsc{about}}\rangle\text{’} \\
\textsc{subj} & {}_g\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{jon}_i\text{’}\end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{pro}\text{’}\end{array}\right] \\
\textsc{obl}_{\textsc{about}} & {}_j\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{pro}_i\text{’} \\ \textsc{prontype} & \textsc{refl}\end{array}\right]
\end{array}\right]
$$

In contrast, (32b) projects a more complex f-structure, with a more complex domain path:[18]

(34) f-structure of (32b)

$$
{}_f\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{throw}\langle\textsc{subj}, \textsc{obj}\rangle\text{’} \\
\textsc{subj} & {}_g\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{pro}_i\text{’}\end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{pro}\text{’}\end{array}\right] \\
\textsc{adjunct} & \left\{ {}_j\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{from}\langle\textsc{obj}\rangle\text{’} \\ \textsc{obj} & {}_k\left[\begin{array}{ll}\textsc{prontype} & \textsc{refl}\end{array}\right]\end{array}\right] \right\}
\end{array}\right]
$$

---

[18] The PP *fra seg selv* ‘from self’ could alternatively be analyzed as an OBL, but the choice between the ADJ and the OBL analysis is largely orthogonal to our current concerns. See also footnote 10 on this issue.

Here the domain path starts at f-structure k, and to reach the f-structure of the antecedent, we need to pass the PRED feature in j – a move that the off-path constraint $\neg(\rightarrow \text{PRED})$ prohibits. As a result, (32b) is ungrammatical.

The primary Hungarian reflexive, *maga*, is grammatical in non-selected spatial PPs. In fact, it is often the only option in standard Hungarian, and a pronominal PP is unacceptable in the particular case of the Hungarian version of (32b) (Rákosi 2010).

(35) Hungarian

a. János$_i$ el-tolt engem magá-tól$_i$.
János away-pushed.3SG me himself-from
'János$_i$ pushed me away from himself$_i$.'

b. *János$_i$ el-tolt engem (ő$_i$-)től-e$_i$.
János away-pushed.3SG me he-from-3SG
'János$_i$ pushed me away from him$_i$.'

The source marker corresponding to the English preposition *from* is expressed as ablative case morphology in Hungarian (*-tól/-től*). Reflexives behave like lexical nouns in this respect, and they take the ablative case suffix as expected (35a). Personal pronouns, however, trigger agreement morphology on the case marker, and the pronoun itself is usually pro-dropped (35b). But whether this pronoun is overt or is pro-dropped, it cannot have a clause-mate antecedent, resulting in the ungrammaticality of (35b).

(35a) is thus in direct contrast with (32b). The Hungarian reflexive *maga*, unlike Norwegian *seg selv*, is subject to the Minimal Complete Nucleus constraint: it has to be bound within a domain that includes a subject. This is captured in (30b) with the help of the off-path constraint $\neg(\rightarrow \text{SUBJ})$. The f-structure of (35a) is analogous to (34), and using that f-structure for the purposes of illustration, the relevant domain path in Hungarian would take us from the f-structure of the reflexive (k) to f-structure j of the adjunct PP, which is contained within the matrix f-structure f, together with the subject antecedent g. Subject g can serve as the antecedent of the reflexive. Being subject to the Minimal Nucleus Constraint requires this search not to pass a subject antecedent, and it follows that Hungarian *maga* cannot take antecedents that are in another clause.

Interestingly, the Hungarian reciprocal anaphor *egymás* is somewhat freer than the reflexive *maga*, as it can take antecedents from within the Minimal Finite Domain. Compare the following two sentences:

(36) Hungarian (Laczkó & Rákosi 2019: 153)

a. A fiúk látták a lányok-kat lerajzol-ni maguk-at.
the boys saw.3PL the girls-ACC draw-INF themselves-ACC
'The boys$_i$ saw the girls$_k$ draw (a picture of) themselves$_{*i/k}$.'

b. A fiúk látták a lányok-kat lerajzol-ni egymás-t.
the boys saw.3PL the girls-ACC draw-INF each.other-ACC
'The boys$_i$ saw the girls$_k$ draw (a picture of) each other$_{i/k}$.'

The reflexive object of the infinitive can only be co-construed with the infinitival subject (controlled by the matrix object), but it cannot take the matrix subject as its antecedent in (36a). It is thus unlike the reciprocal in (36b), which can.

The Norwegian reflexive *seg selv*, the Hungarian reflexive *maga*, and the Hungarian reciprocal *egymás* are all anaphors, yet the binding constraints that apply to them are different. *Seg selv* needs an antecedent in the Coargument Domain, *maga* takes one from the Minimal Complete Nucleus, and *egymás* may have an antecedent even outside of its own embedding clause as long as the search is confined to the Minimal Finite Domain. In fact, the binding constraints that we have discussed in this section create a relatively large space within which particular lexical types of anaphors may vary, and research in the framework of LFG has shown that this space is indeed occupied by an abundance of anaphoric elements attested cross-linguistically. The list includes such relatively atypical anaphors as the *ìı* pronouns of Yą̧g Dii, which must take long distance antecedents (Dalrymple 2015) within a logophoric domain. We discuss logophoricity and these pronouns in Section 4 below.

4 Logophoricity

Anaphors, especially reflexives, may sometimes appear without a clause- or a sentence-mate antecedent, or even in the complete absence of a linguistically expressed antecedent. The following BNC (Davies 2004) examples contain such reflexives.

(37) a. And suddenly Briant felt better. These people were professionals, like *himself*.

b. I've not done this before and I wanted to try it out with a small group like *yourselves* to see how we go on with it.

c. Our group consisted of Stephen, David, Laura and *myself*, and we were aged twenty-two.

d. Lots of love to Birgitta and *yourself*, and to the boys when you see them.

One hallmark of these types of reflexives is that they are more or less freely exchangeable with personal pronouns. Thus, for example, *himself* in (37a) can be replaced with *him*, and both will refer to Briant in the given context.

Many instances of such types of anaphora have been claimed to be conditioned by discourse factors (see Maling 1984, Sells 1987, Pollard & Sag 1992, Reinhart & Reuland 1993, Culy 1994, and Bresnan et al. 2016, among others). The most prominent of these factors is perspective or viewpoint, in the sense that the (discourse) antecedent of the reflexives is a perspective holder. The reflexive in (37a), for example, occurs in a discourse context in which the feelings of Briant are described, and (37c) projects the speaker's perspective and hence creates a context in which the reflexive *myself* is licensed in the absence of a linguistically expressed antecedent. From a purely syntactic perspective, anaphoric data of this type are often approached as exceptional (see the term EXEMPT ANAPHORA in Pollard & Sag 1992). Pertinent research in LFG has focused on anaphoric elements which, unlike the English reflexive, must take a linguistically expressed antecedent which is a perspective holder. Such anaphoric elements are called LOGOPHORS.[19]

Bresnan et al. (2016) offer an in-depth discussion of logophoricity, including its relation to subjectivity. A logophoric pronoun "refers to one whose speech, thoughts, or feelings are represented in indirect discourse, from that person's own point of view" (Bresnan 2016: 255). They treat the Icelandic reflexive *sig* as a logophoric element (see also Maling 1984, as well as Strahan (2009, 2011)), and Lam (2021) provides a logophoric LFG-analysis of the Mandarin Chinese reflexive *ziji*, as well as of the Cantonese reflexive *jighei* (see also Pollard & Xue 1998 on the nonsyntactic uses of *ziji*). A very intriguing type of a logophoric pronominal is discussed in Dalrymple (2015). The Yą̧g Dii language (Niger-Congo/Adamawa-Ubangi, Cameroon) has a complex pronominal system that includes the *ìı* pronouns. These pronouns are like regular anaphors inasmuch as they cannot be used deictically, and they cannot take discourse antecedents. However, "the antecedent of *ìı* must be the subject of a clause that is at least two clauses distant" (Dalrymple 2015: 1090). In example (38), this pronoun is the subject of the embedded clause S3, and it must be co-construed with the subject of the matrix clause S1.

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[19] Most of the pertinent research both within and outside of LFG has focused on reflexives, but, as Pollard & Sag (1992) point out, reciprocal anaphors may also be exempt. Szűcs (2019) discusses complex event nominalization data from Hungarian to show that Hungarian reciprocals embedded in such noun phrases may lack a linguistic antecedent and are then licensed as logophors.

(38) Yąg Dii (Dalrymple 2015: 1091)

$_{S1}$[Àkàw	∅	ǫ̀	$_{S2}$[lig	$_{S3}$[bà	ìi	lá	hęn	lálɨ́	páskà
Teacher$_i$	(he$_i$)	say	house	that	he.ìi$_{i/*j}$	eat	thing	eating	Easter

kan	waa	duulí	bìì	vʉ	wʉlɨ́	máa]	bà	dɨ	tɛ́lá?]
with	child	following	his$_i$	PL	there	when,	that.it	is.there	where?

‘$_{S1}$[The teacher$_i$ asks, $_{S2}$[where is the house $_{S3}$[in which he.ìi$_{i/*j}$ will eat the Easter meal with his$_i$ disciples?]]]’

The antecedent subject must be a perspective holder, and the intermediate subject in *S*2 may or may not be coreferential with the pronoun as long as it does not introduce an independent logophoric domain.

Disregarding now details that are irrelevant for our purposes, the binding constraints on this pronoun can be stated as follows:

(39) Binding constraints for *ìı* (Dalrymple 2015: 1117)

$$(\uparrow_\sigma \text{ ANTECEDENT}) = ((\underset{(\rightarrow \text{ LOG})}{\text{GF}_{\text{LOG}}}\ \ \underset{\neg(\rightarrow \text{ LOG})}{\text{GF}^{*}}\ \ \uparrow)\ \text{SUBJ})_\sigma$$

This lexical specification requires the pronoun to take a subject antecedent from an f-structure where a logophoric domain is specified, and the domain path needs to include an intermediate f-structure where no independent logophoric domain is introduced. Formally, the LOG feature appears within the f-structure that corresponds to the logophoric domain:

(40)
$$_{S1}\left[\begin{array}{ll} \text{SUBJ} & \left[\text{LOGOPHORIC ANTECEDENT}\right] \\ \text{GF}_{\text{LOG}} & _{S2}\left[\begin{array}{l} \text{LOG}\ \ + \\ \ \ _{S3}\left[\ldots\text{ÌI}\ldots\right] \end{array}\right] \end{array}\right]$$

Yąg Dii thus has a pronominal system where logophoricity is a grammaticised notion, and it must be employed as an f-structure feature LOG in the determination of the binding domain. In the particular case of the logophor *ìı*, this domain must be unusually large as it must include an extra clause between the clause that hosts the antecedent and the clause that hosts the logophor.

5 On representing referential dependencies

Anaphoric dependencies may be represented via referential indices. These can be used in the f-structures themselves, a practice which I have followed in this chapter. The indices themselves do not form an integral part of the formalism, however; they are mere mnemonics that help visualize the dependency. The machinery that we have introduced in Section 3 allows us to represent such dependencies in a more elegant manner. The notation, in the tradition of Dalrymple (1993), states that the semantic structure of the antecedent and of the anaphoric element are equivalent. The following is an abbreviation for the binding constraints on the basis of Asudeh (2019), where f is the f-structure of the anaphor and f_σ is its semantic structure (see Asudeh 2023 [this volume] for semantic structure in LFG).

(41) $(f\ \textsc{antecedent})_\sigma = f_\sigma$

As Asudeh (2019) argues, this notation has several theoretical advantages over the referential index notation. Firstly and most importantly, it shifts attention to semantic structure, which is the appropriate place to represent referential dependencies.

The postulation of semantic equivalence between anaphor and antecedent abstracts away from the issue that it is often the case that no strict referential identity is required between the two. In (42), for example, the anaphor stands for the image of Kate in the mirror, whereas the antecedent noun phrase refers to the actual individual herself.

(42) Kate saw *herself* in the mirror.

Rákosi (2009) argues that the Hungarian complex anaphor *önmaga* is especially well-suited to contexts of such referential shifts. In fact, it may even take restrictive adjectival or participial modifiers, as in (43) below.

(43) Hungarian

a	tükör-ben	lát-ott	*önmagam*
the	mirror-in	see-PTCP	myself

‘my self/image seen in the mirror’

(43) evokes a context where the speaker feels alienated from his or her own image. To what extent this variation in anaphora interpretation is integral to the study of the grammar of anaphora is partly a matter of perspective (see also Jackendoff 1992 on this issue in general). In any case, if it is, semantic structure is a natural locus to address this issue.

The statement of semantic identity between anaphor and antecedent, in and of itself, does not account for the semantic differences between plural reflexives and reciprocal anaphors, which obviously differ in interpretation. Moreover, reciprocal interpretation is subject to variation from relatively strong (44a) to relatively weak (44b) readings.

(44) a. The students like *each other.*

b. The students followed *each other* into the classroom.

These issues and the overall semantics of reciprocals are discussed at length in Dalrymple et al. (1998) and Haug & Dalrymple (2020). Dalrymple et al. (2018) develop an LFG-based, fine-grained and comprehensive semantic structure representation of anaphoric dependencies within a dynamic semantics framework, which provides a solution to the issues that we have briefly addressed here (see also Dalrymple et al. 2019). What must be stated on the syntactic side, that is, at the level of f-structure, is the requirement that anaphors and antecedents must have matching agreement features. This is achieved in LFG via the INDEX feature set, discussed in detail in Haug 2023 [this volume].[20]

6 Summary

We have seen that LFG differs from other generative frameworks in explicitly recognizing the empirical fact that anaphoric elements are subject to substantial variation both within and across languages, and no single rule or principle of grammar can capture this versatility in itself. Binding relations are complex dependencies with several parameters, all of which can be stated in the lexical entry of anaphors, in line with the lexicalist nature of LFG grammars.

Research within the LFG tradition also addressed other aspects of the grammar of anaphora which we have not focused on. Constraints on coreference relations including pronouns are discussed in Bresnan et al. (2016), whereas Dalrymple et al. (2018) and Dalrymple et al. (2019) provide an in-depth introduction to the semantic composition of anaphora, including discourse anaphoric relations encoded by personal pronouns and other types of pronominals which we have not touched upon in this chapter.

As happens in other frameworks, too, LFG research has focused mostly on the grammar of reflexive anaphors, but reciprocals have also received attention, see especially Hurst (2006, 2010, 2012) and Hurst & Nordlinger (2021). Morphosyntactic variation is in general significant among different types of anaphors, which, given the f-structure centered approach of LFG, is often not the primary focus of investigation. Nevertheless, a number of LFG works address this variation, from the syntactically active bound anaphoric morphemes in Bantu languages

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[20] Rákosi (2022) argues on the basis of Hungarian data that at least certain types of anaphors may only constrain the INDEX features of their antecedents, but they do not have INDEX features of their own.

(see Bodomo & Che 2023 [this volume]) to the monomorphemic markers of Germanic, Romance and Slavic languages, which may either act as anaphors or as intransitivizers (see, among others, Sells et al. 1987, Alencar & Kelling 2005, Alsina 2023 [this volume], and Hristov 2023 [this volume]). Complex reflexives may have even more complex variants, with interesting syntactic and semantic consequences discussed in Rákosi (2009). Bresnan et al. (2016) give an overview of some issues in typological variation in the morphology of anaphors and its syntactic correlates.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

ASP	aspectual marker	CL	classifier

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Chapter 5

Agreement

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This chapter surveys the treatment of agreement in LFG. We show how theories of agreement can be classified by how they use symmetry and feature sharing in their treatments and how LFG usually opts for a symmetric but not feature sharing account. Other topics include the INDEX/CONCORD distinction, how non-f-structure such as linear order and information structure impacts on agreement, long-distance agreement and Wechsler's Agreement Marking Principle.

1 Introduction

Agreement is the linguistic phenomenon whereby a set of features is realized morphologically on two different syntactic tokens, as we see in (1).

(1) The boy loves the girl.

Both the word *boy* and the word *loves* realize a singular number feature.[1] However, this feature is only meaningful on *boy*, where it indicates that that the noun phrase refers to a single boy; *loves* merely agrees, in this case with its subject. Agreement is therefore a directed phenomenon: the *controller* ('boy') has a set of meaningful features and the *target* ('loves') agrees with these.

"Meaningful" must be taken with a grain of salt. We can also have agreement in purely syntactic features such as CASE or in features that are inherent in the controller but do not carry any obvious meaning, such as GENDER. But even in such cases, we observe directionality. Consider (2) from Latin.

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[1] We are relying here on an inferential, realizational view of morphology whereby *boy* is morphologically singular even if there is no singular morpheme.

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(2) Latin
rosa spinosa floruit
rose:NOM;F;SG thorny:NOM;F;SG bloomed:PST;3SG
'The thorny rose bloomed.'

The nominative case feature that is realized on *rosa* and *spinosa* is only meaningful on *rosa* because it indicates the grammatical function (subject) of the noun phrase. By contrast the grammatical function (adjunct) of *spinosa* is given by the fact that its case agrees with that of its head, rather than by a specific case feature: if the NP was in object position instead, the case of *rosa* would change because the grammatical function of the noun phrase would change; and the case of the adjective *spinosa* would also change, despite its grammatical function as adjunct remaining the same. Finally, the feminine gender feature in (2) is an inherent, purely formal property of the controller: it does not provide any information about the syntactic function or the meaning of the noun phrase headed by *rosa*, but is a non-variable feature of *rosa* which is part of the information conveyed by the lexeme. By contrast, the adjective *spinosa* inflects for this feature and can assume other gender features, depending on the inherent gender of its controller.

There are three main areas where languages display agreement phenomena. First, there is agreement in predicate-argument structures, where one or more arguments typically act as controllers and the predicate is the target. Second, we observe agreement inside NPs, where typically the head noun controls agreement on targets like determiners, quantifiers, adjectives and other modifiers. Third, we have "anaphoric agreement" between anaphors and antecedents. The latter type of agreement has attracted little attention in LFG work and will consequently largely be ignored here, except that it is relevant as a diachronic source of predicate-argument agreement.

In Section 2, we show how theories of agreement can be classified by how they use symmetry and feature sharing in their treatments. In Section 3 we discuss the INDEX/CONCORD distinction that is drawn in much LFG work on agreement. While agreement is generally treated at f-structure in LFG, Section 4 discusses how linear order and information structure impacts on agreement. Section 5 discusses the diachrony of agreement markers. Section 6 discusses long-distance agreement, a phenomenon which suggests there may be a role for feature sharing in agreement to preserve syntactic locality. Finally, Section 7 discusses Wechsler's Agreement Marking Principle, which is a challenge to symmetric accounts of agreement.

2 Agreement in unification grammars

The basic treatment of agreement in unification-based grammars is very straightforward as we simply need to make sure that the relevant features of the controller and the target unify. This is usually done by specifying functional descriptions that put the features in the same position in the functional structure, namely that of the controller. The specifications of (2) are shown in (3) and yield the f-structure in (4). Only relevant features are shown.

(3) *rosa* (↑ PRED) = 'ROSE'
(↑ NUM) = SG
(↑ CASE) = NOM
(↑ GEND) = FEM
floruit (↑ PRED) = 'BLOOM<SUBJ>'
(↑ SUBJ NUM) = SG
(↑ SUBJ CASE) = NOM
(↑ SUBJ PERS) = 3
spinosa (↑ PRED) = 'THORNY'
((ADJ ∈ ↑) NUM) = SG
((ADJ ∈ ↑) CASE) = NOM
((ADJ ∈ ↑) GEND) = FEM

(4)
$$\begin{bmatrix} \text{PRED} & \text{`BLOOM}\langle\text{SUBJ}\rangle\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`ROSE'} \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{NOM} \\ \text{GEND} & \text{FEM} \\ \text{PERS} & 3 \\ \text{ADJ} & \left\{\begin{bmatrix} \text{PRED} & \text{`THORNY'} \end{bmatrix}\right\} \end{bmatrix} \end{bmatrix}$$

In this approach to agreement, there is *symmetry* between the controller and target features in that it does not matter whether a feature value originates from a functional description associated with the controller or the target or both. However, agreement features are *not* shared (in the technical sense of structure sharing in f-structures), but only represented in a single position in the f-structure, that of the controller, reflecting the directedness of agreement. It is this symmetric, yet not feature-sharing approach to agreement that gives the standard LFG analysis its specific flavor, different from analyses that are often found in the derivational tradition starting from Pollock (1989) and in HPSG (Pollard & Sag 1994: chapter 2).

In current derivational approaches, controller features are interpretable and target features are uninterpretable. The Agree mechanism matches uninterpretable features to their interpretable counterparts and deletes them. If uninterpretable features remain, the derivation crashes. Hence all target features must be available on the controller. But in Latin, which is a pro-drop language, this forces us to postulate several null subjects differing only in their interpretable PERS and NUM values, merely to check off the matching uninterpretable features on the verb. The same point is made by Barlow (1988) and Pollard & Sag (1994: 64). Pollard and Sag give the Polish examples in (5), where the verb would be assumed to agree with a null subject.

(5) Polish

kochałem	kochałeś	kochał
I.M loved	you.M loved	he loved
kochałam	kochałaś	kochała
I.F loved	you.F loved	she loved

To maintain an asymmetric view of agreement, we are essentially forced to assume that the examples in (5) involve a multiplicity of phonetically null pronominals, one for each distinct form of the verb.

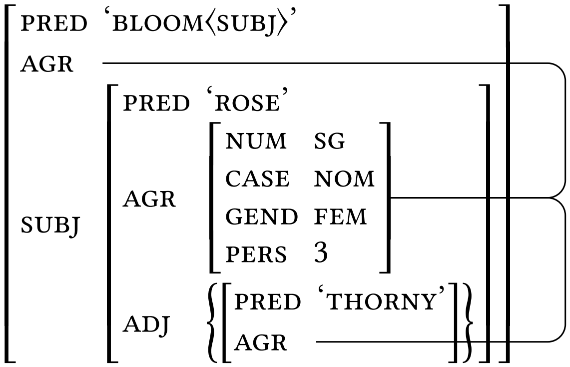
By contrast, on the standard LFG analysis, target features can themselves provide information. Going back to the Latin example from (2), we would get the f-structure in (6) if the subject is pro-dropped to give the simple sentence *floruit* 'It blooms'.

(6)
$$\begin{bmatrix} \text{PRED} & \text{`BLOOM}\langle\text{SUBJ}\rangle\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{NOM} \\ \text{PERS} & 3 \end{bmatrix} \end{bmatrix}$$

This f-structure arises directly from the f-descriptions of *floruit* in (3) plus an optional description (↑ SUBJ PRED) = 'PRO' associated with the verb. The NUM, CASE and PERS features are specified by the target (the verb) directly, with no need for matching features on the null subject, so that we do not need to multiply covert elements. Few LFG practitioners have therefore adopted an asymmetric mechanism for matching target and controller features, although the LFG framework offers such a mechanism in the form of constraining equations. Nevertheless, we will see in Section 3 that some theories of feature indeterminacy and coordination actually require the use of constraining equations, at least to deal with feature resolution. More substantially, Wechsler (2011) has argued that absence of controller features has grammatical effects. This requires a deeper commitment to asymmetry. We discuss his proposal in Section 7.

While it contrasts with Minimalism in that target and controller features are taken to be symmetric, the standard LFG treatment also differs from an approach that is often seen in HPSG based on structure sharing of the agreement features between the target and the controller. In an LFG setting, we could get such an analysis e.g. by embedding agreement features in a feature AGR to be structure shared between the target and the controller. This would yield the f-structure in (7) instead of (4), if we assume that both predicate-argument agreement and NP-internal agreement involve structure sharing.

(7)



Within the HPSG tradition, Kathol (1999) argues for such an approach. His main argument is that in many cases, target and controller morphology is arguably "the same" (such as the *-a* ending in *ros-a* and *spinos-a*). This is particularly common in noun phrase-internal agreement, but occasionally happens also in predicate-argument agreement, cf. (8).

(8) Swahili (Kathol 1999: ex. 14, originally from Welmers 1973: 171)

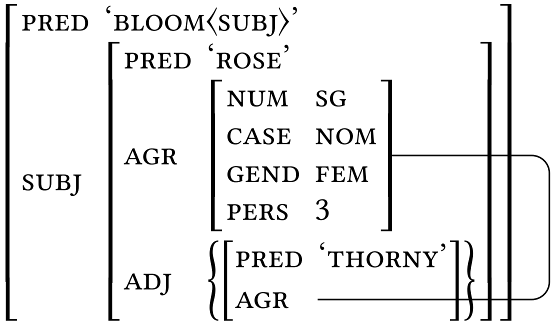
a. **Ki**kapu **ki**kubwa **ki**moja **ki**lianguka.
basket large one fell
'One large basket fell.'

b. **Vi**kapu **vi**kubwa **vi**tatu **vi**lianguka.
baskets large three fell
'Three large baskets fell.'

In such cases, although the morphology is the same, it has to contribute different functional descriptions in the various positions, because the agreement construction is built into the equations. By contrast, if we assume structure sharing, the mapping from morphology to functional descriptions becomes uniform: *-a* in Latin and *ki-* in Swahili always contribute their features to the agr feature structure of the item where they are realized, and agreement will be captured by requiring structure sharing of agr structure in the appropriate configurations.

We can assume that all agreement works in this way, but since morphological identity of target and controller features is much more common in noun phrase-internal agreement, it is possible to assume feature sharing only here and not in predicate-argument agreement. This is illustrated in (9).

(9)



The agr feature bundle is structure shared inside the NP but not between the verb and the NP. This is the option taken in much HPSG work, e.g. Pollard & Sag (1994) and Wechsler & Zlatić (2003). It is natural to connect this difference to the index/concord distinction that we discuss in Section 3: on that view, the agr feature of (9) will be split in two feature bundles, concord (typically relevant for NP-internal agreement) and index (typically between predicates and arguments) and we can assume that only concord agreement involves structure sharing.[2]

Kathol's argument is essentially an architectural argument about how to best capture the morphology-syntax interface. It has not been picked up in the LFG tradition. The most explicit work on the topic, Dalrymple et al. (2019: Chapter 12) assumes the traditional LFG approach and consequently postulates complex so-called m-features (morphological features that are to be mapped to functional descriptions). That is, a first person plural form of the verb is associated with the m-feature in (10).

(10) m-agr:⟨agr(su):{pers:1, num:pl}⟩

The form, then, carries information not just about the features it contributes (first person and plural number) but also *where* it contributes those features (in this

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[2] Note that Wechsler & Zlatić (2003: 145) say that "subject-verb agreement…is modeled in terms of structure-sharing", although it is clear from Wechsler & Zlatić (2003: 21) that they do not assume the verb bears its own person and number features. I assume that "structure sharing" is used loosely here in the sense of cospecification of features.

case, to the subject). Therefore, there cannot be a uniform representation of *-a* in *ros-a* and *spinos-a* (or *ki-* and *vi-* in 8), since they contribute the same feature to *different* locations. In a structure sharing account we *can* have a uniform representation (of the relevant morphemes or paradigmatic inferences, depending on your view of morphology), where e.g. *-a* is simply associated with nominative, singular, feminine features and the feature sharing that forces agreement stems from the relevant agreement construction. But as (10) shows, we do not *need* structure sharing: we can capture the same facts without it, but at the cost of a (slight) complication of the morphology-syntax interface.

In addition to the architectural issue, the structure sharing approach also makes different empirical predictions in some cases, because the same syntactic position can be simultaneously target and controller for two different agreement processes involving the same feature and hence give rise to so-called long distance agreement. We return to this in Section 6.

To sum up, the standard LFG treatment is symmetric but not feature-sharing: it is based on features contributed by defining equations from (potentially) several sources (the controller and one or more targets) to a single syntactic position. While there has been little pressure to change this except for special constructions, the complexities of agreement phenomena cross-linguistically has led to expansions in many different directions.

3 INDEX, CONCORD and coordination

It is possible for nominal controllers to trigger different values for the same feature on different targets, as in the Serbo-Croatian example (11) from Wechsler & Zlatić (2003: 5).

(11) Serbo-Croatian

Ta	dobra	deca	su	došla.
that:F;SG	good:F;SG	children:(F;SG)	AUX;3PL	come:PRF;PTCP;N;PL

‘Those good children came.’

Here the noun *deca* ‘children’ triggers feminine singular agreement on the determiner and the adjective, but neuter plural agreement on the predicate.[3] Such examples require that we postulate two different bundles of agreement features, generally called INDEX and CONCORD (Pollard & Sag 1994, Kathol 1999, Wechsler

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[3] Note, though, that the feminine singular and the neuter plural are syncretic in Serbo-Croatian. See Alsina & Arsenijević (2012a,b) and Wechsler & Zlatić (2012) for discussion.

& Zlatić 2003). Both index and concord are syntactic features, modelled at f-structure in LFG, but the intuition is that index features are more closely related to semantics and are the ones that are related to the reference of a noun phrase, typically gender, person and number (but not case). By contrast, concord features are more closely related to morphological class and typically include gender, number and case (but not person). According to Wechsler (2011) this division reflects the historical origin of the morphology on the agreement targets, which typically comes from incorporated pronouns in the case of index agreement, but from nominal classifiers (and other sources) in the case of concord agreement. concord and index are also different in that concord agreement is generally found inside NPs whereas index features are typically relevant to predicate-argument agreement.

Since gender and number are present both in index and concord, they may take different values in those contexts and that is what happens in (11). The f-structure for *ta dobra deca* in this example is shown in (12).

(12)
$$\left[\begin{array}{ll} \textsc{concord} & \left[\begin{array}{ll}\textsc{gend} & \textsc{fem}\\ \textsc{num} & \textsc{sg}\\ \textsc{case} & \textsc{nom}\end{array}\right] \\ \textsc{index} & \left[\begin{array}{ll}\textsc{gend} & \textsc{neut}\\ \textsc{num} & \textsc{pl}\\ \textsc{pers} & 3\end{array}\right]\end{array}\right]$$

It is worth pointing out that although index is in some sense "closer" to the semantics than concord, both are syntactic features, represented at f-structure. In addition to these two kinds of agreement it is necessary to postulate a third, semantic/pragmatic kind of agreement. This is particularly common in pronoun-antecedent agreement. For example, the Serbian/Croatian diminutive noun *devojče* 'girl' may be referred to with a neuter pronoun (reflecting its index gend feature), or with a feminine pronoun, reflecting the meaning of its anteceedent.

Much work in LFG uses representations like (4) as a simplification when the index/concord distinction is not relevant, but actual work on agreement has generally assumed the distinction. However, Alsina & Arsenijević (2012a,b) argued against having two sets of syntactic agreement features. For counterarguments defending the index/concord distinction, see Wechsler & Zlatić (2012) and Hristov (2013).

While some words like *deca* appear to be lexically specified with different index and concord features, another important motivation for the distinction comes from different behaviour in coordinate structures. Consider (13) from Belyaev et al. (2015: 36)

(13) This/*These man and woman are/*is eating sushi.

The coordinate noun phrase in (13) consists of two singular nouns. The determiner must agree in singular number with each of these nouns, whereas the predicate must agree in plural number with the coordination as a whole. This indicates that CONCORD NUM, relevant for NP-internal agreement, is singular, but INDEX NUM, relevant for predicate agreement, is plural.

To derive this CONCORD/INDEX distinction in number, King & Dalrymple (2004) proposed that INDEX features are nondistributive, i.e. they are features not just of the individual conjuncts but also of the conjunction as a whole, based on rules of feature resolution; whereas CONCORD features are distributive, i.e. properties of the individual conjuncts but not of the conjunction as a whole. That is, a conjunction of two singular NPs such as *man and woman* cannot trigger a plural determiner (**These man and woman*) because the determiner agrees in CONCORD. However, it does trigger plural number agreement on the verb (if it is the subject) because the conjunction as a whole has a NUM PL feature in the INDEX, different from the singular feature of the two conjuncts, as shown in (14).

(14)
$$\left[\begin{array}{l} \textsc{index} \begin{bmatrix}\textsc{num} & \textsc{pl}\end{bmatrix} \\ \left\{ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{woman}\text{’} \\ \textsc{concord} & \begin{bmatrix}\textsc{num} & \textsc{sg}\end{bmatrix} \\ \textsc{index} & \begin{bmatrix}\textsc{num} & \textsc{sg}\end{bmatrix} \end{bmatrix} \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{woman}\text{’} \\ \textsc{concord} & \begin{bmatrix}\textsc{num} & \textsc{sg}\end{bmatrix} \\ \textsc{index} & \begin{bmatrix}\textsc{num} & \textsc{sg}\end{bmatrix} \end{bmatrix} \right\} \end{array}\right]$$

This raises the question of how the features of a coordination are related to those of the conjuncts. The distinction between distributive and nondistributive features was originally introduced by Dalrymple & Kaplan (2000) who used set-valued features to model both indeterminacy and feature resolution in coordination. For example, the PERSON feature is treated in terms of sets over the atomic markers *S* (for “speaker”) and *H* (for “hearer”). In a language like English or Spanish, with no exclusive/inclusive distinction in the first person plural, sets over these atoms are interpreted as in (15).[4]

(15) $\{S, H\}$ first person
$\{H\}$ second person
$\{\}$ third person

On this interpretation, feature resolution corresponds to set union and can be encoded in the phrase structure rule for coordination as in (16).

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[4] The system of Dalrymple & Kaplan (2000) can also capture the first person exclusive as $\{S\}$ in languages where this is needed.

(16)
$$\text{NP} \longrightarrow \begin{array}{ccc} \text{NP} & \text{CONJ} & \text{NP} \\ \uparrow=\downarrow & & \uparrow=\downarrow \\ (\downarrow \textsc{person}) \subseteq (\uparrow \textsc{person}) & & (\downarrow \textsc{person}) \subseteq (\uparrow \textsc{person}) \end{array}$$

Because the values in (15) are ordered by set inclusion we get a hierarchy effect in resolution, where second and third person resolves to second person, and first and second/third person resolves to first person.

It is worth pointing out that this requires the target features to be stated with a constraining equation as in the sample first person entry in (17).

(17) $(\uparrow \textsc{person}) =_c \{S, H\}$

If the target features were stated constructively, as in the standard approach, a first person verb would be compatible with the coordination of two second person forms, because the first person from would set the PERSON feature to $\{S, H\}$ and each conjunct would simply check that $\{H\}$ is a subset of that. In other words, the set-based approach requires us to give up the symmetric approach to agreement and would therefore run into similar problems with e.g. pro-drop as other asymmetric approaches to agreement, as discussed above.

Alternative accounts of feature resolution that are based on ordinary feature structures rather than sets seem at first sight not to require constraining equations. In particular, Dalrymple et al. (2009) suggests using ordinary LFG features to encode what would be set membership in the analysis of Dalrymple & Kaplan (2000) and to deal with feature indeterminacy that way. Sadler (2011) extends that approach to coordination. For example, in a language like Icelandic, where any coordination of nouns with different genders resolve to neuter gender, the set-based approach would assume values as in (18).

(18) $\{M, F\}$ neuter gender
$\{M\}$ masculine gender
$\{F\}$ feminine gender

This can be translated into standard feature structures by decomposing gender into two features, M and F, as follows.

(19)
a. neuter gender: $\begin{bmatrix} \textsc{m} & - \\ \textsc{f} & - \end{bmatrix}$

b. masculine gender: $\begin{bmatrix} \textsc{m} & + \\ \textsc{f} & - \end{bmatrix}$

c. feminine gender: $\begin{bmatrix} \textsc{m} & - \\ \textsc{f} & + \end{bmatrix}$

The resolution rule will then specify that for each gender feature, if all the conjuncts are +, the set is also assigned +; otherwise the set is assigned −. However, as it turns out, stating this resolution rule explicitly requires the use of constraining equations, namely an implicational constraint.[5] Still, the situation is different from the set-based solution in that the equations on both the target and on the controller conjuncts are constructive. It is only the resolution rule that makes use of constraining equations, suggesting that even in a declarative theory like LFG, feature resolution requires a procedural approach:[6] first, we construct the conjuncts and then we can compute the features of the coordination. On the other hand, the agreement mechanism itself does not require constraining equations, and since the target features are still specified constructively we do not run into problems with pro-drop.

4 Factors outside the f-structure

While agreement is generally determined in terms of f-structure relations, it is widely acknowledged that other factors are also relevant, in particular linear order/c-structure and information structure.

4.1 Linear order

That linear order can be relevant for agreement is shown by so-called single conjunct agreement. (20–21) show some examples from Kuhn & Sadler (2007).

(20) Czech
Na rohožce seděla kočka a pes.
on mat was.sitting:F;SG cat:F;SG and dog:M;SG
'The cat and the dog were sitting on the mat.'

(21) Portuguese
os [mitos e lendas] brasileiras
the:M;PL myth:M;PL and legend:F;PL Brazilian:F;PL
'the Brazilian myths and legends'

In (20), from Czech, the predicate *seděla* agrees only with the closest subject conjunct, *kočka*. In (21), from Portuguese, the determiner agrees with its closest

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[5] See Dalrymple et al. (2019: 640) for a formalisation of the required resolution rule.

[6] The use of constraining equations in LFG in general has been taken to be a "dynamic residue that resists a purely declarative analysis" (Blackburn & Gardent 1995: 44).

conjunct, the first one, whereas the postposed adjective agrees with the second conjunct, which again is the closest one. Examples such as (21) show that we cannot simply pick out a single distinguished conjunct and make that available for agreement: what is relevant is the distance between the target and the controller.

Kuhn & Sadler (2007) discuss earlier approaches to single conjunct agreement and propose a solution based on dividing features into not only the standard distributive/nondistributive classification, but also to distinguish left-peripheral, right-peripheral and proximity-based features. Dalrymple & Hristov (2010) dispense with the need for dividing features this way and instead provide definitions of new f-structure path descriptions. For example, $f_{(L)}$ is defined as in (22).

(22) $$f_{(L)} \quad \equiv \quad f \qquad \underset{\neg[(\leftarrow \in) \prec_f \rightarrow]}{\in^*}$$

Here, $\in^*$ picks out an arbitrarily embedded member of the set (to account for nested coordination); the Kleene star also allows zero levels of embedding, which would make $f_{(L)}$ refer simply to f. However, in case we pick a set member, it must be the leftmost member of f. This is accomplished by the off-path constraint $\neg[(\leftarrow \in) \prec_f \rightarrow]$, which says that at any point in the path of (potentially nested) coordinations, there must not be other conjuncts $(\leftarrow \in)$ that f-precede $(\prec_f)$ the one we pick $(\rightarrow)$. Hence, if f is not a set, $f_{(L)}$ equals f, but if f *is* a set, $f_{(L)}$ can be either the whole set f or its leftmost member. This allows modelling of optional left conjunct agreement. We can also capture obligatory left conjunct agreement by defining f_L just like $f_{(L)}$ except it can never refer to a set. (So f_L always picks the leftmost member of f.) Similarly we can define f_R and $f_{(R)}$ by reversing the f-precedence relation and finally f_C (closest conjunct) as f_L if $\downarrow$ f-precedes f_L and f_R if f_R f-precedes $\downarrow$. This solution makes it possible to describe (optional or obligatory) single conjunct agreement irrespective of whether the relevant agreement feature(s) are distributive or not; and it does so without altering the LFG formalism.

Consider the f-structure for (21).

(23) $$\begin{bmatrix} \left\{ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{myth}\text{’} \\ \textsc{concord} & \begin{bmatrix} \textsc{num} & \textsc{pl} \\ \textsc{gend} & \textsc{m} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{legend}\text{’} \\ \textsc{concord} & \begin{bmatrix} \textsc{num} & \textsc{pl} \\ \textsc{gend} & \textsc{f} \end{bmatrix} \end{bmatrix} \right\} \\ \textsc{adj} \quad \left\{ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{Brazilian}\text{’} \end{bmatrix} \right\} \end{bmatrix}$$

This f-structure satisfies the following functional description of *brasileiras.*

(24) $((\textsc{adj}\ \uparrow)_C\ \textsc{concord num}) = \textsc{pl}$
$((\textsc{adj}\ \uparrow)_C\ \textsc{concord gend}) = \textsc{f}$

(ADJ ↑) refers in the normal way to the f-structure of the head, and the subscript C then makes sure we select the closest conjunct; if (ADJ ↑) was not a set, the subscript C would simply have no effect.

4.2 Information structure

Besides c-structure/linear order, information structure is also relevant for agreement processes in many languages, as discussed by Dalrymple & Nikolaeva (2011). In their architecture, discourse functions are modelled as features at s-structure and can be accessed from the f-structure through the σ-projection. Dalrymple & Nikolaeva (2011: 123) provide the specification in (25) of the third person singular topical oblique agreement marker in Itelmen.

(25) (↑ OBL PERS) = 3
(↑ OBL NUM) = SG
$((\uparrow \text{OBL})_\sigma$ DF) = TOPIC

More complicated patterns are also possible. Object agreement in Itelmen is only optionally an indicator of the topicality of the object, but it does indicate that there is no oblique topic. This is captured by the description in (26) of the first person singular object agreement marker.

(26) (↑ OBJ PERS) = 1
(↑ OBJ NUM) = SG
$\neg[((\uparrow \text{OBL})_\sigma$ DF) = TOPIC]
$(((\uparrow \text{OBJ})_\sigma$ DF) = TOPIC)

In addition to precedence and information structure role, LFG analyses have shown that agreement can be sensitive to other factors such as adjacency (direct precedence) and various prominence hierarchies based on person and grammatical functions. Broadwell et al. (2011) and Belyaev (2013) analyse such patterns in Kaqchikel and Dargwa respectively and show how they be captured with LFG augmented with Optimality Theory (OT).

5 Diachrony: grammatical and anaphoric agreement

It is a long-standing observation from comparative linguistics (Bopp 1933 [1857]) that agreement markers in predicate-argument structures (i.e. INDEX agreement) arise from incorporated pronouns. That is, we have an evolution from anaphoric agreement with a dislocated noun phrase (*The man, he came*) to grammatical agreement (*The man he-came*). As pointed out by Bresnan & Mchombo (1987), LFG is well placed to capture this development because (unlike what happens in many other formal frameworks), pronouns and agreement markers are very similar, yet also distinct in a way which generates clear predictions about differences between anaphoric and grammatical agreement. In particular, incorporated pronouns always introduce a semantic form (PRED 'PRO'), while agreement markers do not introduce a semantic form or do so only optionally (if the language allows pro-drop). Otherwise, both agreement markers and incorporated pronouns introduce the relevant agreement features. Bresnan & Mchombo (1987) argue that in Chichewa, subject agreement is grammatical and obligatory whereas object agreement is anaphoric and optional. They represent subject markers (SM) and object markers (OM) with the lexical entries in (27).[7]

(27) SM- (↑ SUBJ) = ↓
(↓ INDEX) = α
((↓ PRED) = 'pro')

OM- (↑ OBJ) = ↓
(↓ INDEX) = α
(↓ PRED) = 'pro'

From a diachronic point of view, the subject marker and the object marker reflect different points on a grammaticalization path from pronouns to agreement morphology: the object marker has lost its c-structure independence, but is still in all respects a pronoun at f-structure, contributing its own PRED value. The subject marker has evolved one step further in that the PRED value contribution has become optional. There is a clear connection between the formal representations at the two stages, and the relation between them fits well with the intuitive notion of "bleaching" or "loss of content" in grammaticalization processes.

At the same time, the subtle difference between the two representations, along with some other independent properties of Chichewa, suffice to predict a number of differences between subject and object agreement. First, because the Chichewa sentence structure consists of a subject NP, a head-initial VP and a topic NP (in any order), the NP object must appear directly after the verb (i.e. inside the VP) whenever there is no object marker. When there is an object marker, however, that marker is the actual object, whereas the apparent NP object is an anaphorically linked topic, which can therefore appear anywhere in the clause.

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[7] We adopt the convention of treating sublexical units such as the subject and object marker as if they were nodes in a syntactic tree, with ↓ designating their own f-structure and ↑ that of the lexical item they attach to, as is done also in the presentation in Bresnan et al. (2016).

Second, because the object marker is a light (i.e. incorporated) anaphoric pronoun, it blocks the use of the independent pronoun in this function, with the effect that the independent object pronoun is reserved for cases of focus and contrastive topics.[8] No such effect is found with the subject marker. Third, objects can be questioned in situ but only when there is no object marker. All these predictions are borne out in Chichewa.

In sum, the LFG framework makes it possible to understand fundamental differences between grammatical agreement with governed functions and anaphoric agreement with discourse functions, while at the same time providing a plausible diachronic pathway from the latter to the former, in line with what we observe in language change. Notice that the analysis relies crucially on treating the subject marker as ambiguous between a true pronoun (with a PRED 'PRO' feature) and an agreement marker (without it). This holds for LFG analyses of pro-drop generally. Toivonen (2000) provides motivation for this kind of "lexical split" analysis by pointing to the case of Finnish possessives, where the agreement marker and the suffixal pronoun differ in other features as well. For more on the LFG analysis of pro-drop, see Toivonen 2023 [this volume].

6 A role for feature sharing? – Agreement domains

In line with the general philosophy of LFG, the formalism itself does not in any way constrain how agreement domains are defined. We could easily write constraints that would enforce purely linear agreement (e.g. agree with closest NP irrespective of grammatical function) or agreement across unbounded domains (e.g. agree with COMP* SUBJ). An advantage of this is that LFG has no problems capturing surprising agreement relations such as those found in Archi, where agreement targets include a mixed bag of a number of first person forms, some adverbial elements, an emphatic particle and one postposition, which all agree with the absolutive element in their clause. (28) shows how the lexical entry for the first person dative pronoun looks according to Sadler (2016), assuming the absolutive argument bears the grammatical function PIV.

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[8] Though as a reviewer remarks, this blocking effect is not formalized in Bresnan & Mchombo (1987).

(28) *d-ez*
(↑ PRED) = ‘PRO’
(↑ NUM) = SG
(↑ PERS) = 1
(↑ CASE) = DAT
((PATHOUT ↑) PIV GEND) = II
((PATHOUT ↑) PIV NUM) = SG

That is, the first person dative pronoun agrees with a PIV argument that is found by first going up PATHOUT, which is defined as {SUBJ|OBJ|OBL|OBL OBJ}. (29) shows an example where a first person pronoun embedded in PP (OBL OBJ) agrees with the absolutive.

(29) Archi

d-ez	χir	d-e<r>qˤa-r-ši	d-i
II.SG-1SG.DAT	behind	II.SG-<IPFV>go-IPFV-CVB	II.SG-be.PRES

‘She goes after me.’

The first person dative pronoun bears the noun class II (essentially human feminine) marker *d-* because it agrees with the absolutive argument *she* (only expressed through agreement on the verb), irrespective of the gender of the speaker. The equation ((OBL OBJ ↑) PIV GEND) = II captures that. But the use of inside-out functional uncertainties may be problematic in cases where it does not refer uniquely because of structure sharing. More work is needed on this kind of complex agreement paths.

The approach of Sadler (2016) can in principle be extended with paths that cross clausal boundaries (so-called long distance agreement). However, the fact that we *can* write such equations does not mean that we *should*. Locality of grammatical processes remains an important theoretical concern in LFG even if it is not hardwired into the formalism. Haug & Nikitina (2015) argue that several cases of so-called long distance agreement can be given a local treatment if the agreement process is assumed to be structure-sharing. Their main example concerns the so-called “dominant participle” construction in Latin,[9] where a noun and a participle form a non-finite clause which is headed by the participle but bears the agreement features of the noun.

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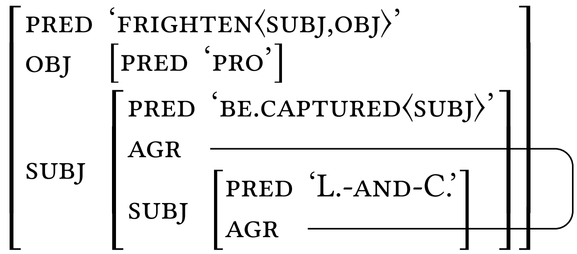
[9] Haug & Nikitina (2015) also argue that the same analysis may work for long distance agreement in Tsez, Passamaquoddy and Innu-Aimûn, which has been widely discussed in the generative literature (Branigan & Mackenzie 2002, Bruening 2001, Polinsky & Potsdam 2001).

(30) Latin
ne eum Lentulus et Cethegus … deprehensi
lest him:acc L.:nom;m and C.:nom;m captured:nom;m;pl
terrerent
frighten:impf;subj;3pl
'lest the capture of Lentulus and Cethegus should frighten him' (Sall., Cat 48.4)

According to the analysis in Haug & Nikitina (2015), *Lentulus et Cethegus…deprehensi* ('that Lentulus and Cethegus were captured') is a clause which acts as the subject of the matrix verb *terrerent*. Yet unlike other clausal subjects in Latin, it does not trigger default third person singular agreement on the predicate. Instead, the matrix verb is plural, meaning that it either agrees with the embedded subject *Lentulus et Cethegus*, or the plural feature of the embedded subject has somehow been transferred to the predicate *deprehensi*. *Deprehensi* does bear morphological plural marking, but on the standard, non-feature sharing approach to agreement this feature would only be active in the subject (controller) position. If instead we suppose that features in this kind of agreement are active in both the target and the controller, the target may in turn serve as the controller for another agreement process with the matrix verb as the target. This yields the f-structure in (31).

(31)


Structure sharing agreement between *Lentulus et Cethegus* and *deprehensi* makes the agreement features available in the f-structure which is subj agr relative to the matrix verb, so that there can be normal predicate–subject agreement in the matrix clause. In principle, that agreement could also be structure sharing, but as the apparent long-distance agreement can only be positively demonstrated in participial clauses, Haug & Nikitina (2015) remain agnostic on the matter. However, a similar feature-sharing account of agreement was extended to finite verb agreement by Alsina & Vigo (2014, 2017). Interestingly, their arguments for adopting structure sharing are different: in some cases, such as copular inversion in Catalan and raising constructions in Icelandic, the controller cannot be specified lexically, but is determined by OT constraints over the global f-structure. This, they hold, argues for a view that targets and controllers lexically specify features of their own AGR and then OT constraints decide which AGR structures should be linked to each other. Finally, a feature sharing approach to agreement is also adopted by Sadler (2019) to account for an adjectival construction in Modern Standard Arabic where the target adjective agrees with two distinct controllers.

7 A challenge to symmetry: The Agreement Marking Principle

Wechsler (2011) proposes the principle in (32), called the *Agreement Marking Principle.*

(32) Agreement is driven by a syntactic feature of the controller, if the controller has such a feature. If the controller lacks such a feature, then the target agreement inflection is semantically interpreted as characterizing the controller denotation.

With this principle, Wechsler seeks to explain so-called mixed agreement, i.e. cases where a polite plural pronoun triggers plural agreement on the verb, but singular agreement on some other target, e.g. a predicative adjective as in (33) from French.

(33) French

Vous	êtes	loyal.
you.PL	are.2PL	loyal.M.SG

'You (singular, formal, male) are loyal.'

This pattern follows from the Agreement Marking Principle on the assumption that *vous* bears an INDEX NUM PL feature that is able control INDEX agreement on the verb, but *no* CONCORD NUM feature, which leaves the predicative adjective without an agreement controller, thereby licensing semantic agreement. Moreover, the Agreement Marking Principle gives us an *explanation* of the so-called "polite plural generalization", that there are no languages[10] with the opposite pattern, i.e. where the polite plural pronoun triggers plural agreement on the adjective but allows singular agreement on the verb, or more generally, following Wechsler, on any target that has the PERSON feature. This polite plural generalization follows because pronouns by necessity have INDEX features and any PERSON target must be an INDEX target.

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[10] See Wechsler (2011: Section 2.1) for the typological data.

Formalizing the Agreement Marking Principle requires use of constraining equations. Wechsler's analysis of the French feminine definite article *la* is given in (34), where $\textbf{female}(\uparrow_\sigma)$ is a simplified representation for the relevant semantic resource that will ensure that the referent is interpreted as female.

(34) *la* $(\uparrow \textsc{gend}) =_c \textsc{f} \vee [\textbf{female}(\uparrow_\sigma) \wedge \neg (\uparrow \textsc{gend})]$

The idea is that when *la* combines with a noun that is lexically specified as feminine gender, such as *sentinelle* 'sentry', the feminine feature is *not* semantically interpreted; but when it combines with a noun that does not have a gender feature, such as *professeur*, it *will* be interpreted semantically. However, this entails a move away from the traditional symmetric approach to agreement in LFG to the asymmetric approach associated with derivational syntax.

As pointed out by Wechsler, the Agreement Marking Principle is not in itself a descriptive generalization, since the presence versus absence of a given agreement feature on the controller NP is not always directly observable, but rather depends upon the grammatical analysis of the NP. However, the radically symmetric nature of the standard LFG analysis allows for cases where there is *no controller* NP at all. This is what we saw in the standard analysis of *floruit* in (6). The lexical entry of the verb on the standard analysis will be as in (35).

(35) *floruit* $(\uparrow \textsc{pred}) = \text{`}\textsc{bloom}<\textsc{subj}>\text{'}$
$(\uparrow \textsc{subj case}) = \textsc{nom}$
$(\uparrow \textsc{subj num}) = \textsc{sg}$
$(\uparrow \textsc{subj pers}) = 3$
$((\uparrow \textsc{subj pred}) = \text{`}\textsc{pro}\text{'})$

On the traditional LFG analysis, which also underlies the diachronic analysis of anaphoric agreement discussed in Section 5, there simply *is* no controller: it is constructed by the target. If we change (35) to interpret the number and person agreement along the lines of the Agreement Marking Principle, we get (36), where $\textbf{\textsc{non-participant}}(\uparrow_\sigma)$ is shorthand for some semantic resource that ensures the subject referent is distinct from the discourse participants (speaker or hearer).

(36) *floruit* $(\uparrow \textsc{pred}) = \text{`}\textsc{bloom}\langle\textsc{subj}\rangle\text{'}$
$(\uparrow \textsc{subj case}) = \textsc{nom}$
$(\uparrow \textsc{subj pers}) =_c 3 \vee [\textbf{\textsc{non-participant}}(\uparrow_\sigma) \wedge \neg (\uparrow \textsc{subj pers})]$
$(\uparrow \textsc{subj num}) =_c \textsc{sg} \vee [\textbf{\textsc{non-participant}}(\uparrow_\sigma) \wedge \neg (\uparrow \textsc{subj num})]$
$((\uparrow \textsc{subj pred}) = \text{`}\textsc{pro}\text{'})$

If we want to maintain the Agreement Marking Principle there are a number of ways we can go. First, we can take (36) at face value and assume that since there is no controller, the agreement features are interpreted semantically. This would yield the prediction that in pro-drop structures, agreement features are always semantically interpreted, which is a strong and quite probably false assumption.[11] Second, we can exploit the fact that the LFG formalism cannot faithfully express the Agreement Marking Principle as formulated in (32). (32) says that agreement in some feature is syntactic, "if the controller has such a feature". However, the LFG formalism offers no way of checking where a feature originates. Constraining equations check whether some feature is present in the minimal solution to the f-description, irrespective of where they originate. Therefore, we can add the constructive equations (↑ SUBJ PERSON) = 3 and (↑ SUBJ NUM) = SG to the optional part of (36). This preserves the formalization of the Agreement Marking Principle, but arguably not its spirit, since the same lexical item provides both target and controller features. Finally, we could envisage a c-structure controller (with the appropriate features) in pro-drop structures, although this seems at odds with all standard assumptions of LFG.

In sum, it is not clear how to best integrate the Agreement Marking Principle in LFG. More generally, symmetry between target and controller features does important work in LFG's traditional theory of agreement and it requires substantial work to alter this fundamental setup.

8 Agreement and semantics

A general question which has not received much attention in the LFG literature concerns how f-structure agreement features relate to the semantic content that they (sometimes) encode. In the standard LFG architecture, levels of linguistic description as found in the projection architecture are related by codescription, where linguistic items simultaneously describe different structures, including syntax and semantics. For example, the lexical entry for a singular noun might look like (37), where $1(x)$ is a cardinality test on the referent.

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[11] In fact, a reviewer offers a counterexample from Spanish, where second person plural forms can be used for very elevated addressees in a very formal register and crucially the interpretation does not change whether the subject is expressed by means of the pronoun *vos* or is null:

(i) Spanish
(Vos) sois muy bondadoso.
you.PL are.2.PL very kind.M.SG
'You (singular, formal, male) are very kind'

(37) *horse* (↑ PRED) = ‘HORSE’
(↑ INDEX NUM) = SG
(↑ CONCORD NUM) = SG
$\lambda x.horse^{*}(x) \wedge 1(x) : v \multimap r$

This lexical entry simultaneously specifies syntactic singular number (in the form of f-structure features) and semantic singular number (simplified as a cardinality check on x). On the alternative, so-called “description-by-analysis” approach (Halvorsen 1983), semantics is not cospecified together with syntax, but is instead read off the constructed f-structure.

Although codescription is the standard, Andrews (2008) points to two problems for this approach, both having to do with agreement. The first and most obvious problem is that in lexical entries like (37), there is no necessary connection between the syntactic and semantic singular number features: yet outside the limited class of *pluralia tantum* these are closely connected in a way we would predict more clearly if we simply had semantics read the f-structure features. There is to my knowledge no theory of how this connection would work in a codescription approach, but it seems conceivable that the morphology-syntax interface developed in Dalrymple et al. (2019: Chapter 12) could also take care of the interface with semantics and restrict the mappings in a principled way.

The second problem for codescription, according to Andrews (2008), is that it creates the need to decide which of the various lexical entries introducing a given feature-value occurrence is the one that is introducing the semantic constructor. This again relates to the question of symmetry or not between target and controller features. Andrews considers an Italian example with possible pro-drop (38).

(38) Italian

(le	ragazze)	vengono
the.FEM.PL	girls.FEM.PL	come.3PL

‘The girls/they are coming.’

If the subject is present, we presumably want the noun to introduce the plural meaning constructor and the verb not to, but if the subject is omitted, then the verb presumably provides the constructor. However, we already need to make sure that the PRED feature of the subject is instantiated only once, so it is not clear that this is a deep problem, although as Andrews points out, it does open the door to some stipulation.

NP-internal agreement raises more tricky problems. As discussed by Belyaev et al. (2015), there are languages where a plural head noun can take two coordinated singular adjectives as modifiers, as in (39) from Russian.

(39) Russian
krasnyj i belyj flagi
red.SG and white.SG flag.PL
'(the) red and (the) white flags' [2 flags total: one red, one white]

Belyaev et al. (2015) call this pattern "resolving agreement". On their analysis, it has the f-structure in (40).[12] Notice that this treats CONCORD as non-distributive; according to Belyaev et al. (2015) the distributivity of CONCORD is subject to variation across languages, and even across different constructions within particular languages.

(40)
$$\left[\begin{array}{l}
\text{CONCORD}\ \ [\text{NUM}\ \ \text{PL}] \\
\text{INDEX}\ \ [\text{NUM}\ \ \text{PL}] \\
\text{CONJ}\ \ \text{AND} \\
\left\{ \begin{bmatrix} \text{PRED} & \text{`FLAG'} \\ \text{CONCORD} & [\text{NUM}\ \ \text{SG}] \\ \text{ADJ} & \left\{[\text{PRED}\ \ \text{`WHITE'}]\right\} \end{bmatrix} \begin{bmatrix} \text{PRED} & \text{`FLAG'} \\ \text{CONCORD} & [\text{NUM}\ \ \text{SG}] \\ \text{ADJ} & \left\{[\text{PRED}\ \ \text{`RED'}]\right\} \end{bmatrix} \right\}
\end{array}\right]$$

Belyaev et al. (2015) do not offer an explicit semantics in their account, but it is clear that we will have to interpret agreement features from the target (the adjectives) one way or another. Notice that the analysis does not provide an INDEX NUM SG feature on the conjuncts and it would not be trivial to get that. So on a description by analysis approach, we need to interpret the CONCORD NUM SG features of the conjuncts, although CONCORD features are normally understood as meaningless. The (INDEX) NUM PL feature of the whole noun phrase would be superfluous but not harmful, just like in other cases of group formation from two singular nouns.

On a codescription approach, we cannot directly exploit the fact that there are two singular flags in the f-structure in (40). Instead it seems likely that the lexical entry of the singular adjectives themselves will introduce singular number constraints. The special phrase structure rule for resolving agreement might also play a role in constraining when an adjective's number feature is interpreted, to

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[12] See Belyaev et al. (2015) for the details of how this f-structure arises. In short, the relevant rule for adjective coordination creates two incomplete (PRED-less) NPs, to which each adjective contributes their CONCORD features, including singular number. The PRED feature originating in the noun is distributive and gets copied into each conjunct.

avoid problems of interpreting adjective number features when they agree with e.g. a *plurale tantum*.

We cannot address this issue in further detail here, but we can conclude that in one way or another, the morphological singular feature that occurs on the adjectives in (39) will have to be interpreted. Although details remain unclear, this supports the general symmetric approach to agreement in LFG.

9 Summary

We have seen that the standard treatment of agreement in LFG relies heavily on unification: the controller and the target co-specify a piece of functional structure. There is therefore symmetry between controller and target features, as both contribute grammatical information on an equal footing. On the other hand, the piece of functional structure that is co-specified is usually found only in the syntactic position of the controller (except when feature sharing is assumed), accounting for the directed nature of agreement. To account for certain phenomena in coordination and with special lexical items, it has proven necessary to operate with two such positions (f-structure features), INDEX and CONCORD. While the phenomenon of agreement is thus handled at f-structure, the projection architecture makes it possible to model interactions with other aspects of grammatical structure, notably c-structure and information structure, as has proven necessary for several phenomena.

The symmetric but not feature sharing theory of agreement has proven successful for example in accounting for the diachrony of agreement marking. Nevertheless, there are some constructions that seem to suggest modifications of the basic framework: long distance agreement across clause boundaries can be analyzed as local agreement if we allow structure sharing at least for (some) instances of CONCORD agreement, whereas Wechsler's Agreement Marking Principle suggests that target and controller features are not symmetric. On the other hand, the semantic contribution that target features sometimes make seem to support the traditional, symmetric analysis.

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Chapter 6

Case

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This chapter surveys work on case within LFG, beginning with some of the earliest studies in Bresnan (1982). The chapter then moves on to cover the interaction of Mapping Theory with case marking, Optimality Theoretic approaches to case and the ideas articulated by Constructive Case. It closes with an outlook on more recent analyses. While these recent analyses are couched within current LFG and are applicable to a wider range of phenomena, they echo the basic insights of some of the earliest approaches to case in that they essentially take a lexical semantic view of case, but go beyond the lexicon and use LFG's projection architecture to chart the complex interaction between lexical, structural and semantic/pragmatic factors exhibited by case markers crosslinguistically, including core case markers. Examples in this chapter are drawn mainly from Australian, Scandinavian, and South Asian languages.

1 Introduction

In LFG there is no one theory of case and so this chapter goes through a variety of approaches. While the approaches differ formally and focus on a diverse set of phenomena, they are unified by the same underlying sense of how case should be analyzed. Case marking is seen as being closely connected to the identification of grammatical relations (henceforth grammatical functions or GFs), but also to the realization of lexical semantic information, such as experiencer or causer/causee semantics, instruments, goals, locations, etc. Like any piece of morphological or syntactic information, case is seen as contributing to the overall morphosyntactic and semantic analysis of a clause. That is, case marking is taken to provide important information about GF status (e.g., SUBJ vs. OBJ vs. OBJ$_\theta$ or OBL$_\theta$) and about the lexical semantics of the arguments of a predicate. This can go so far as

Miriam Butt. 2023. Case. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 219–266. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185944

taking the form of 'Constructive Case' whereby the case marking is responsible for the 'creation' or introduction of a particular GF into the syntax (Section 4). For example, the ergative might come with the information that a SUBJ must exist in the clause and thus contribute a SUBJ feature to the f-structure analysis.

The chapter begins with a look at the earliest treatments of case in LFG in Section 2, which developed the basic insights informing later work. Case marking is modeled as a combination of syntactic and lexical semantic information and plays a role in the mapping from semantic arguments to GFs. This is discussed in Section 3, with Section 6 laying out the effects of case at the clausal semantic level, i.e. in terms of telicity or partitivity and modality. Case also appears to have pragmatic impact in that it can express information structural meaning and can be governed by information structural concerns.

With the rise of Optimality Theory (Prince & Smolensky 1993), influential work by Aissen as well as Woolford sought to account for Differential Case Marking (DCM) and other distributions of case via an Optimality Theory (OT) approach (Aissen 1999, 2003, Woolford 2001). LFG took an early interest in the possibilities of OT (Bresnan 2000) and as discussed in Section 5, this included experimenting with OT for analyses of case.

Some of the material in this chapter has already been presented in Butt (2006) and Butt (2008), particularly the description of Constructive Case and the mapping between semantic arguments and GFs. However, this contribution provides a deeper look at case in early LFG and at case within approaches inspired by OT. It also updates the discussion with respect to new proposals for mapping/linking and ties the various facets of case marking together in a sketch for an overall comprehensive approach in Section 7. Section 8 summarizes.

2 Early LFG

Some of the earliest LFG work included papers that were specifically devoted to case. This section discusses the contributions by Neidle (1982), Andrews (1982) and Mohanan (1982) on a diverse range of languages, namely Russian, Icelandic and Malayalam, respectively.

2.1 Russian

Neidle (1982) looked at patterns of case agreement in Russian complements and secondary predicates. In essence, Neidle's overall approach to case did not differ much from what would have been standard assumptions at the time in that

Neidle divides case into two broad categories: 1) *structurally predictable* case; 2) *lexically required* case and exceptions. This bipartite distinction still underlies most of the assumptions and theorizing on case in standard GB/Minimalist approaches, e.g., see Butt (2006), Bobaljik & Wurmbrand (2008) for overviews, and is currently framed as an opposition between dependent vs. inherent case, e.g., Baker & Bobaljik (2017).

A special feature of Neidle's approach is the adoption of Jakobson's feature decompositional approach to case (Jakobson 1936). Neidle also briefly touches on the issue of genitive objects in Russian, which are introduced structurally in the presence of negation and more generally when the object is non-quantized. In the latter case, the genitive may be part of a Differential Case Marking (DCM) pattern by which the genitive is used for non-quantized objects and the accusative for quantized objects, e.g., in verbs such as 'demand' (Neidle 1982: 400). Genitive case is sometimes also required by the inherent lexical semantics of the verb (e.g., 'wish').

Neidle does not quite integrate the quantizedness semantics into her account and instead opts for a simple distinction between structural and inherent case. Structural case is assigned via f(unctional)-structure annotations on c(onstituent)-structure rules. For example, the annotations on an object OBJ and an indirect object (termed OBJ2 in early LFG) might look as in (1), where the Jakobsonian-inspired featural decomposition (−, −, +) corresponds to accusative whereas the (+, −, +) corresponds to a dative.

(1)	VP	⟶	V	NP	NP
			↑=↓	(↑ OBJ)=↓	(↑ OBJ2)=↓
				(↓ CASE)=(−, −, +)	(↓ CASE)=(+, −, +)

The structural case assignment is matched up with the functional information gleaned from the morphological case marking on nouns, pronouns, adjectives, etc. That is, if a phrase structure rule as in (1) calls for an accusative object, then whatever noun or pronoun this NP is instantiated by needs to have accusative morphology. Given this approach to structural case, the lexical entries for verbs generally contain no information about case: as shown in (2), verbs specify the type and number of the GFs that are expected (as per basic LFG theory), but do not contain additional information about case.[1]

(2) %vstem V (↑ PRED)='%vstem⟨(↑ SUBJ),(↑ OBJ)⟩'

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[1] The lexical entry in (2) has been adapted from the original with respect to how a verb stem is represented. The % indicates a variable that can be filled by some value (Crouch et al. 2011). In the lexical entry in (2), this might be the verb 'kill', for example.

On the other hand, a specification for case marking is added to those verbal entries where the case marking patterns are identifiable as being due to the semantics of the verbs (e.g., ‘wish’). This is illustrated in (3), where the case information corresponds to a genitive.[2]

(3) *wish* V (↑ PRED)=‘WISH⟨(↑ SUBJ),(↑ OBJ)⟩’
(↑ OBJ CASE) = (−, +, +)

Effects of the genitive of negation are handled at the c-structural level, with the rule introducing the negation also introducing information that triggers genitive case on the object. The overall approach is thus one in which there is a complex interaction between c-structural, morphological and lexical information. While Neidle’s particular approach in terms of the Jakobsonian-inspired featural decomposition of case was not taken up in LFG, the basic approach to modeling the interplay between lexical semantics, phrase structure and morphological information continues to inform LFG.

2.2 Icelandic

As exemplified by Neidle’s approach, there has never been an assumption within LFG that case should be associated strictly with one GF (or vice versa) or that agreement and case should be inextricably bound up with one another. This is because of the very early recognition within LFG that in addition to non-accusative objects such as those found in Russian: 1) non-nominative subjects also exist in the world’s languages and thus need to be accounted for; 2) agreement does not necessarily track subject status. This was famously established in the early days of LFG with respect to Icelandic (Andrews 1976, Zaenen et al. 1985). In both of the examples in (4) (based on Andrews 1982: 462–463) the dative argument can be shown to be a subject via a battery of subject tests such as reflexivization, control, subject-verb inversion, extraction from complement clauses and subject

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[2] The explanation of Neidle’s approach here is designed to provide the essence of her ideas, not the particulars. As such the lexical entry is simplified and as part of this simplification, the verb stem has been given in English. The overall analysis Neidle proposes for Russian is complex in its details and the interested reader is referred to the original paper both for more information as to the feature decomposition approach to case and the details of the complex interaction between morphology, c-structure and the lexicon that she maps out. However, as Neidle’s paper is one of the earliest papers on LFG and the theory has developed since, particularly with respect to approaches to morphology, attempting to provide more details as to her approach as part of this chapter (as some reviewers have suggested) would lead us too far afield into a comparison of early vs. current LFG.

ellipsis. The example in (4b) additionally shows that agreement is not an indicator of subjecthood in Icelandic since the third singular verb does not agree with the first person singular subject.

(4) Icelandic

a. Barn-inu batnaði veik-in.
child-DEF.DAT recovered.from.3SG disease-DEF.NOM
'The child recovered from the disease.'

b. Mér er kalt.
I.DAT be.3SG cold
'I am cold.'

Andrews (1982) also discusses instances of non-accusative objects[3] and notes that nominative objects are the rule in dative subject examples as in (4a). These and other considerations lead Andrews to provide a rich and detailed analysis of the case marking patterns in Icelandic as part of a longer paper on Icelandic syntax.

The overall approach to case is similar to that taken by Neidle, though the formalization is quite different. Like Neidle, Andrews (1982) invokes Jakobson on case, but does not adopt a feature decomposition approach. Rather, he builds on Jakobson's idea that the nominative should be analyzed as a default, unmarked (almost non-case) in Indo-European. As a consequence, Andrews develops an account by which nominative is assigned as a default case as part of the syntax (c-structure rules) if no other case has been specified. Accusative is assigned to objects as a default as well, but only in a structure where there is a nominative subject. All other case marking is specified as part of the lexicon.

Andrews specifically notes that the choice of non-default case marking is not arbitrary, but can be tied to semantic generalizations such as experiencer/perception semantics, the semantics of verbs of lacking and wanting, etc. (Andrews 1982: 463). Essentially, non-nominative subjects all seem to mark non-agentivity of one sort or another. However, despite a sense of systematicity underlying the connection between semantics and case marking, Andrews decides that because there is no invariant meaning one can assign to a case, a strategy of encoding non-nominative subject (and non-accusative object) case as part of the lexicon should be followed: "case selection is basically lexical and idiosyncratic, but subject to regularities keyed to the semantics of the matrix verb" (Andrews 1982: 464). As in Neidle's approach, further structurally motivated instances of non-default case marking are allowed. This is exemplified by structural genitives in

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[3] Also see Svenonius (2002) for a more recent in-depth analysis of non-accusative object marking.

Russian, and in Icelandic non-default case occurs in some instances of passivization. Other case marking that goes beyond the core patterns is dealt with via lexically (or otherwise) stipulated information.

Interestingly, Andrews' basic approach foreshadows the notion of *Dependent Case* (Marantz 2000, Baker 2015). This sees the central problem of case theory as deciding on how to apportion structural case between two core argument participants, with the case marking of one being dependent on the structure of the other. So, if a subject is ergative, there are mechanisms in place which ensure that the object is nominative/absolutive. This is similar (but not identical) to Andrews' treatment of nominative objects in the presence of dative subjects and accusative objects in the presence of nominative subjects.

2.3 Malayalam

A different approach to case is taken by Mohanan (1982). Working on Malayalam, Mohanan entertains an approach pioneered by the Sanskrit grammarian Pāṇini (Böhtlingk 1839–1840) and taken up by Ostler (1979). This holds that the distribution of case can be expressed in terms of generalizations referring directly to thematic/semantic roles. However, Mohanan shows that it is also necessary to assume a structural level at which GFs are encoded in order to be able to properly account for the distribution of case in Malayalam. That is, the level of GFs (f-structure) must mediate between the overt expression of case and the lexical semantics of verbs. In line with Andrews' findings for Icelandic, Mohanan establishes a systematic relationship between lexical semantics and case, but not a one-to-one relationship. In a precursor to Mapping Theory (Section 3), Mohanan proposes the principles in (5).[4]

(5) **Principles of Case Interpretation**

a. Intrepret accusative case as the direct object (OBJ).

b. Interpret dative case as either the indirect object (OBJ2) or the subject (SUBJ).

c. Interpret nominative case as either the subject (SUBJ) or the direct object (OBJ) if the NP is [−animate]; otherwise interpret nominative case as the subject (SUBJ).

There are several things to note about these principles. For one, they assume that case marking plays a central role in the determination of GFs (rather than

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[4] These have been simplified slightly with respect to the dative for ease of exposition.

constituting features that must be spelled out, checked off or interpreted, as in GB/Minimalist approaches, for instance). For another, the animacy condition in (5c) constitutes an indirect analysis of the DCM phenomenon found in Malayalam whereby animate objects must be marked with the accusative.

The Principles of Case Interpretation are encoded in the grammar via f-structural annotations on c-structure rules which ensure that indirect objects are dative, subjects are either nominative or dative and objects either accusative or nominative. Mohanan is able to capture this space of possibilities elegantly by also working with Jakobson's case features. While the alternation between nominative and accusative objects is taken to be governed by animacy (via well-formedness checking at f-structure), no general principles for the appearance of dative vs. nominative subjects are built into the system. Rather, like Neidle and Andrews, Mohanan steers the licensing of dative subjects via lexical stipulation in the verb's entry, as shown in (6), taken from Mohanan (1982: 545). He classifies both 'sleep' and 'be hungry' as intransitive experiencer verbs. The nominative case on the subject of the verb 'sleep' is taken to follow from the general Principles of Case Interpretation in conjunction with the functional annotations on the c-structure rules. On the other hand, the verb 'be hungry' is lexically stipulated to have a dative subject. The choice of dative vs. nominative subjects is thus steered via the presence or absence of information found in the lexical entries.

(6) a. *uraŋŋ* V (↑ PRED)=‘SLEEP⟨ (↑ SUBJ) ⟩’
EXPERIENCER

b. *wiš̄akk* V (↑ PRED)=‘BE HUNGRY⟨ (↑ SUBJ) ⟩
EXPERIENCER

Mohanan generally assumes that a verb's lexical entry expresses both the thematic roles it takes and the grammatical relations that these correspond to, as shown in (6) and (7). This is in line with early LFG approaches to predicate-argument structure, which assumed a close connection between thematic roles and GFs but did not yet articulate that relationship in any detail (cf. the contributions in Butt & King 2006 [1983]). The articulation of this relationship came with the advent of linking (Section 3).

(7) *t̪inn* V (↑ PRED)=‘EAT⟨(↑ SUBJ), (↑ OBJ) ⟩’
AGENT PATIENT

LFG's work on the linking or *mapping* between thematic roles and GFs in the 1980s and 1990s also entailed a closer look at the lexical semantics of verbs and verb classes, with detailed work such as that by Jackendoff (1990) and Levin (1993) providing inspiration. As such, the conclusions arrrived at by Mohanan that the case patterns in Malayalam are too irregular to be governed by general principles deserve a second look from today's perspective. Consider, for example, the contrasts in (8) and (9), taken from Mohanan (1982: 540–541).[5] Mohanan considers the verbs to "…presumably have the same thematic roles" (Mohanan 1982: 540), namely to all have experiencer arguments. However, the 'became' in (8a) is rather more indicative of an undergoer/patient so this is more likely to be an unaccusative, rather than an experiencer verb. This difference in lexical semantics is likely to govern the difference in subject case so that experiencer semantics is expressed via a dative subject while unaccusatives simply receive a nominative subject by default.

(8) Malayalam

a. awaḷ taḷarn̪n̪u.
she.NOM was tired
'She became tired.'

b. awaḷ-kkə wiš̄an̪n̪u.
she-DAT hungered
'She was hungry.'

Similarly, the contrast between (9a) and (9b) can potentially be explained by (9b) involving a metaphorical location ('happiness came to me'), which lends itself to dative subjects, as argued for by a.o. Landau (2010) and suggested by Localist approaches to case and argument structure, e.g. Gruber (1965), Jackendoff (1990).

(9) Malayalam

a. ñ̄aan san̪t̪oos̩iccu.
I.NOM was happy
'I was happy.'

b. eni-kkə san̪t̪oos̩am wan̪n̪u.
I-DAT happiness came
'I was happy.'

Contrasts such as in (9) are standardly and systematically found in South Asian languages and they thus deserve a better explanation than being relegated to

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[5] The glosses in these Malayalam examples provide slightly more detail than in the original.

lexical stipulation. The same applies to contrasts as in (10), from Mohanan (1982: 542), where a difference in modality is expressed solely in terms of a difference in case marking on the subject.

(10) Malayalam

a. kuṭṭi aanaye ṇuḷḷ-aṇam.
child.NOM elephant.ACC pinch-MOD
'The child must pinch the elephant.'

b. kuṭṭi-kkə aanaye ṇuḷḷ-aṇam.
child-DAT elephant.ACC pinch-MOD
'The child wants to pinch the elephant.'

Mohanan again resorts to lexical stipulation to model the two different readings (permission vs. promise), but given that these types of contrasts are also widely found in other South Asian languages (Butt & Ahmed Khan 2011, Bhatt et al. 2011), again a more principled analysis is in order (see Section 7).

3 Mapping Theory

Over time, the understanding of case and its relationship with predicate arguments deepened and LFG developed a dedicated *Mapping Theory* to model and explain the systematicity found across a typologically diverse set of languages. A subset of the semantics associated with case has thus by now been covered by this more principled account of the relationship between lexical semantics and GFs. This section briefly charts the development of Mapping Theory from early ideas and formulations to today's standard instantiation, focusing particularly on the role of case. The reader is referred to Findlay et al. 2023 [this volume] for a fuller discussion of Mapping Theory and more recent developments.

3.1 Association Principles with case

It is perhaps no accident that the beginnings of LFG's Mapping Theory were first articulated with respect to Icelandic (Zaenen et al. 1985) — a language with robust case marking that attracted intense linguistic interest in the 1980s because of its demonstrated use of non-nominative subjects (Andrews 1976). Zaenen et al. (1985) present a detailed study of the interaction between Icelandic case and GFs, which bears similarities to the approaches sketched in the previous section. However, the Icelandic Association Principles formulated by Zaenen et al. (1985) in

(11) contrast with Mohanan's principles for Malayalam. Where Mohanan linked case directly to GFs, Zaenen et al. (1985) postulate a complex interrelationship between case, thematic roles and GFs. Another feature of the principles is that they include universal as well as language-specific postulations, as can be seen via a comparison of Icelandic and German, for which Zaenen et al. (1985) provide a comparative analysis.

(11) **Icelandic Association Principles**

1. AGENTS are linked to SUBJ. (Universal)
2. Casemarked THEMES are assigned to the lowest available GF. (Language Specific)
3. If there is only one thematic role, it is assigned to SUBJ; if there are two, they are assigned to SUBJ and OBJ; if there are three, they are assigned to SUBJ, OBJ, 2OBJ.[6] This principle applies after principle 2 and after the assignment of restricted GFs. (Universal)
4. Default Case-Marking: the highest available GF is assigned NOM case, the next highest ACC. (Universal)

(12) **German Association Principles**

1. AGENTS are linked to SUBJ. (Universal)
2. Casemarked THEMATIC ROLES are assigned to 2OBJ. (Language Specific)
3. If there is only one thematic role, it is assigned to SUBJ; if there are two, they are assigned to SUBJ and OBJ; if there are three, they are assigned to SUBJ, OBJ, 2OBJ. This principle applies after principle 2 and after the assignment of restricted GFs. (Universal)
4. Default Case-Marking: the highest available GF is assigned NOM case, the next highest ACC. (Universal)

Like the 1982 approaches of Neidle, Mohanan and Andrews, Zaenen et al. (1985) rely on a mix of universal and structurally determined case assignment (default nominative on subjects and accusative on objects), language-specific rules and lexically stipulated case marking patterns. However, Zaenen et al. (1985) differ significantly from Andrews' approach to Icelandic in that they include thematic roles in the statement of generalizations and associate case as one of several features with a given GF. Andrews, on the other hand, argued for the use of a "composite function" in which GF and case information are welded together to provide

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[6] This corresponds to OBJ_θ within later LFG approaches.

differentiation among GFs. So for example, one could have a SUBJ DAT vs. a SUBJ ACC or OBJ ACC. These composite functions were licensed by a complex interplay between f-structure annotations and lexical specifications. Over time, Zaenen et al.'s technically simpler but architecturally more complex approach was adopted as the standard way of thinking about Icelandic case marking patterns within LFG.

3.2 Argument structure

We here illustrate Zaenen et al.'s system by way of the example in (13) (Zaenen et al. 1985: 470). The Icelandic verb *óska* 'to wish' is ditransitive, but the goal argument ('her' in 13) is optional.

(13) Icelandic

þú	hefur	óskað	(henni)	þess
you	have	wished	her.DAT	this.GEN

'You have wished this on/for her.'

The genitive and dative on the theme and goal arguments, respectively, are encoded as part of the lexical entry of the verb, as shown in (14). Note that this lexical entry differs from those encountered in the 1982 papers in that Zaenen et al. (1985: 465) "postulate a level of representation at which the valency of a verb is determined and its arguments can be distinguished in terms of thematic roles." The encoding of the number and type of arguments of a verb via a separate level of argument structure was due to a forceful demonstration by Rappaport (2006 [1983]) with respect to derived nominals that argument structure needed to be posited as an independent level of representation.[7]

(14)

óska:	< agent	theme	(goal)>
		[+gen]	[+dat]
a.	SUBJ	2OBJ	OBJ
b.	SUBJ	OBJ	
	[+nom]		

The thematic roles in the verb's argument structure are linked to GFs via the Association Principles in (11). The agent is linked to SUBJ and receives nominative case via the universal principles in 1 and 4. When the goal argument is present, the

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[7] See Chomsky (1970) for similar conclusions with respect to nominalizations, which led to a general understanding of argument structure as a separate level of representation, currently often realized as vP in Minimalist approaches to syntax.

case marked theme is assigned to the lowest available GF (Principle 2, language-specific), which is the secondary object. That leaves the goal argument to be assigned to the OBJ, since by Principle 3 (universal) if there are three thematic roles, they need to be assigned to SUBJ, OBJ and 2OBJ. In this case SUBJ and 2OBJ have already been assigned, leaving only OBJ.

When the goal argument is not present, the agent is again linked to SUBJ and receives nominative case via the universal principles in 1 and 4. But this time the genitive case marked theme is assigned to OBJ as the lowest available GF, as shown in (14b). The status of OBJ is significant as it is this argument that can be realized as a subject under passivization. The lexically determined case marking is also significant, as these cases tend to be retained in constructions like the passive, as shown in (15) (Zaenen et al. 1985: 471).

(15) Icelandic

a. þess var óskað (*henni)
this.GEN was wished her.DAT
'This was wished.'

b. Henni var óskað þess
her.DAT was wished this.GEN
'She was wished this.'

Today's standard Mapping Theory relates GFs to thematic roles via two abstract linking features, [±*o*](bjective) and [±*r*](estrictive), by which both thematic roles and GFs can be classified (Bresnan & Zaenen 1990, Bresnan 2001, Butt 2006). Additionally, a number of principles govern the association of GFs and thematic roles. These principles were worked out on the basis of a wide range of data, including Bantu, Germanic and Romance. LFG's Mapping Theory can account for a wide range of argument changing operations such as locative inversion, causativization, passives (argument deletion) or applicatives (argument addition), e.g. see Levin (1987), Alsina & Mchombo (1993), Bresnan & Kanerva (1989), Bresnan & Moshi (1990), Alsina & Joshi (1991).

Based on his work with Romance languages (mainly Catalan), Alsina (1996) proposed an alternative version of Mapping Theory and in recent years, Kibort has worked out a revised version, which abstracts away from the use of thematic roles, instead working with abstract argument positions and a complex interplay between syntax and semantics (Kibort 2007, 2013, 2014, Kibort & Maling 2015). This chapter does not delve further into the details of linking as the role of case in most versions of linking has stayed much as it was in Zaenen et al.'s analysis of Icelandic: an extra piece of information that helps determine the mapping between GFs and thematic roles and that needs to be accounted for as part of the mapping between argument structure and GFs. See Butt (2006) and Findlay et al. 2023 [this volume] for overview discussions.

However, we will include a discussion of Schätzle (2018) in Section 6, as she works with Kibort's revised version of linking, and develops an event-based theory of linking for an analysis of the historical rise and spread of dative subjects in Icelandic (yes — again Icelandic!).

3.3 Quirky case

Before moving away from the early LFG approaches to case and linking, this section takes a look at a significant concept that also resulted from the concentrated work on Icelandic: *lexically inherent* or *quirky case*. The data from Icelandic and other languages support a distinction between at least two types of case assignment/licensing. In the papers discussed so far, this was thought of as a distinction between structurally assigned and "lexically inherent" case. The latter also came to be known as "quirky case".

However, the anchoring of case marking information in lexical entries together with the term "quirky" suggests a random lawlessness that must be idiosyncratically stipulated as part of lexical entries. This view on non-default case has become widely accepted within linguistics, but lacks empirical support. As already noted by Andrews (1982) for Icelandic, for example, and confirmed by the data and analyses in Zaenen et al.'s paper, the correlation between thematic role and case marking in Icelandic is actually quite regular in that the "quirky" cases are generally regularly associated with a given thematic role. There seem to be only very few instances of truly idiosyncratic case marking that do not follow from general semantic principles.

Van Valin (1991) explicitly revisited the Zaenen et al. paper and made this point, working out an alternative analysis within Role and Reference Grammar (RRG). Van Valin (1991) takes an event-based approach, working with differences between Vendlerian states, activities, achievements and accomplishments in combination with a macro-role approach to the arguments of a predicate. The paper mainly focuses on dative arguments, whereby dative case is assigned to those arguments which cannot be assigned a macro-role (either actor or undergoer). Dative arguments thus constitute the 'elsewhere' case and do not need to be lexically encoded/stipulated. Van Valin does not explicitly address the other types of non-default case marking.

Although Van Valin frees dative marked arguments from being lexically stipulated, he also essentially works with a bipartite system: case marking which is determined systematically via reference to macro-roles vs. case marking that is idiosyncratic. However, the empirical evidence supports a tripartite, rather than a bipartite approach to case: 1) structural case (e.g., nominative/accusative), 2) semantically conditioned case; 3) idiosyncratic case. Despite the empirical evidence for a tripartite view, this approach constitutes an exception rather than the rule in the literature. Versions of a tripartite view of case marking have been argued for by Donohue (2004) and Woolford (2006), for example. Within LFG this view was first clearly articulated by Butt & King (2004), see Section 7.

4 Constructive case

In this section we turn to a very different type of case marking, namely a phenomenon that has come to be known as *case stacking*, illustrated in (16). Within LFG, Nordlinger (1998, 2000) took on this phenomenon with respect to Australian languages and proposed a strongly lexicalist analysis in which the case markers themselves contribute information about the gfs of a clause.

(16) Martuthunira (Dench 1995: 60)
Ngayu nhawu-lha ngurnu tharnta-a mirtily-marta-a
I.nom saw-pst that.acc euro-acc joey-prop-acc
thara-ngka-marta-a.
pouch-loc-prop-acc
‘I saw the euro with a joey in (its) pouch.’

In (16) the main predicate is ‘see’, which takes a nominative subject (‘I’) and an accusative object, ‘euro’ (a type of kangaroo). The clause also contains two modifying NPs, ‘joey’ (a baby kangaroo) and ‘pouch’. The accusative on these nouns signifies that they modify the obj ‘euro’, the proprietive shows that these are part of a possessive or accompanying relation to another word and the locative on ‘pouch’ signals that this is the location of the joey. The f-structure in (17) shows these dependency relations among the NPs.

(17)
$$\left[\begin{array}{ll}
\text{PRED} & \text{‘SEE}\langle\text{SUBJ,OBJ}\rangle\text{’} \\
\text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘PRO’} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 1 \\ \text{CASE} & \text{NOM} \end{array}\right] \\
\text{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘EURO’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{ACC} \\ \text{ADJUNCT} & \left\{\left[\begin{array}{ll} \text{PRED} & \text{‘JOEY’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{PROP} \\ \text{ADJUNCT} & \left\{\left[\begin{array}{ll} \text{PRED} & \text{‘POUCH’} \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{LOC} \end{array}\right]\right\} \end{array}\right]\right\} \end{array}\right] \\
\text{TENSE} & \text{PST} \\
\text{MOOD} & \text{INDICATIVE}
\end{array}\right]$$

None of this case marking by itself is out of the ordinary. What is special is the ability of languages like Martuthunira to stack cases on top of one another. In a language like Martuthunira that has fairly free word order, this stacked marking of dependents unambiguously indicates which elements belong to which other elements syntactically (see Butt 2000 for some discussion).

The individual case markers could be dealt with straightforwardly by a mix of structural and lexically inherent case, as had been done in the past. However, the case stacking is a different matter. It is not particularly feasible to stipulate all possible case stacking patterns in the lexical entries of the verbs. This kind of “anticipatory” case marking would lead to an unwanted proliferation of disjunctions in the verbal lexicon. Given that Martuthunira has fairly free word order, trying to write rules in the syntax that would anticipate all possible patterns of case stacking would result in an unwieldy and uninsightful treatment of the phenomenon.

Instead, Nordlinger’s solution is to see case morphology as being *constructive* in the sense that a case marker comes with information as to what type of GF it is expecting to mark. Formally, this is accomplished via *inside-out functional* *designation* (Dalrymple 1993, 2001), as illustrated in the (sub)lexical entries for the case markers in (18). The first line in each of the entries is standard: each case marker specifies that the attribute case is assigned a certain value (ergative, accusative, etc.). This ensures that whatever constituent carries the case marker will be analyzed as ergative, or accusative, or locative, etc.

The second line in each entry has the ↑ behind the gf rather than in front of it, signaling inside-out functional designation (Belyaev 2023: Section 3.2.4 [this volume]). This has the effect of adding a constraint on the type of gf the case marker can be associated with. In (18) the effect is that the ergative is constrained to appear within a subj, the accusative within an obj, etc.[8]

(18) a. ergative: (↑ case) = erg
(subj ↑)

b. accusative: (↑ case) = acc
(obj ↑)

c. locative: (↑ case) = loc
(adjunct ↑)

b. proprietive: (↑ case) = prop
(adjunct ↑)

Nordlinger works on the Australian language Wambaya and develops an analysis of the complex interaction between morphology and syntax that characterizes case stacking. Reproducing the entire analysis including an explanation of Wambaya morphosyntax goes far beyond the limited space available in a handbook article: this section therefore stays with the Martuthunira example for purposes of illustrating the general idea behind constructive case.

For the sake of concreteness, this section assumes a view of the morphology-syntax interface in which sublexical items are produced by rules which are analogous to phrase structure rules. This is the approach generally adopted in the ParGram grammar development world (Butt et al. 1999) and as such is useful for a concrete illustration. Note, however, that current LFG literature differs on assumptions as to the morphology-syntax interface. The illustration here adopts the general architecture articulated in Dalrymple (2015).

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[8] Andrews (1996) also takes on case stacking and also uses LFG's inside-out functionality. However, his focus is on the interaction between morphology and syntax, rather than on case per se.

To begin with, let us consider the partial f-structure resulting from just the information on ‘pouch’ shown in (19). The stacked case marking on this noun not only provides information on the case of the noun (the innermost case morphology), it also “anticipates” the larger structure it will be embedded in. The PREDs of that larger structure will be filled in as part of the overall annotated c-structural analysis, with the partial f-structures corresponding to each of the nouns (and the verb) unifying into the full f-structure in (17).

(19)
$$\left[\begin{array}{ll} \mathrm{OBJ} & \left[\begin{array}{ll} \mathrm{CASE} & \mathrm{ACC} \\ \mathrm{ADJUNCT} & \left\{\left[\begin{array}{ll} \mathrm{CASE} & \mathrm{PROP} \\ \mathrm{ADJUNCT} & \left\{\left[\begin{array}{ll} \mathrm{CASE} & \mathrm{LOC} \\ \mathrm{PRED} & \text{‘POUCH’} \\ \mathrm{NUM} & \mathrm{SG} \\ \mathrm{PERS} & 3 \end{array}\right]\right\} \end{array}\right]\right\} \end{array}\right] \end{array}\right]$$

Recall that the inside-out function designation only serves as a constraint on f-structure. That, is the information found on ‘pouch’ postulates that there should be an OBJ into which it can be embedded. This condition will only be fulfilled if such an OBJ ends up being introduced somewhere so the actual introduction of the OBJ thus needs to come from some other part of the syntax or lexicon.

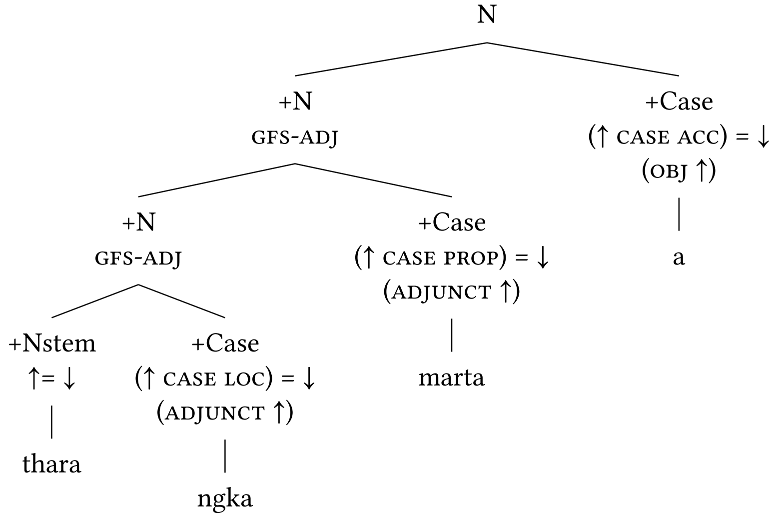
For purposes of illustration, let us assume a (simplified) phrase structure rule for clauses as in (20), which reflects the tendency in Australian languages for a (finite) verb to be in second position and models the general free word order for Australian languages. We can thus have one GF or an adjunct introduced by the XP before the verb and any GF or adjuncts after the verb. Note that “GFS-ADJ” is a template that is expandable as in (21). Similarly, XPs could be expanded to a number of different phrase structure categories, including NPs.

(20)
$$\begin{array}{lllll} \mathrm{S} & \longrightarrow & \mathrm{XP} & \mathrm{V} & \mathrm{XP}^{*} \\ & & @\mathrm{GFS\text{-}ADJ} & \uparrow=\downarrow & @\mathrm{GFS\text{-}ADJ} \end{array}$$

(21)
$$\begin{array}{l} \mathrm{GF\text{-}ADJS} = \{\, (\uparrow \mathrm{SUBJ}) = \downarrow \mid (\uparrow \mathrm{OBJ}) = \downarrow \mid (\uparrow \mathrm{OBL}_{\theta}) = \downarrow \\ \qquad\qquad \mid (\uparrow \mathrm{OBJ}_{\theta}) = \downarrow \mid \downarrow \in (\uparrow \mathrm{ADJUNCT})\} \end{array}$$

Since most of the action takes place in the morphological component in Marthuthunira, let us take a look at a possible sublexical structure (for a discussion of sublexical structure and sublexical rules, see Belyaev 2023: 2.2 [this volume]). In (22) the N expands into a set of sublexical categories, marked with a + for ease of exposition. In our example, we have a noun stem that can combine with a case marker, yielding a sublexical N (+N). This can combine with further case markers, as shown in (22), finally yielding an N.[9]

(22)



The inside-out functional designation on *ngka*, for example, requires that this be part of an ADJUNCT. This is only a constraint and as such does not "construct" the ADJUNCT per se. However, taken together with the space of possibilties licensed by the functional annotations on the mother +N node, the inside-out designation has the effect of selecting exactly the ADJUNCT among the space of possibilities provided by the expansion of GFS-ADJ in (21) and thus, in effect, serving to "construct" this GF by way of the sublexical specification on the case marker.

The same formal effect is found with the accusative marker — here the governing GF is constrained to be an OBJ and this causes the OBJ option to be selected from the set of possibilities in (21), but this time they are selected from the functional annotations on the XP in rule (20), which is instantiated by an NP and expands into the N in (22).

Overall, taking together the functional annotations in the phrase structural and the sublexical space within the N leads us to the f-structure in (19). This partial f-structure can then be unified straightforwardly with information coming from other parts of the clause via the standard unification mechanism in LFG. For example, the unification of (19) with the partial f-structure corresponding to the word *mirtily-marta-a* 'joey-PROP-ACC' shown in (23) results in the unified f-structure in (24). This unification takes place with respect to the information com-

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[9] Of course, the possible space of combinations in the morphological component must be constrained and this can be done quite simply by writing suitable sublexical rules, but describing all the details here would take us too far afield.

ing from the other words in the clause as well, resulting in the final f-structural analysis in (17).

(23)
$$\left[\begin{array}{ll} \text{OBJ} & \left[\begin{array}{ll} \text{CASE} & \text{ACC} \\ \text{ADJUNCT} & \left\{ \left[\begin{array}{ll} \text{CASE} & \text{PROP} \\ \text{PRED} & \text{`JOEY'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \end{array} \right] \right\} \end{array} \right] \end{array} \right]$$

(24)
$$\left[\begin{array}{ll} \text{OBJ} & \left[\begin{array}{ll} \text{CASE} & \text{ACC} \\ \text{ADJUNCT} & \left\{ \left[\begin{array}{ll} \text{CASE} & \text{PROP} \\ \text{PRED} & \text{`JOEY'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \\ \text{ADJUNCT} & \left\{ \left[ \begin{array}{ll} \text{CASE} & \text{LOC} \\ \text{PRED} & \text{`POUCH'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \end{array} \right] \right\} \end{array} \right] \right\} \end{array} \right] \end{array} \right]$$

Nordlinger's constructive case idea thus establishes case marking as carrying important information for the overall clausal analysis and invests case markers with (sub)lexically contributed information. Because the GF specifications on the case markers clearly signal which parts of the clause belong together, effects of free word order are accounted for automatically. For example, the discontinuous constituents, as illustrated in the Wambaya example in (25), can be treated very naturally. As sketched above for Martuthunira, each word in the clause produces a partial f-structure. These partial f-structures are then unified with others to produce the overall analysis, with the particular position in the clause or adjacency not mattering for the f-structural analysis. What matters is the compatibility of the information coming from the various bits and pieces of the clause, which means that discontinunous constituents which are each marked as ergative will end up being unifed under the same GF at f-structure, in this case the ergative subject.

(25) Wambaya (Nordlinger 1998: 96)

galalarrinyi-ni	gini-ng-a	dawu	bugayini-ni
dog.I-ERG	3SG.M.A-1.O-NFUT	bite	big.I-ERG

'The big dog bit me.'

Butt & King (1991, 2004) take a similarly constructive approach to case in addressing the case marking and free word order patterns of Urdu and they combine this with a theory of linking. This is discussed in Section 7. Before moving on to this and some further aspects governing the distribution of case from an LFG perspective, we however first delve into the insights offered by an adoption of Optimality Theory into LFG.

5 Optimality-Theoretic approaches

Optimality Theory (OT) was originally formulated with respect to phonological phenomena (Prince & Smolensky 1993, Kager 1999), but quickly found its way into syntactic work (Grimshaw 1997) and analyses of case patterns (Legendre et al. 2000). OT assumes an architecture by which several input candidates are generated by a given grammar. These input candidates are subject to a series of ranked constraints and result in just one of the candidates being picked as the most "optimal", i.e. as the resulting surface string. This version of OT is essentially focused on production, but a *bidirectional* version of OT, which could take both the production and the comprehension perspective into account, has been formulated as well (Blutner 2000, Dekker & von Rooy 2000). Constraints are assumed to be universally applicable across all languages, but the rankings of the constraints may differ, giving rise to language-particular patterns (see Kuhn 2023 [this volume] for an overview).

Bresnan (2000) introduced a version of OT that is compatible with LFG, arguing for the merits of this approach. Within OT-LFG, the input to an evaluation by OT constraints is assumed to be f-structure and c-structure pairings and the task of the OT constraints is to pick out the most optimal pairing. Work on case within OT-LFG has generally built on Bresnan's blueprint as well as the notions introduced by bidirectional OT.

5.1 Harmonic Alignment and DCM

OT-LFG work on case also made crucial use of the ideas in Aissen's seminal OT papers (Aissen 1999, 2003), in which she proposes a series of typologically motivated "Harmonic Alignment Scales" to account for DCM. For example, Aissen works with Silverstein's famous person and animacy hierarchy with respect to split ergativity (Silverstein 1976). She distills his and other insights found in the literature into three *universal prominence scales* shown in (27). These scales are applied to DCM, for example, with respect to differential subject marking of the type illustrated in (26) for Punjabi. In Punjabi third person subjects, but not first or second person subjects, may be overtly marked with ergative case.

(26) Punjabi

a. mɛ̃ bɑkra vec^{h}-i-a
PRON.1.SG.F/M goat.M.SG.NOM sell-PST-M.SG
'I (male or female) sold the goat.'

b. o=ne bɑkra vec^{h}-i-a
PRON.3.SG.F/M=ERG goat.M.SG.NOM sell-PST-M.SG
'He/She sold the goat.'

(27) Thematic Role Scale: Agent > Patient
Relational Scale: Subject > Non-subject
Person Scale: Local Person (1st&2nd) > 3rd Person

The three separate preference scales interact across languages. Within OT this interaction is modeled via the concept of *Harmonic Alignment* (Prince & Smolensky 1993), by which each element of a scale is associated with an element of another scale, going from right to left. The Harmonic Alignment of just the Relational and the Person scale in (27) is shown in the second column in (28) (Aissen 1999: 681). The third column in (28) shows the OT constraints derived from the Harmonic Alignment of the two scales. The constraints are arrrived at by interpreting the ranked elements in the Harmonic Alignment as situations which should be avoided, whereby lower ranked elements are the ones to be avoided more strongly than a higher ranked element. So in column 2 the 'x ≻ y' means 'x is less marked/more harmonic than y', and in column 3 the 'x ≫ y' means that the x constraint is ranked higher, i.e., is stronger, than the y constraint.

(28)

Scales	Harmonic Alignment	Constraint Alignment
Local > 3 Su > Non-Su	Su/Local ≻ Su/3 Non-Su/3 ≻ Non-Su/Local	*Su/3 ≫ *Su/Local *Non-Su/Local ≫ *Non-Su/3

Constraints within OT are understood to interact with a notion of markedness, with constraints conspiring to work towards unmarked situations and against marked situations. The Harmonic Aligment scales above state that 1st and 2nd person subjects are less marked than 3rd person subjects and that 3rd person non-subjects are less marked than 1st or 2nd person non-subjects (as per typological observations). Under the assumption that overt case is used to flag those NPs which are marked in some way, these scales and the constraints derived from them correctly predict that ergative case is more likely to occur on 3rd person subjects (the more marked situation), rather than on 1st person subjects. And this is indeed what is observed in Punjabi (26) and crosslinguistically.

Aissen derives another set of constraints targeting the realization of case on objects, and these are provided in (29). She uses these constraints to provide an analysis of well-known Differential Object Marking (DOM) phenomena, such as the definiteness and specificity effects discussed for Turkish by Enç (1991); see also Butt (2006) for an overview discussion.

(29) Relational Scale: Subject > Non-subject
Animacy Scale: Human > Animate > Inanimate
Definiteness Scale: Pronoun > Proper Name > Definite > Indefinite Specific > Nonspecific

Again, these relational scales are based on crosslinguistic observations. We have already seen animacy playing a role in Malayalam case assignment (Section 2). This feature, along with others, also plays a role in Indo-Aryan case marking, as illustrated via the specificity alternation (see 31 for an example).

5.2 OT-LFG and case

Working broadly within OT-LFG, Deo & Sharma (2006) take on the interaction between verb agreement and “core” case marking (ergative, accusative and nominative) on subjects and objects in a range of Indo-Aryan languages. The patterns are complex, but Deo and Sharma identify a set of generally applicable constraints whose variable ranking accounts for the patterns they find across Indo-Aryan and with respect to dialectal variation. In this, they build on Aissen’s work, which is geared mostly towards accounting for the overt morphological realization of case, and combine this with arguments and proposals by Woolford (2001), who focuses more on the abstract realization of case.

Asudeh (2001) contributes to discussions on OT and case by taking on the question of how optionality should be dealt with within OT. This is an interesting problem as OT assumes there should be exactly one optimal candidate, not two or more. Asudeh focuses on data from Marathi as compiled by Joshi (1993), who shows that certain verb classes (mostly involving datives) allow for variable linking. In (30), for example, either one of the arguments could be linked to SUBJ, and the other is then linked to OBJ.

(30) Marathi
sumaa-laa ek pustak milaale
Suma-DAT one book.NOM got
‘Suma got a book.’

In order to account for this type of undisputed optionality in linking possibilities in Marathi, Asudeh makes use of the stochastic version of OT (Boersma 2000), which allows for the ranking of constraints on a continuous rather than a discrete scale and thus provides a way of allowing for optionality. Building on Joshi's original analysis, Asudeh works with Proto-Roles (see Section 6) to steer case assignment and takes up bidirectional OT in the discussion of OT approaches to optionality and, by extension, ambiguity.

Lee (2001a,b) focuses on word order freezing problems in two languages that otherwise allow fairly free scrambling of major constituents: Hindi and Korean. For example, in Hindi subjects and objects can in principle occur in any order, as illustrated by (31), in which the object is overtly marked as accusative, expressing specificity on the object.

(31) Hindi

a. pɑtt^{h}ɑr botɑl=ko toḍ-e-g-a
stone.NOM bottle=ACC break.3.SG-FUT-M.SG
'The stone will break the (particular) bottle.'

b. botɑl=ko pɑtt^{h}ɑr toḍ-e-g-a
bottle=ACC stone.NOM break.3.SG-FUT-M.SG
'The stone will break the (particular) bottle.'

However, when both arguments have the same case marking the clause-initial argument must be interpreted as the subject, as illustrated in (32). This situation occurs when the object is also nominative (and thus non-specific in this Hindi DOM phenomenon) and if all else is equal, e.g., both arguments are equally non-animate as in (32).

(32) Hindi

a. pɑtt^{h}ɑr botɑl toḍ-e-g-a
stone.NOM bottle.NOM break.3.SG-FUT-M.SG
'The stone will break a/the bottle.'

b. botɑl pɑtt^{h}ɑr toḍ-e-g-a
bottle.NOM stone.NOM break.3.SG-FUT-M.SG
'The bottle will break a/the stone.'

Lee works with notions of markedness in conjunction with bidirectional OT constraints to model phenomena such as these. The idea is that constraints from both the production and the comprehension side conspire together to allow for only clause-initial subjects in situations like (32) and that this working together of constraints makes visible the fact that unmarked word order in Hindi and Korean is SOV ("emergence of the unmarked").

Word order in Hindi and Korean has been shown to be associated with information structural effects and Lee's work accordingly includes a larger treatment of word order in terms of information structure. Lee proposes OT constraints which model the interaction of case marking, word order and discourse functions (e.g., topic and focus).

Like Lee, Dalrymple & Nikolaeva (2011) identify information structure as playing a central role in case marking phenomena. Unlike Lee, Dalrymple & Nikolaeva (2011) see the notion of topicality being directly linked to case marking and the innovation of case marking. Dalrymple & Nikolaeva (2011) take on DOM in a large swathe of languages and argue that the OT approaches to case pioneered by Aissen do not go deep enough and that information structural concerns must be taken to play a central role. They develop an alternative LFG analysis which uses LFG's projection architecture to model a complex interaction between c-structure, f-structure, i(nformation)-structure and semantic interpretation. The semantic component is modeled via glue semantics, see Asudeh 2023 [this volume]. Dalrymple & Nikolaeva (2011) analyze a large variety of DOM in very different languages from this clausal semantic perspective on case. In more recent work, Donohue (2020) analyzes the case marking system of Fore, a Papuan language, by building on OT-LFG, Aissen's prominence scales and the bidirectional OT approach to case pioneered by Lee (2001a,b). The account focuses on instances of word order freezing and, more generally, on the strategies for case disambiguation found in Fore.

6 Clausal vs. lexical perspectives

LFG's original approach to linking, argument alternations and valency changing relations such as passives, applicatives or causatives was formulated to apply entirely within the lexicon, in keeping with LFG's primarily lexical perspective on syntax, cf. Findlay et al. 2023 [this volume] and Section 3 of this chapter. Mohanan (1994), Butt (1995) and Alsina (1996) established that this lexical version of linking could not account for argument structure phenemona found with syntactically formed complex predicates. As a consequence, linking within LFG is no longer confined to apply within the lexicon.

In addition to this basic insight into the domain of linking, there is another dimension to the lexical vs. clausal divide which is relevant for an understanding of case. Case is classically understood as marking the relationship between a head and its dependents (Blake 2001). This relationship can be expressed entirely lexically. But, as we have already seen, case expresses much more than specifying how a dependent is related to a head/predicate. Section 5 on OT showed that case regularly marks degrees of agentivity, animacy and referentiality across a wide range of languages. Dalrymple & Nikolaeva (2011) furthermore conclusively demonstrate that information structure plays a large role in the development and structure of case systems, and we saw in the examples from Malayalam in (10) that case can be used to express modality. These semantic reflexes of case marking necessarily need to be taken into account, with Dalrymple & Nikolaeva (2011) rightly criticizing the existing OT accounts for being inherently too limited to provide a full account of the empirically attested patterns.

One underlying reason for this limitation is that while the OT accounts make reference to semantic concepts, they are primarily concerned with accounting for a structural relationship between the two core arguments of a clause (generally the SUBJ and OBJ) and the alternations found in case marking on these two core arguments. An approach to case which allows for the systematic expression of semantic dimensions in conjunction with structural considerations has been articulated clearly by Butt & King (2003, 2004) and has been recently extended in Schätzle (2018) and Beck & Butt (2024). As discussed in Section 7, this approach is quite complex and builds on a number of important semantic insights and formal ingredients. These are presented as part of this section.

6.1 Proto-roles

Classic LFG's Mapping Theory works with thematic roles such as *agent, patient, goal*, etc. The use of such thematic role labels has repeatedly been shown to be problematic, with Grimshaw (1990) advocating for an approach that separates out arguments slots from semantic content and Dowty (1991) instead proposing to see predicate arguments as a collection of semantic entailments from which prototypical Agent vs. Patient roles can be defined. Van Valin (1991) and Van Valin & LaPolla (1997) propose a similar approach whereby the Macro-Roles Actor vs. Undergoer are defined on the basis of event-based properties (e.g., activities vs. results).

Taking these observations and proposals on board, Kibort has formulated a new version of LFG's Mapping Theory in a series of papers (Kibort 2007, 2013, 2014, Kibort & Maling 2015). This revised version adopts Grimshaw's idea of separating out argument slots from semantic content, but does not incorporate a notion of Proto-Roles. However, the idea of Proto-Roles has been adopted within

LFG in a variety of other work, e.g., Alsina (1996), Asudeh (2001) and perhaps most significantly, by Zaenen (1993).

Zaenen shows how Dowty's collection of Proto-Agent vs. Proto-Patient semantic entailments as shown in (33) can be mapped onto LFG's existing Mapping Theory, which uses the features [$\pm o, r$] to relate GFs and thematic roles (see Findlay et al. 2023 [this volume]). Zaenen's principles are shown in (34). These principles interact with other principles of LFG's Mapping Theory to ensure that [$-o$] marked participants are realized either as SUBJ or an OBL, [$+o$] marked participants are linked to an OBJ or an OBJ_θ, etc.

(33) **Proto-Role Entailments**

Proto-Agent Properties

a. volitional involvement in the event or state
(Ex.: Kim in *Kim is ignoring Sandy.*)

b. sentience (and/or perception)
(Ex.: Kim in *Kim sees/fears Sandy.*)

c. causing an event or change of state in another participant
(Ex.: loneliness in *Loneliness causes unhappiness.*)

d. movement (relative to the position of another participant)
(Ex.: tumbleweed in *The tumbleweed passed the rock.*)

e. (exists independently of the event named by the verb)
(Ex.: Kim in *Kim needs a new car.*)

Proto-Patient Properties

a. undergoes change of state
(Ex.: cake in *Kim baked a cake.*, error in *Kim erased the error.*)

b. incremental theme
(Ex.: apple in *Kim ate the apple.*)

c. causally affected by another participant
(Ex.: Sandy in *Kim kicked Sandy.*)

d. stationary relative to movement of another participant
(Ex.: rock in *The tumbleweed passed the rock.*)

e. (does not exist independently of the event, or not at all)
(Ex.: house in *Kim built a house.*)

(34) **Association of Features with Participants** (Zaenen 1993:150,152)

1. If a participant has more patient properties than agent properties, it is marked [$-r$].

2. If a participant has more agent properties than patient properties it is marked [−*o*].
3. If a participant has an equal number of properties, it is marked [−*r*].
4. If a participant has neither agent nor patient properties, it is marked [−*o*].

Neither Kibort nor Zaenen deals with case marking per se. Zaenen applies her formalism to Dutch, which does not exhibit case. Kibort works with Slavic languages and Icelandic, which do have case, but she treats case as a piece of information which informs the linking, rather than as a phenomenon that needs to be explained. In contrast, Schätzle (2018) explicitly works on case and combines Kibort's revised linking theory with Zaenen's integration of Proto-Roles for her analysis of the diachronic trajectory of Icelandic dative subjects, see Section 7.

6.2 Clausal semantics

The idea of Proto-Roles can in principle be applied within the lexicon to refer to the lexical semantics of the predicate. However, properties such as undergoing a change of state, being an incremental theme or attaining an endpoint along a path have by now been firmly established as resulting out of an interaction of the semantics of the Proto-Patient argument with the semantics of the event described by the verb (e.g., Krifka 1992, Verkuyl 1993). The quantizedness of the Proto-Patient argument has been shown to be crucial in determining the telicity of an event; more recently the effect is referred to in terms of scalarity (Hay et al. 1999, Kennedy & Levin 2008). The DCM alternation in (35) provides a representative example of this phenomenon in Finnish (also recall the Russian genitive alternation with respect to quantizedness discussed by Neidle, Section 2) When 'bear' is accusative, it definitely undergoes a change of state (dies) and the entire event is telic. In contrast, when one wishes to express that the intended endpoint of the action was not achieved, 'bear' appears in the partitive.

(35) Finnish

a. Ammu-i-n karhu-n
shoot-PST-1SG bear-ACC
'I shot the/a bear.' (Kiparsky 1998: 267)

b. Ammu-i-n karhu-a
shoot-PST-1SG bear-PART
'I shot at the/a bear (bear is not dead).' (Kiparsky 1998: 267)

Ramchand (1997) discusses the Finnish data along with Scottish Gaelic alternations as in (36) and (37). She analyzes the differences in terms of boundedness. The alternation in (36) is essentially parallel to the Finnish example in (35). The alternation in (37) presents an interestingly different situation, but one that can also be analyzed in terms of boundedness: it expresses the difference between wanting something (unbounded) and getting it (bounded).

(36) Scottish Gaelic

a. tha Calum air na craobhan a ghearradh
be.PRS Calum ASP the trees.DIR OAGR cut.VN
'Calum has cut the trees.'

b. tha Calum a' ghearradh nan craobhan
be.prs Calum ASP cut.VN the trees.GEN
'Calum is cutting the trees (no tree has necessarily been cut yet).'

(37) Scottish Gaelic

a. tha mi air am ball iarraidh
be.prs I ASP the ball.DIR want.VN
'I have acquired the ball.'

b. tha mi ag iarraidh a'bhuill
be.prs I ASP want.VN the ball.GEN
'I want the ball.'

Ramchand (2008) extends and refines her analysis so that events are seen as being built up out of a tripartite structure consisting of an init(iation) subevent, a proc(ess) subevent and a res(ult) subevent. This tripartite structure contrasts with the more common bipartite approach found in the majority of event-based approaches to linking. For example, Jackendoff (1990) assumes a basic CAUSE-BECOME (init-res) relationship and makes provisions for activity verbs (proc), but does not combine all three subevent types into one tripartite template (see Levin & Rappaport Hovav 2005 for an overview), Ramchand demonstrates that her system works for a number of varied phenomena across languages and it has been adopted within LFG by Schätzle (2018) and Beck & Butt (2024), as discussed in the next section.

7 A comprehensive theory

This section first introduces an overall framework for case as developed by Butt and King in various papers (Section 7.1) and then goes on to look at the relationship between case and the theory of linking developed by Schätzle (2018) and Beck & Butt (2024) in Section 7.2.

7.1 Types of case

Butt & King (2003, 2004) develop a theory of case that allows for four basic types: 1) structural case; 2) default case; 3) semantic case; 4) idiosyncratic case. This categorization differs significantly from other theories of case and is explained in some detail via examples in the next subsections. Notably, Butt and King's notion of semantic case is often conflated with idiosyncratic case in other theories and referred to as just one category of quirky/inherent case. Butt and King, on the other hand, argue that the two types need to be separated out for an effective understanding of case systems. Butt and King also define structural case as being that type of case which is only due to purely structural factors. The most common type of case marking in their system is that of semantic case, which exhibits a mix of systematic semantic and structural factors. Crucially, Butt and King center their analysis around an explanation of case alternations (including DCM) and consequently dub their theory *Differential Case Theory* or DCT. Butt and King illustrate their analyses mainly with respect to Urdu, but also include data from Georgian.

7.1.1 Semantic case: Mix of structure and semantics

Urdu has a complex system of case marking. Most of the case marking involves a mixture of structural and semantic factors as illustrated by the core examples in (38) and (39). Overt case marking generally takes the form of case clitics (see Butt & Ahmed Khan (2011) for a history of the development of case marking in Urdu) and the absence of any case marking is glossed as nominative (Mohanan 1994). The ergative is required with (di)transitive agentive verbs when the verb morphology is perfective, see (38a) vs. (38b). The accusative *ko* and the null nominative engage in DOM, with the accusative expressing specificity (Butt 1993) and generally required on animate objects, see (38a,b) vs. (38c).[10]

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[10] Agreement in Urdu/Hindi works as follows. The verb will only agree with a nominative (unmarked) argument. If the SUBJ is unmarked, the verb agrees with this (38b), else the verb agrees with OBJ if that is unmarked (38a). If neither the SUBJ or the OBJ is available for agreement, the verb defaults to a masculine singular form, as in (38c). See Mohanan (1994) for a comprehensive discussion and Butt (2014) and references therein for information about verb agreement beyond the simple clause.

(38) Urdu

a. nadya=ne gaṛi cɑla-yi hɛ
Nadya.F.SG=ERG car.F.SG.NOM drive-PFV.F.SG be.PRS.3.SG
'Nadya has driven a car.'

b. nadya gaṛi cɑla-ti hɛ
Nadya.F.SG.NOM car.F.SG.NOM drive-IPFV.F.SG be.PRS.3.SG
'Nadya drives a car.'

c. nadya=ne gaṛi=ko cɑla-ya hɛ
Nadya.F.SG=ERG car.F.SG=ACC drive-PFV.M.SG be.PRS.3.SG
'Nadya has driven the car.'

The Urdu ergative and accusative are structural in that they can only appear on subjects and objects, respectively. However, they are also semantically constrained in that they express object referentiality and animacy (accusative) and subject agentivity. The latter is illustrated by (39) where the presence of the ergative case on an unergative verb yields an 'on purpose' reading that is absent when the subject is nominative.

(39) Urdu

a. ram kʰãs-a
Ram.M.SG.NOM cough-PFV.M.SG
'Ram coughed.' (Tuite et al. 1985: 264)

b. ram=ne kʰãs-a
Ram.M.SG=ERG cough-PFV.M.SG
'Ram coughed (on purpose).' (Tuite et al. 1985: 264)

Most case markers in Urdu exhibit this mix of structural and semantic properties and fall under the category of semantic case in DCT.

Butt and King model semantic case via an essentially lexical semantic approach to case in that they associate the relevant information directly with the case marker, specifying both the GF the case marker is compatible with and any attendant semantic information. This is illustrated for the accusative in (40).

(40) ko (↑ CASE) = acc
(OBJ ↑)
(↑SPECIFICITY) = +

Butt and King's approach uses inside-out functional designation like Nordlinger's Constructive Case approach (Section 4) and bears similarities to that approach in that case markers are taken to contribute to the overall analysis of the clause with information that goes beyond just the statement of what type of case is involved.[11] However, the approach goes beyond Constructive Case in providing a more complete view on the interaction between the lexical semantics of a verb, case semantics and structural case requirements.

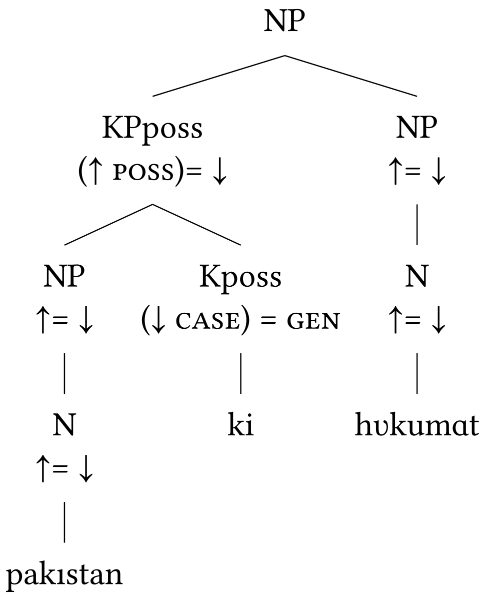
7.1.2 Structural case

Examples of structural case tend to be restricted. In Urdu, an example of a purely structural case is the genitive in NPs, such as in (41), taken from Bögel & Butt (2012).

(41) Urdu
pakıstan=ki hʊkumɑt
Pakistan=GEN.F.SG government.F.SG
'The government of Pakistan'

Genitive within NPs is assigned on purely structural grounds – there are no particular semantics associated with it. As in the early LFG approaches (Section 2) this type of case is therefore assigned only on the basis of c-structure configuration, by means of f-structure annotations on the appropriate c-structure nodes. An example, based on Bögel & Butt (2012), is provided in (42).

(42)



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[11] Butt & King (2003, 2004) build on initial proposals by Butt & King (1991), foreshadowing Nordlinger's (1998) ideas on Constructive Case.

7.1.3 Reassessment of quirky case

Butt and King's category of semantic case separates out those case marking patterns which are associated with systematic semantic import from truly idiosyncratic case marking that needs to be stipulated (mostly as part of lexical entries). The dative is a prime example for a type of case that is often analyzed as an instance of quirky/inherent/idiosyncratic case despite the fact that it is demonstrably and very systematically associated with a certain semantic import (cf. the discussions in Section 2 and Section 3 above).

In Urdu the dative is also realized by the clitic *ko*. In its function as a dative, the *ko* can appear on indirect goal objects as in (43) and on experiencer subjects, as shown in (44).

(43) Urdu
nadya=ne bɪlli=ko dud di-ya hɛ
Nadya.f=erg cat.f.sg=dat milk.m.nom give-pfv.m.sg be.prs.3.sg
'Nadya has given milk to the cat.'

(44) Urdu
nadya=ko ḍɑr lɑg-a
Nadya.f.sg=dat fear.m.sg.nom be attached-pfv.m.sg
'Nadya was afraid.' (lit. Fear is attached to Nadya.)

The dative alternates systematically with the ergative to express a contrast in agentivity, with the dative signaling reduced agency, generally giving rise to experiencer semantics as in (44) and (45a), but also to deontic modality as in (46a).

(45) Urdu
a. nadya=ko kɑhani yad a-yi
Nadya.f.sg=dat story.f.sg.nom memory come-pfv.f.sg
'Nadya remembered the story.'
b. nadya=ne kɑhani yad k-i
Nadya.f.sg=erg story.f.sg.nom memory do-pfv.f.sg
'Nadya remembered the story (actively).'

(46) Urdu
a. nadya=ko zu ja-na hɛ
Nadya.f.sg=dat zoo.m.sg.obl go-inf.m.sg be.prs.3.sg
'Nadya has/wants to go to the zoo.'

b. nadya=ne zu ja-na hɛ
Nadya.F.SG=ERG zoo.M.SG.OBL go-INF.M.SG be.PRS.3.SG
'Nadya wants to go to the zoo.'

The systematic dative-ergative alternation as well as the tie in to modality indicates that these case patterns are not exclusively due to the lexically specified inherent semantics of a verb, but that the information associated with the case marker is making a significant contribution to the overall semantics of the clause. Generally, the dative marks goal arguments, whether these be recipients (43) or experiencers (44). In a very systematic alternation with the ergative, the dative signals reduced agentivity. The dative and its attendant signaling of reduced agency is pressed into service in the expression of modality in Urdu more generally, see Bhatt et al. (2011) for an overview of modals in Urdu/Hindi. The Urdu dative *ko* is thus also analyzed as an instance of semantic case in DCT.

7.1.4 Idiosyncratic case

Idiosyncratic case is the type of case where no systematic generalizations, either of a structural or of a semantic kind, can be found. This is what distinguishes idiosyncratic case from both semantic and structural case. Instances of idiosyncratic case are typically due to diachronic developments that render the original reason for the case marking opaque, or which result in morphophonological changes that cause the case markers themselves to change and to be reclassified.

An example of truly idiosyncratic marking in Urdu is shown in (47). Recall that Urdu requires the ergative on subjects of agentive transitive perfect verbs. However, while the verb 'bring' in (47) falls into this category, its subject is nominative.

(47) nadya kɪtab la-yi
Nadya.F.SG.NOM book.F.SG.NOM bring-PFV.F.SG
'Nadya brought a book.'

There are no other straightforwardly agentive transitive verbs which behave like this, so this exceptional and idiosyncratic nominative case must be stipulated as part of the lexical entry of *la* 'bring'. Another exceptional verb is *bol* 'speak', which is unergative and should therefore allow for an ergative subject in the perfective, but does not.

7.1.5 Default case

Finally, Butt and King also provide for default case marking. Default case marking occurs when an NP is not already specified for a case feature via some part of the grammar (lexicon, syntax). In languages which require all NPs to be case marked, such NPs receive a default case. In Urdu the default case is the phonologically null nominative, which can only appear on subjects and objects. Default case can be assured via well-formedness statements in the functional annotations on the NP node at c-structure, as shown in (48).

(48)
1. Well-formedness principle: NP: (↑ CASE)
2. Default: (↑ SUBJ CASE)=NOM
3. Default: (↑ OBJ CASE)=NOM

These rules constrain every NP to be associated with a case feature and to make sure that subjects and objects are assigned nominative case in the absence of any other specification. Basically the annotations check if there is a case feature realized. If not, then nominative is assigned by default. This type of if-then realization of functional annotations is slightly more complex than illustrated in (48), which is kept simple for purposes of illustration. A full implementation can be found in the Urdu ParGram grammar (Butt & King 2002, Bögel et al. 2009).

7.2 Event-based linking

The theory in Section 7.1 as to the types of case that must be accounted for does not make reference to linking. However, a theory of linking is clearly also needed as it determines how the event semantics of a verb plays out in terms of syntactic valency and case marking. We saw in Section 6 that an *event-based* approach is necessary for an understanding of DCM patterns (e.g., for telicity or boundedness/scalarity more generally). An event-based approach is also what underlies the generally accepted ideas behind Dowty's Proto-Roles or Van Valin's Macro-Roles, as the prototypical Agent/Patient properties are defined in terms of how the participant is related to the event being described (change of state is being effected, one participant is stationary with respect to another participant, etc.).

Event-based approaches to linking are common (e.g., Jackendoff 1990, Van Valin & LaPolla 1997, Rappaport Hovav & Levin 1998, Croft 2012, see Levin & Rappaport Hovav (2005) for an overview), but are employed within LFG only in a subset of linking approaches. This occurs either indirectly via the incorporation of a notion of Proto-Roles, or explicitly in adaptations of Jackendoff's Lexical-Conceptual Structures, as done by Butt (1995).

Kibort's revised version of Mapping Theory improves on the classic version of mapping within LFG by separating out argument slots from semantic content and formulating new mapping principles that make reference to semantics (Kibort 2014). However, semantic principles are made use of only occasionally and relatively indirectly.

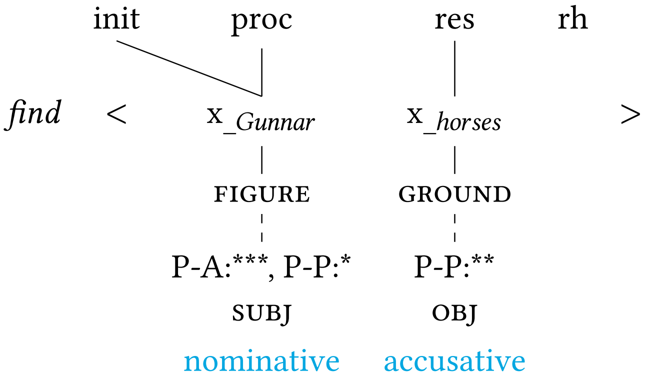
Schätzle (2018) bases herself on Kibort's revised Mapping Theory but brings in semantic information explicitly on several dimensions. Importantly, she adopts Ramchand's (2008) tripartite division of events into three types of subevents: init(iation), proc(ess), res(ult). This event semantic dimension is used to derive Proto-Role properties and these in turn are used to determine the linking between argument slots and GFs. Schätzle also integrates a Figure/Ground dimension. This is intended to do justice to the information-structural effects found with respect to case. However, she does not need the full-fledged representation of information-structure developed by Dalrymple & Nikolaeva (2011), instead adopting the basic Figure/Ground distinction first developed by Talmy (1978).

Schätzle's basic system is illustrated below with respect to the Icelandic example in (49), which is taken from Beck & Butt (2024) and represents a revised version of the original in Schätzle (2018).

(49)	Gunnar	fann	seint	hrossin	um	daginn
	Gunnar.NOM	find.PST.3SG	late	horse.PL.DEF.ACC	during	day.DEF.ACC

'Gunnar found the horses late during the day.'

(IcePaHC, 1400.GUNNAR.NAR-SAG,.281)

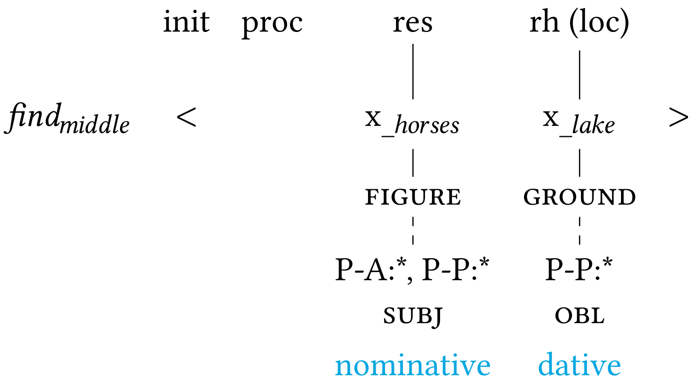


The main predicate here is *finna* 'find', which expresses a dynamic event. The event consists of an initiation of the event, a process during which the event takes place and a result. The initiator of the event is 'Gunnar' so this role is linked to the init subevent. The initiator is also the participant involved in the event as it unfolds, so is also linked to the proc subevent. The 'horses' argument is linked to the result subevent as finding the horses represents the successful culmination of the event. As a sentient initiator that is also the Figure of the clause, Gunnar thus picks up three Proto-Agent (P-A) properties (sentience, init, Figure). As an undergoer of a process, Gunnar receives one Proto-Patient (P-P) property (the occurrence and number of Proto-Role properties is indicated via the number of of '*' on the features P-A and P-P). The 'horses' argument is the Ground and the resultee and as such picks up two Proto-Patient properties and no Proto-Agent properties. The participant with the most Proto-Agent properties is linked to the SUBJ, leaving the horses to be linked to OBJ. The case marking on the SUBJ and OBJ in this case is an instance of default case: the subject is nominative and the object is accusative in the absence of any other specification.

Schätzle (2018) is primarily concerned with investigating the diachronic increase in the occurrence of dative subjects in Icelandic. Using corpus linguistic methodology, she pinpoints the lexicalization of former middles as experiencer verbs as a major reason for the increased use of dative subjects in Icelandic. One of the verbs that has undergone such lexicalization is the verb *finna* 'find', featured in (49). This was reanalyzed as a stative experiencer and raising predicate via middle formation with the middle morpheme *-st* in the history of Icelandic and came to mean 'find, feel, think, seem'.

Schätzle (2018) shows how this process of reanalysis can be understood as a form of locative inversion. There are several steps to this posited diachronic change. First, consider the linking configuration for the middle version of the example in (49), as shown in (50). Under middle formation, *finna* becomes *finna-st*, meaning 'be found, meet', and the initiation subevent is absent for the purposes of linking. The middle predication essentially describes a result, which is that there are found horses.

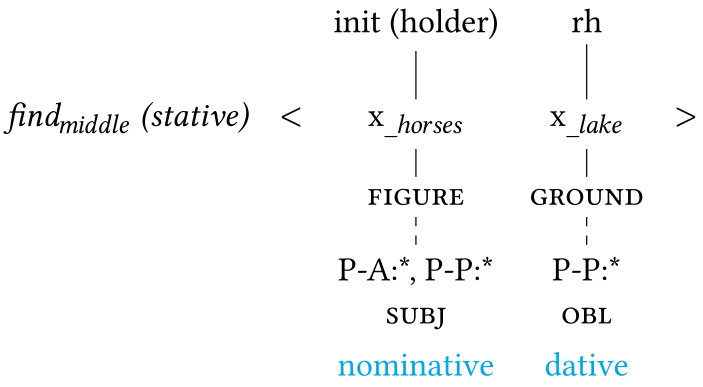
(50) The horses were found at the lake.



Schätzle also adopts Ramchand's (2008) notion of a *rh(eme)*. A rheme serves as a complement slot that modifies the core predication. In (50) this rheme slot is occupied by the locative 'at the lake'. Rhemes are generally not compatible with the Figure role: they provide a Ground argument. So in (50) 'horses' acts as the Figure, picking up one Proto-Agent property. This argument is linked to the result subevent, which yields one Proto-Patient property. The horses thus have more Proto-Agent properties (one) than the lake (none) and so the horses are linked to SUBJ. The rheme is also a locative and this configuration yields a linking to OBL. The SUBJ is nominative per default, and the OBL is marked with the Icelandic spatial dative.

The configuration in (50) in fact very closely resembles that of a straightforwardly stative predication, which is also one possible interpretation of the middle form of 'find'. In this case it means something along the lines of 'be situated/located'. Schätzle posits that in this case the original result participant is interpreted as the holder of a state. The holder of a state is linked to the init subevent in Ramchand's system. As shown in (51), there is no change in the overall linking configuration and the attendent case marking, but there is a change in the interpretation of the event semantics: (51) shows a stative predication rather than the result part of a dynamic event.

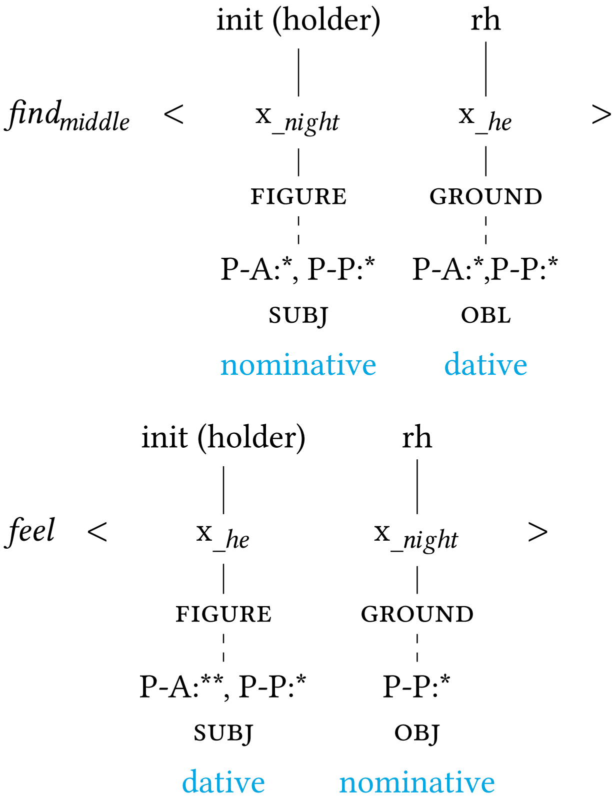
(51) The horses were (located/situated) at the lake.



Schätzle postulates that over time, this type of stative predication via middle formation led to lexicalized experiencer predicates as in (52), where *finna* means 'feel'. These experiencer predicates feature a dative SUBJ synchronically and Schätzle proposes that the dative SUBJ is the result of a flip in the linking relation that occurred when the Ground argument is sentient, as shown in the linking configurations in (52). The first configuration corresponds to a literal locative reading of 'The night was found at him.' and shows the same relations as in

(51), just with a sentient Ground. But this small difference results in an equal distribution of Proto-Role properties across the two event participants. This taken together with a crosslinguistic preference for sentient participants to be interpreted as a Figure rather than as a Ground leads to an unstable linking configuration.

(52) og fannst honum nótt.
and feel.PST.MID.3SG he.DAT night.NOM
‘and he felt the night.’
(IcePaHC, 1861.ORRUSTA.NAR-FIC,.1670)



This unstable linking configuration can be resolved by flipping the Figure/Ground relations and associating the sentient argument with the holder of the state, as shown in the lower linking configuration. With this simple configurational change, the sentient argument now picks up two Proto-Agent properties (Figure and sentience), and one Proto-Patient property as a holder of a state. The other argument receives only one Proto-Patient property as the Ground. The overall effect is that the sentient argument is now linked to SUBJ, the other (non-spatial) argument to OBJ. The originally spatial dative marking is retained on the newly minted SUBJ and feeds into a general pattern of dative marked experiencer subjects in the language.

Beck & Butt (2024) use the same analysis of locative inversion to account for patterns of dative subjects in Indo-Aryan. Their approach also provides an account for the Marathi optional dative subjects discussed by Asudeh (2001) and in Section 5 of this chapter. In Beck and Butt's account the observed optionality is attributed to an unstable linking configuration of the type shown in the upper part of (52). This leads to an optionality that is slowly resolved over time in favor of a dative subject constellation as shown in the lower part of (52). Deo (2003) shows that this is the change that is indeed happening in Marathi, verb class by verb class, verb by verb.

Overall, in this event-based approach to linking, case is matched with certain linking configurations. For example, in Icelandic and Marathi, the holder of a state as in the lower linking configuration in (52) must systematically be associated with a dative and this expresses experiencer semantics.

8 Summary

This chapter has surveyed LFG work on case from some of the earliest LFG papers to some of the most recent developments. The LFG perspective, particularly with respect to Icelandic, was instrumental in establishing a basic division between structural and lexically specified case, where the latter also came to be known as 'quirky' case. Later work put the relationship between predicate arguments and GF on a more systematic footing via the formulation of Mapping Theory. Case was always relevant for Mapping, but not integrated into the theory itself. The event-based linking developed by Schätzle (2018) and Beck & Butt (2024) offers a more natural way of integrating case information, while also building on Kibort's revised Mapping Theory and allowing for an integration of Proto-Role properties. The integration of such Proto-Role properties into accounts of case and linking has been experimented with in a number of ways within LFG over the years, especially in terms of work done within OT-LFG.

Butt and King formulate a theory of case, which distinguishes between four types of case: 1) structural, 2) default, 3) semantically generalizable and 4) idiosyncratic. Their notion of semantic case centrally applies to core arguments of a verb and includes accounts of Differential Case Marking, including modality. Case markers are considered to have their own lexical entries and to be associated with syntactic and semantic information which contributes to the overall syntactic and semantics analysis of the clause. This is in line with Nordlinger's idea of Constructive Case, which can additionally account for case stacking.

This chapter has not included a comparison of LFG with other theories. In terms of linking, LFG employs a distinct version, but the essence of, and the insights behind, linking have very much in common with other theories of the interface between lexical semantics and syntax. The same is true for the OT-LFG approaches to case, which build directly on mainstream OT insights and proposals. However, as far as I am aware, the idea of Constructive Case and the four-way distinction between different types of case is unique to LFG.

Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

A	agent	O	object
ASP	aspectual marker	OAGR	object agreement
DIR	directional	PART	partitive
I	class I	PRON	pronoun
MID	middle	PROP	proprietive
MOD	modal	VN	verbal noun

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Chapter 7

Complex predicates

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This chapter surveys LFG work on a somewhat diverse collection of constructions often called complex predicate constructions, which can be broadly characterized by saying that the number of superficially apparent predicates is arguably different from that of actual predicates, either because two apparent predicates can be argued to have combined into one, or one apparent predicate with an affix is actually two predicates. Some of these constructions are also called Reanalysis, Restructuring, Clause Union or Light Verb Constructions, others are often called Serial Verb Constructions. Here we discuss the main analyses of these that have appeared in LFG, giving an overview of the sorts of criteria and analyses that have appeared in the LFG literature.

1 Introduction

The term COMPLEX PREDICATE has been widely and rather loosely applied to a variety of constructions where for some reason it appears that two predicates that might be regarded as independent are behaving as one. This happens in multiple ways, with the result that the term has been applied to constructions which are perhaps not very closely related. The major cases appear to be:

(1) a. Two apparent predicates which appear to be syntactically and morphologically autonomous, but are nonetheless closely integrated semantically. Such constructions were called ‘composite predicates’ in the non-LFG analysis of Cattell (1984), but ‘complex predicates’ in the LFG analyses of Ishikawa (1985) and Matsumoto (1996). One component, the syntactically higher one, is a verb, often called a ‘Light Verb’. The other can be of various categories; Cattell studied

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verb-noun complex predicates in English, Ishikawa investigated a few verb-verb complex predicates in Japanese, and Matsumoto investigated both types of complex predicates in Japanese.

b. Two or more apparent predicates that are integrated semantically, and syntactically to a greater degree than in (1a) or (1c), but still morphologically distinct, in particular, the light verb is still a distinct stem rather than an affix. Examples include Noun+Verb combinations in Hindi (Mohanan 1994), and combinations of noun and other hard-to-categorize items with verbs in Jaminjung (Schultze-Berndt 2000).

c. Items that appear to be distinct morphological and syntactic words, but show deeper signs of integration, such as sharing a single argument structure. This is often called Restructuring, Reanalysis, or Clause Union, and is exemplified by a variety of constructions including especially causatives in Romance (Alsina 1996, 1997, Andrews & Manning 1999, Andrews 2018b, Manning 1992, 1996b), and also Urdu (Butt 1995, 1997, Lowe 2016).

d. Two or more items that are integrated morphologically (for example, one is a stem, the other like an affix), but have a considerable degree of semantic and syntactic autonomy (for example, causatives in Japanese (Ishikawa 1985) and Bantu (Alsina 1997)).

e. Serial Verb Constructions (SVCs), where two or more Vs or VPs occur together with some kind of sharing or combination of argument structure (for example, Tariana as described by Aikhenvald 2003 and analysed in LFG by Andrews & Manning 1999, Dagaare and Akan as described and analysed by Bodomo 1996, 1997, and Barayin as described and analysed by Lovestrand 2018).

These divisions cross-classify extensively with the semantic/conceptual categories expressed by the constructions:

(2) a. Desiderative, modal, potential and other concepts, shading in an unclear manner into auxiliaries expressing tense, aspect and mood (in the LFG literature, discussed in connection with Restructuring and SVCs).

b. Causative, applicative and other valence change (restructuring, SVCs and morphology).

c. Associated motion (restructuring, SVCs, and morphology).[1]
d. Alternatives to a mono-lexical predicate (SVCs and light verb constructions).

In the following sections, I will consider in turn the construction types of (1), with some discussion of the semantic categories they express, and especially the criteria that have been applied to distinguish the supposed complex predicate constructions from similar ones, such as control constructions.

2 Composite predicates

This term was used in the non-LFG analysis of Cattell (1984) to refer to combinations such as *take a walk* or *have a look*, which appear to involve both a main verb and an apparent full NP object, these semantically interpreted together as at least roughly equivalent to a single lexical verb, in many cases. I am not aware of any attempt to reanalyse Catell's English data in LFG, but similar expressions in Japanese were treated at length (Matsumoto 1996), who however called them 'complex predicates'. He also looked at a variety of verb+verb constructions, such as benefactive *morau*, which had been early called 'complex predicates' by Ishikawa (1985).

Ishikawa and Matsumoto developed similar analyses, the latter considerably more extensive and detailed. In both cases, the constructions were treated as XCOMP constructions, with functional control of a SUBJ, motivated by the possiblities for reflexivization for *zibun*, along with a mechanism for allowing arguments to be expressed either in the higher or the lower structure. Ishikawa (1985: 99–100) proposed a principle of 'Object Function Sharing' whereby the equation $(\uparrow \textsc{obj})=(\uparrow \textsc{xcomp}\ \textsc{obj})$ can be added to lexical entries under various circumstances. Matsumoto observed that the apparent possibility of expressing arguments at either level applied to adjuncts as well as arguments, and was also found with a wide range of XCOMP structures, indeed, all of those in Japanese, and so proposed that the nonconfigurational c-structure rule for S could introduce GF's preceded by any number of XCOMPs, constituting a use of functional uncertainty (Matsumoto 1996: 87):

(3)
$$\begin{array}{llcc} \text{S} & \longrightarrow & \text{NP}^{*} & \{\text{V,A}\} \\ & & (\uparrow \textsc{xcomp}^{*}\ \textsc{gf})=\downarrow & \uparrow=\downarrow \end{array}$$

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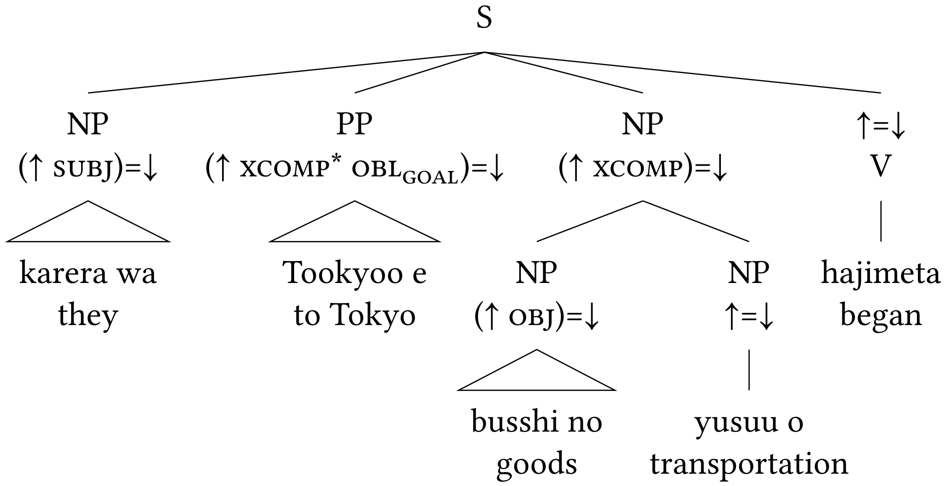
[1] A category that might be unfamiliar to some readers, designating patterns of motion associated with an activity, first identified and named by Koch (1984).

The predicates of these XCOMPs could be verbs, adjectives or verbal nouns, but are all analysed as having verb-like PRED-features taking sentential grammatical relations. But Matsumoto used the resources of LFG to assure that when an argument was expressed in an NP, it was marked with the nominal dependent marker *no* rather than the sentential object marker *o*.

For example, a sample structure is:

(4) Japanese (Matsumoto 1996: 88)

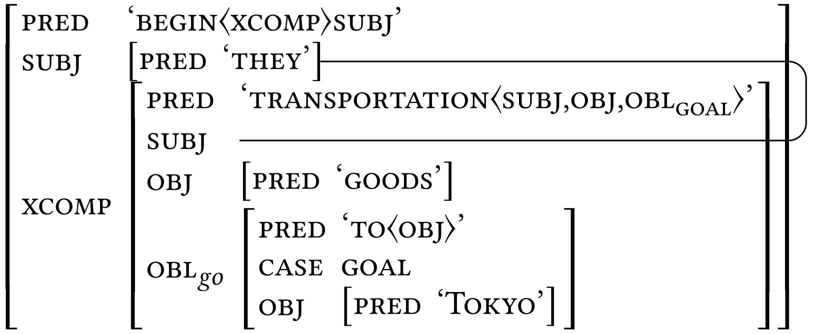
a.



b. karera wa Tookyoo e busshi no yusuu o hajimeta
they TOP Tokyo to goods GEN transportation ACC begin.PST
'They began the transportation of goods to Tokyo.'

The subject is shared between the main clause and the XCOMP by means of functional control, while the directional argument is attributed to the complement clause by means of the functional uncertainty expression, and the object is expressed in the complement clause (with different case-marking conventions in both places, as formalized in LFG by Matsumoto). So the resulting f-structure is:

(5)



Variants of this work for a wide range of structures, including the constructions with NP+*suru* (in which the nominal is marked with the accusative marker *o*; there are also incorporational structures without *o*, to be discussed later), in which the XCOMP-value presumably supplies the meaning, with *suru* being semantically empty, merely transmitting it up to the top sentence level:

(6) Japanese (Matsumoto 1996: 74)
karera wa soko e sono busshi no yusoo o suru
they TOP there GOAL the goods GEN transport ACC do
'They will transport the goods there.'

On this analysis, these structures do not involve any special combination of predicates, so I think it is reasonable to call them 'composite predicates' on the basis of the resemblance that some of them have to the structures investigated by Cattell. But they do have one feature that relates them to the clearer cases of complex predicates, which is the sharing of nonsubject arguments. The word-order characteristics of Japanese (verb final, variable ordering of arguments and adjuncts) allow a reasonably clean treatment of this with the phrase-structure stipulation of (3), which is also very similar to LFG proposals for the intricacies of West Germanic infinitival complements (Zaenen & Kaplan 1995, Kaplan & Zaenen 2003), which are often treated as a kind of complex predicate in the Minimalist literature (for example, Wurmbrand 2017, where complex/restructuring predicates are analysed in terms of certain verbal projections being absent), but not in LFG, where sharing of grammatical attributes is normally required for the term 'complex predicate' to be used.

3 Light verb + coverb structures

The next structures we consider resemble composite predicates in a number of ways, but the apparent complement of the light verb shows signs of syntactic or morphological reduction. Most of the work in LFG has been on Hindi, starting with Mohanan (1994), followed by Mohanan (1997). Occasional later discussions, such as Andrews & Manning (1999: 34–37), consider Wagiman rather than Hindi.

Mohanan considered examples such as:

(7) Hindi
Mohan ko kahaanii yaad aayii
Mohan DAT story.NOM memory.NOM come.PRF
'Mohan remembered the story.'

Here the combination *yaad aayii* functions equivalently to the English inflected verb ‘remembered’. She established a number of facts about these constructions which distinguish them from the composite predicates:

(8) a. The nominal component (here *yaad*) is not head of an NP (cannot be modified by adjectives or coordinated), but an N component of a structure along the lines of $[\mathrm{N}\ \overline{\mathrm{V}}]_{\overline{\mathrm{V}}}$ (the structures are recursive, and contain various other things beyond the V and the N).

b. The V component has some mobility (topicalization but not scrambling); the N does not.

c. The nominal and the verb are jointly responsible for licensing the arguments.

d. Nevertheless, in the most prevalent subtype, the verb can agree with the nominal, so it would appear to bear a grammatical function in f-structure, under traditional assumptions (proposals for a morphological structure might change this).

e. The verbs which participate in this construction also have independent verbal functions.

Concomitant with (8a), there is no reason to believe that there is any expression of arguments by any nominal strategy: the arguments are all expressed as if they were arguments of a simple lexical verb.

Mohanan reconciles these somewhat contradictory phenomena by making use of the fact that LFG deploys multiple levels of representation, including originally c-structure and f-structure, but later extended to include some kind of argument structure (ARG STR) and semantic structure (SEM STR) (the details of what is proposed for these and other additional levels are subject to considerable variation in the literature). In her analysis, ARG STR intervenes between f-structure and SEM STR, and permits a semantically complex combination to function in certain respects as a single-level, monoclausal structure.

The SEM STR of the light verb and the noun fit together in a standard predicate-argument combination, where, for example, in the following example meaning ‘remember’, the upper predicate is a motion verb interpreted metaphorically, while the lower means ‘memory’, the Destination of the upper predicate being identified with the Experiencer of the lower one, which also has an ‘Experienced’ argument:

(9)
$$\begin{bmatrix} \text{REL} & \textit{COME} \\ \text{DEST} & [\,] \\ \text{COME-ER} & \begin{bmatrix} \text{REL} & \textit{MEMORY} \\ \text{EXP-ER} & \\ \text{EXP-ED} & [\,] \end{bmatrix} \end{bmatrix}$$

Mohanan argues from reflexivization phenomena that these form a ‘monoclausal’ pool (Mohanan 1994: 281, 1997: 443–444), but there is a problem with this.

She shows that the complex predicates divide in two types. In the majority type, the light verb agrees in gender with the nominal if the subject is ergative, exactly as would happen if the nominal was an ordinary direct object. Furthermore, a sole argument of this nominal must be in an oblique case, never nominative (lacking any overt case marking) or accusative. In the other type, the verb cannot agree with the nominal, and any sole argument of the nominal is nominative/accusative like an ordinary direct object (Mohanan 1997: 457–469). This indicates that in the first type, there are two levels of f-structure, and the lower level has an effect on the marking of the arguments and perhaps even their grammatical function. It is not clear to me how to integrate the agreement phenomena with the theme of monoclausality (but it is not incompatible with various forms of argument-sharing).

In summary, the first type is similar to the composite predicates as analysed by Matsumoto, but with an apparent difference in reflexivization behavior, while the second seems more like the ones investigated not so much by LFG workers, but more by typologically oriented ones such as Schultze-Berndt (2000) and many others, where there does not appear to be evidence that the non-verbal component (often called a coverb) bears any grammatical function. Neither of these types appear to have attracted much attention in the LFG literature subsequent to the 1990s, a situation that should perhaps be remedied.

4 “Restructuring” complex predicates

These are the constructions that seem to have attracted the most discussion since the 1990s, but without the emergence of a full consensus on how they should be treated. From an LFG perspective, they have the general appearance of control structures, with a subordinate structure that has more apparent syntactic autonomy than the previous type, but the main and subordinate structures also show evidence of being compacted into a single f-structure (monoclausality), with some evidence against an XCOMP analysis. Studies of these structures appear to have begun in the late eighties and early nineties, early full publications being

Butt (1993, 1995) investigating Urdu, and Alsina (1996) investigating Catalan.[2] These closely related approaches were then presented in shorter form in Butt (1997) and Alsina (1997). Also, Manning (1992) developed arguments about the constituent structures of Spanish, while Andrews & Manning (1993, 1999) made proposals about how to handle these constructions in a substantially modified version of LFG. Somewhat later, people began working on similar constructions in Mainland Scandinavian languages; a recent summary is provided by Lødrup (2014a), citing especially earlier LFG work by Niño (1997) and Sells (2004). This work raises a considerable number of interesting questions at the descriptive level, which however do not seem to have attracted a large amount of theoretical attention.

The work on these constructions is distinguished from the earlier work of Ishikawa and Matsumoto on Japanese by the existence of evidence for monoclausality, indicating that in spite of having the superficial appearance of XCOMP structures, they have a single level of f-structure, constituting the LFG version of the 'Clause Union' of Aissen & Perlmutter (1983) or the 'Restructuring' of Rizzi (1978). This however creates a tension with the evidence for hierarchical semantic interpretations matching the c-structure, for which various solutions have been proposed. The Urdu-Hindi[3] and Romance streams contribute somewhat different elements to the picture; we begin with Urdu-Hindi, then look at Romance, and finally make some briefer observations about Mainland Scandinavian. We conclude the section with some theoretical discussion.

4.1 Urdu-Hindi

Butt (1993, 1995, 1997) considered two kinds of complex predicate structures, the 'permissive', which contrasts in interesting ways with an 'instructive' construction that appears to be an ordinary XCOMP structure, and 'aspectual' complex predicates. The former have assumed a prominent position in subsequent discussion, whereas the latter so far appear to have been of more limited interest.

4.1.1 Permissives

Butt's treatment of permissive constructions has made fundamental contributions to the subsequent discussion in at least two ways. First, she showed that there was a distinction between 'complex predicates' (the permissive) and 'complement structures' (the instructive), each appearing with the same two different constituent structures, one where the subordinate verb is head of its own

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[2] This was a reworking of the Romance language portion of Alsina (1993).

[3] Urdu put first in this combination, since the actual work is largely directed at Urdu, but with high applicability and close relationship to work on Hindi.

VP, another where it forms a complex verb with a light verb. Since both kinds of structures have been argued for in Romance, it is very significant that they can both be found in a single language. Second, she applied a number of tests originally developed by Mohanan (1994) to show that the permissives were monoclausal. These tests involved phenomena of agreement (with objects), control, and anaphora.

The tests involving anaphora are especially important because they refute the possibility of analysing the permissive as an XCOMP in the manner of Ishikawa or Matsumoto. There are two relevant phenomena, bound anaphora with *apnaa*, and obviation with *uskaa*, as illustrated by this selection of examples from Andrews & Manning (1999):

(10) Urdu

a. Anjum$_i$ ne Saddaf$_j$ ko apnaa$_{i/*j}$ xat likʰ-ne
Anjum$_i$ ERG Saddaf$_j$ DAT self's$_{i/*j}$ letter.M.NOM write-INF
di-yaa
give-PRF.M.SG
'Anjum$_i$ let Saddaf$_j$ write her$_{i/*j}$ letter.'

b. Anjum$_i$ ne Saddaf$_j$ ko us-kaa$_{*i/j}$ xat likʰ-ne
Anjum$_i$ ERG Saddaf$_j$ DAT her$_{*i/j}$ letter.M.NOM write-INF
di-yaa
give–PRF.M.SG
'Anjum$_i$ let Saddaf$_j$ write her$_{*i/j}$ letter.'

c. Anjum$_i$ ne Saddaf$_j$ ko apnaa$_{i/j}$ xat likʰ-ne ko
Anjum$_i$ ERG Saddaf$_j$ DAT self's$_{i/j}$ letter.M.NOM write-INF ACC
kah-aa
say–PRF.M.SG
'Anjum$_i$ told Saddaf$_j$ to write her$_{i/j}$ letter.'

d. Anjum$_i$ ne Saddaf$_j$ ko us-kaa$_{i/*j}$ xat likʰ-ne ko
Anjum$_i$ ERG Saddaf$_j$ DAT her$_{i/*j}$ letter.M.NOM write-INF ACC
kah-aa
say-PRF.M.SG
'Anjum$_i$ told Saddaf$_j$ to write her$_{i/*j}$ letter.'

(10a) and (10b) are permissives, and we see in (10a) that the bound pronominal *apnaa* can be anteceded by the overt syntactic subject *Anjum* but not the overt object functioning as the so-called 'causee agent'[4] *Saddaf.* But the facts are reversed

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[4] The causee agent is the agent of the embedded verb in a causative/permissive construction.

in (10b) with the free pronominal *uskaa*. Here, coreference with the causee agent is good, with the overt subject bad. In both cases, the facts are as they would be in a simple clause. See Butt (2014) for an updated version of this and other arguments for monoclausality, which includes a discussion of the observation by Davison (2013) that the coindexing in (10a) is an oversimplification of the facts: some speakers do accept coreference with either the overt subject or the causee agent. Butt explains this as a consequence of the fact that cross-linguistically, it is often possible for bound pronouns to accept a 'logical subject' (highest-ranked argument of a predicate) as their antecedent, regardless of whether or not this is a syntactic subject. Intra-speaker variation with respect to examples like (10a) is therefore not a critical problem.

Another important property of the permissive is that it seems to have the same c-structure configurations as the instructive. Either the embedded verb and its complements can appear as a VP, which can scramble as a unit to the front of the sentence, but not be interrupted, or, both verbs can appear as a complex verb with the nominal complements able to be scrambled, in which case the two verbs only move as a unit (Butt 1995: 43–47, 1997: 113–115). A selection of examples illustrating VP scrambling and non-interruptibility is (11–12) below, from Andrews & Manning (1999: 23):

(11) Urdu Instructive (Biclausal)

a. Anjum ne **[ciṭṭʰii likʰ-ne]** ko Saddaf ko kah-aa
Anjum ERG letter(NOM) write-INF ACC Saddaf DAT say-PRF.M.SG
'Anjum told Saddaf to write a letter.'

b. Anjum ne kah-aa Saddaf ko **[ciṭṭʰii likʰ-ne]** ko
Anjum ERG say-PRF.M.SG Saddaf DAT letter.NOM write-INF ACC
'Anjum told Saddaf to write a letter.'

c. *Anjum ne kah-aa **ciṭṭʰ ii** Saddaf ko **likʰ-ne** ko

(12) Urdu Permissive (Monoclausal)

a. Anjum ne **[ciṭṭʰii likʰ-ne]** Saddaf ko d-ii
Anjum ERG letter(NOM) write-INF Saddaf DAT give-PRF.F.SG
'Anjum let Saddaf write a letter.'

b. Anjum ne d-ii Saddaf ko **[ciṭṭʰii likʰ-ne]**
Anjum ERG give-PRF.F.SG Saddaf DAT letter(NOM) write-INF
'Anjum let Saddaf write a letter.'

c. *Anjum ne d-ii **ciṭṭʰii** Saddaf ko **likʰ-ne**

The (b) examples are somewhat degraded for pragmatic reasons,[5] while (c) are ungrammatical.

But there are apparent exceptions to non-interruptibility, which arise exactly when the two Vs are adjacent, motivating a surface complex verb construction, similar to the N+V structures investigated by Mohanan:

(13) Urdu
  a. Anjum ne Saddaf ko **likʰ-ne ko kah-aa** ciṭṭʰ ii.
  b. Anjum ne **likʰ-ne ko kah-aa** Saddaf ko ciṭṭʰ ii.

(14) Urdu
  a. Anjum ne Saddaf ko **likʰ-ne d-ii** ciṭṭʰii.
  b. Anjum ne **likʰ-ne d-ii** Saddaf ko ciṭṭʰii.

This is significant for at least two reasons. First, as emphasized by Butt, it corroborates the thesis of LFG that there are (at least) two distinct levels, c-structure and f-structure, with a substantial degree of independence, since each of the two c-structures can occur with both of the f-structures. Second, both of these c-structures have been proposed for the complex predicates of Romance, with, for example. Manning (1992) arguing for a VP complement of complex predicates in Spanish, similarly to Alsina (1996) for Chicheŵa, while Kayne (1975) and subsequent work arguing for a complex verb treatment of causatives in French. Note that the examples in (13) require that it be possible to annotate an NP in the matrix with xcomp obj (Butt 1997: 117, ex (19a)), as also required for the analyses of Japanese by Ishikawa and Matsumoto.

4.1.2 Aspectuals

The permissive complex predicates appear to have the same semantic structure as many complement structures, for example *let* or *allow* in English, with different c- and f-structural packaging, but the semantics of the aspectual complex predicates is harder to explain. They focus on properties of an action such as completion, initiation and volitionality, without giving an impression of taking the main verb as an argument (as is usually the case with the Romance complex predicates considered below). Rather, Butt uses the general framework of Jackendoff (1990) to endow them with a kind of enriched argument structure that combines with that of the main verb.

Some examples are:

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[5] P.c. from Miriam Butt to Christopher Manning, 1997.

(15) Urdu

a. Anjum ne ciṭṭi likʰ l-ii
Anjum erg note.f.NOM write take-prf.f.sg
'Anjum wrote a note (completely).' (Butt 1995: 93)

b. vo ro paṛ-aa
he.nom cry fall-prf.m.sg
'He fell to weeping (involuntarily).' (Butt 1995: 109)

c. us ne ro ḍaal-aa
he erg cry put-prf.m.sg
'He wept heavily (on purpose).' (Butt 1995: 109)

Butt shows that these pass the tests for monoclausality, but the only one that is really significant is the obligatory agreement with the object as illustrated in (15a),[6] since, if they were xcomps, the complement and matrix subjects would be the same, so the anaphora and control tests would give the same outcomes. She also shows that the c-structures are somewhat different: since the VP structure is unavailable, only the one with a complex verb is possible.

These constructions seem rather different from the intransitive complex predicates in Romance, which from a semantic point of view appear to be syntactic alternatives to ordinary xcomps. Perhaps for this reason, there seems to have been relatively little further work on them, but see Butt (2010).

4.2 Romance

LFG treatments of complex predicates in Romance languages were developed at about the same time and in close communication with the work on Hindi and Urdu, largely by Alex Alsina and Christopher Manning, as presented in Alsina (1993, 1996, 1997), Manning (1992, 1996b), and Andrews & Manning (1993, 1999), building on earlier work mostly in the frameworks of Relational Grammar and Government-Binding Theory.

Although there are many similarities between the Urdu-Hindi permissive complex predicates and the complex predicates of Romance languages, there are significant differences in some of the more empirically striking phenomena. In the Urdu-Hindi permissives, there is clear evidence for two different constituent structures, one a complex verb, the other a VP complement, both also used by the instructive, which is clearly a control structure, bearing the xcomp GF in

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[6] Although the agent is semantically feminine, it is also ergative, so the verb cannot be agreeing with it.

f-structure. In Romance, however, although there are also xcomps that are morphologically similar to the complex predicates, they have different word-order properties, suggesting a different c-structure. Many verbs can furthermore appear in either construction, with different verbs having different preferences.

The word-order correlations of xcomp vs complex predicate constructions in Romance do not seem to have been much discussed in the LFG literature, but are considered in Sheehan (2016: 982), who illustrates both constructions being possible for perception verbs in French, where the xcomp structure, Exceptional Case Marking (ECM) in the Minimalist Framework, is preferred:

(16) French

a. Jean voir Marie manger le gâteau.
   Jean sees Marie eat.inf the cake
   'Jean sees Marie eating the cake.' (Sheehan (2016: 982, ex. 8b), ECM/xcomp)

b. Jean voit manger le gâteau à Marie.
   Jean sees eat the cake to Mary
   'John sees Mary eating the cake.' (ex 15a, p983; Sheehan (2016: 983, ex. 15a), Restructuring/complex predicate)

The literature agrees that none of the evidence for being a complex predicate construction can appear with the ECM/control structure word order.

Superficially, for the complex predicates, a complex verb structure similar to that of Hindi seems plausible, but, as we will discuss, the LFG literature provides a number of arguments against this. Another difference is that Romance languages have extensive evidence for different orderings of the light verbs producing different interpretations, as well as a considerably richer system of morphological marking of the semantically subordinate verbs by the light verbs. These phenomena create difficulties for a proposal where the f-structure is flat.

The constructions furthermore have a more diverse semantic range that those in Urdu-Hindi, comprising

(17) a. Causative, including extensions including permission, ordering and persuasion
   b. 'Modal' (ability, possibility, desire)
   c. Aspectual (starting and finishing, as well as Perfect and Progressive)
   d. Associated Motion

Another difference is that while in Urdu-Hindi the list of light verbs appears to be limited and closed, in some of the Romance languages it seems to be larger and hazier; for example Solà (2002: 226–228) lists 31 predicates in Catalan excluding the traditional aspectual auxiliaries, which have clitic climbing for arguments, and he indicates that there are more.[7]

The most widely used argument for clause union is the phenomenon of 'clitic climbing', whereby a preverbal clitic appears in front of the light verb rather than next to the verb it is an argument of:

(18) Spanish
Lo quiero ver.
it want.1.SG see.INF
'I want to see it.'

In principle, this argument can be circumvented by allowing the clitics to carry annotations such as '(↑ XCOMP* OBJ)=↓', but there are some issues with this, such as the fact noted originally by Rizzi (1978: 120) that in Italian, the capacity for clitics to climb disappears when the putative XCOMP is preposed by *wh*-movement (and in various other situations):

(19) Italian
a. questi argomenti, dei quali ti verrò a parlare
these arguments of.the which you.DAT come.FUT.1SG to talk.INF
al più presto, …
as soon as possible
'these arguments, about which I will begin to talk as soon as possible, …'
b. *questi argomenti, a parlare dei quali ti verrò
these arguments, to talk.INF of.the which you.DAT come.FUT.1SG
a più presto …'
as soon as possible
'these arguments, about which I will begin to talk as soon as possible, …'

In LFG, this would minimally indicate that there were two possible annotations for these apparent VPs, one allowing (pied-piped) *wh*-movement, the other not. An important characteristic of clitic climbing, discussed by Sheehan (2016) and also by Andrews & Manning (1993) is that it is not in general obligatory, but

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[7] Note also the relevant observation of García (2009: 185), working in a strongly functionalist approach, that constructions that normally reject indications of being a complex predicate, such as clitic climbing (see below) may accept it under certain pragmatic conditions.

optional, subject to complex preferences and conditions, discussed extensively from a functional perspective by García (2009).

Various further arguments from the literature are reviewed from an LFG perspective in Andrews & Manning (1999: 47–59) of which we will specifically mention one for Catalan from Alsina (1996: 217), which shows that the apparent complement in a restructuring construction does not have a subject, unlike an XCOMP. The argument is that causee agents can't host bare floated quantifiers, although non-overt equi-infinitive subjects can:

(20) Catalan (Alsina, p.c.)

a. Els metges$_i$ ens$_j$ deixen beure una cervesa cadascun$_{i/*j}$.
the doctors us let drink a beer each
'Each of the doctors let us drink a beer.'
*'The doctors let each of us drink a beer.'

b. Els metges$_i$ ens$_j$ han convençut beure una cervesa cadascun$_{i/*j}$.
the doctors us have convinced drink a beer each
'Each of the doctors has convinced us to drink a beer.'
*'The doctors have convinced each of us to drink a beer.'

This is the same kind of argument for clause union as the ones from anaphora for Hindi and Urdu by Mohanan and Butt.

The arguments for clause-union in Romance are similar to those from Urdu-Hindi, but the situation with c-structure is somewhat less clear, in that there is nothing comparable to Butt's argument that both a VP and a complex V structure are available. Rather, both have been argued for, complex Vs mostly in HPSG (Abeillé & Godard 1994, 1996) and VP complements in LFG. Manning (1992, 1996b) presenting arguments drawing heavily on previous work by Kayne and others on French, observes that clitics can climb out of coordinated VPs each with their own causee agent in Spanish as well as French:

(21) a. French
Marie le ferait lire à Jean et dechirer à Paul.
Marie it will.make read.INF to Jean and tear up.INF to Paul
'Marie will make Jean read it and Paul tear it up.'

b. Spanish
Carlos me estaba tratando de topar y de empujar contra María.
Carlos me was trying of bump.INF and of push.INF against Maria
'Carlos was trying to bump into me and push me against Maria.'

He counters proposals to use coordination reduction to explain this away.

Alsina (1997: 226) gives an argument from coordination and provides additional ones from nominalization and from the fact that various elements, such as sentence adverbials set off by comma-pauses, can be inserted between the main and light verbs:

(22) Catalan

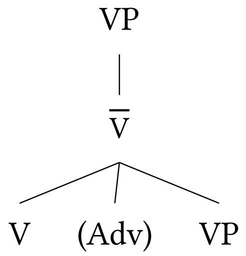
a. La Maria ha fet de debó riure el nen.
the Mary has made truly laugh.INF the boy
‘Mary has truly made the boy laugh.’

b. La Maria ha fet, em penso, riure el nen.
the Mary has made I think laugh.INF the boy
‘Mary has made the boy laugh, I think.’

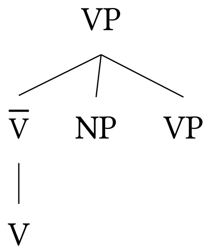
Although it is often possible for certain kinds of particles to be inserted into complex verb structures,[8] this seems to be more than is generally allowed, vindicating the argument.

Although the LFG literature does not have much to say about the c-structure of the complex predicates, I suggest that it is reasonable to propose that they are expansions of an ‘inner VP’, or $\overline{\text{V}}$, to V and VP, as in (23a), whereas the XCOMP/control/ECM constructions are expansions of VP, as in (23b):

(23) a.



b.



The nature of the c-structure difference remains to be fully elucidated.

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[8] As discussed for Tariana by Aikhenvald (2003) and Jaminjung by Schultze-Berndt (2000).

Although the nature of the constituent structure of Romance complex predicates is not entirely clear, something that is clear is the effect of the c-structure on semantic interpretation. Alsina (1997: 238) provides examples that show the same light verbs appearing in different arrangements in Catalan clause union constructions, and Solà (2002: 239) provides a few more:

(24) Catalan

a. Li acabo de fer llegir la carta.
him.DAT finish.1SG of make.INF read.INF the letter
'I finish making him read the letter.' (Alsina 1997: 238)

b. Li faig acabar de llegir la carta.
him.DAT make.1SG finish.INF of read.INF the letter
'I make him finish reading the letter.' (Alsina 1997: 238)

c. Les pot aver vistes.
them.F.PL can.SG have.INF seen.PST.PTCP.F.PL
'He/She can have seen them.' (Solà 2002: 239)

d. Les ha pogudes veure.
them.F.PL have.3SG been able.PST.PTCP.F.PL see.INF
'He/she has been able to see them.' (Solà 2002: 239)

In Urdu, on the other hand, multiple light verbs occur in an order consistent with semantic interpretation, assuming head-final ordering, but no cases of multiple possible orderings have been produced. The issue of how to control the semantic interpretation in Romance languages is therefore more acute, and there is disagreement about how to do it, as we discuss below.

A final characteristic of Romance is a substantially greater variety of subordinate verb forms. There are three inflectional categories, infinitive, active (present) participle, and passive (past) participle, the latter occurring in both agreeing and non-agreeing forms, with the further problem of specifying the verb-markers as such *a* 'to/at', *de* 'of' and others, mostly historically prepositions. This means that the question of how the marking of the subordinate verb is to be accomplished is more acute. However, the theoretical treatment is not as troublesome as the semantics, as we shall see.

4.3 Mainland Scandinavian

The most striking feature of the Scandinavian constructions is that their most obvious evidence for monoclausality is apparent verbal feature agreement between the light verb and its semantic complement, as illustrated in these examples from Norwegian:

(25) Norwegian (Lødrup 2014a: 4)

a. Forsøk å les!
try.IMP to read.IMP
'Try to read!'

b. Det har jeg glemt å fortalt.
that have.PRS I forget.PTCP to tell.PTCP
'I forgot to say that.'

c. Jeg prøvde å leste det lure smilet hennes.
I try.PST to read.PST the sly grin.DEF her
'I tried to read her sly grin.'

The inflectional agreement in the above examples is optional, most common with imperative forms (25a), less common with participles (25b), and possible for only some speakers with the finite past (25c).

The most-discussed evidence for reanalysis is 'long passives', which are arguably produced by morphological features associated with passive voice being shared across the two levels, as analysed by Lødrup (2014b). An example is:

(26) Norwegian (Lødrup 2014b: 388)
at vaskemaskin-en må huskes å slås på
that washing machine-the must remember.INF.PASS 'to' turn.INF.PASS on
'that you must remember to turn on the washing machine'

While the tense-mood features of (25) appear to percolate down from the upper to the lower verb, the voice feature of (26) percolates in the opposite direction, in a manner somewhat reminiscent of the analysis of auxiliary selection in Italian in Andrews & Manning (1999: 56–60).[9] This suggests that this is a complex predicate structure where both verbs are associated with the same f-structure. Lødrup discusses further verbal constructions similar to these that do not appear to be complex predicate constructions; space precludes discussing them here. Similar phenomena appear to be found in Swedish and Danish, but have not been reported for Icelandic.

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[9] Due to Manning, according to my recollections.

4.4 Theoretical approaches

A central conclusion from the data of these languages is that the apparent multiple levels of c-structure correspond to one level of f-structure. For example, according to both Butt's and Alsina's analyses, the f-structure of (24a) would be:

(27)
$$\begin{bmatrix}
\text{SUBJ} & \begin{bmatrix}\text{PRED} & \text{`PRO'}\\ \text{PERS} & 1\\ \text{NUM} & \text{SG}\end{bmatrix}\\
\text{PRED} & \text{`FINISH-MAKE-READ'}\\
\text{OBJ} & \begin{bmatrix}\text{SPEC} & \text{DEF}\\ \text{GEND} & \text{FEM}\\ \text{NUM} & \text{SG}\\ \text{PRED} & \text{`LETTER'}\end{bmatrix}\\
\text{OBJ}_{\theta} & \begin{bmatrix}\text{CASE} & \text{DAT}\\ \text{NUM} & \text{SG}\\ \text{PERS} & 3\end{bmatrix}
\end{bmatrix}$$

There are three problems that arise:

(28) a. The morphological marking

b. The combination of multiple PRED-values into one

c. The effect of arrangement on semantic interpretation

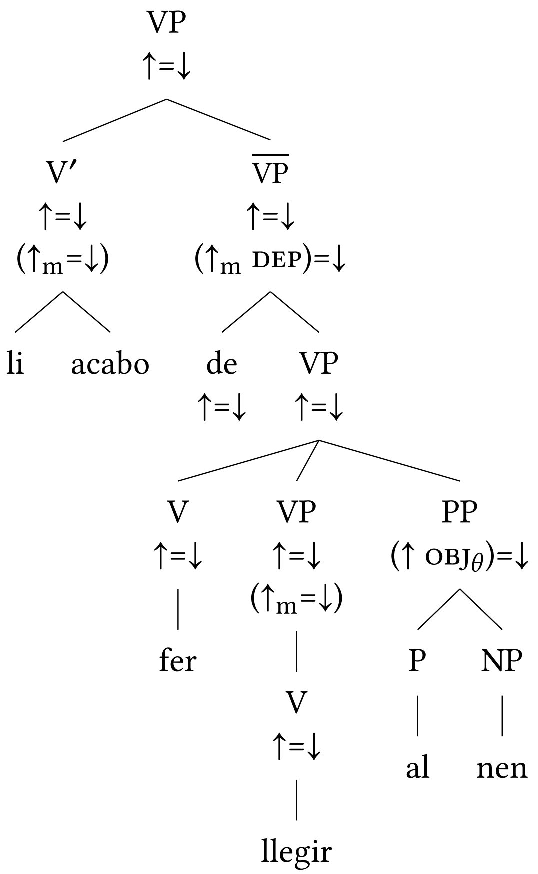
(28a) is the easiest to deal with, because, as discussed in Butt et al. (1999) it can be managed by proposing a morphological projection (m-structure), that comes directly off c-structure, where the relevant featural information can be stored. The m-structure attributes normally proposed are VMARK with values DE, A, etc, for the apparently prepositional marking, and VFORM for the inflectional categories, with values FIN, INF, PRS.PTCP and PST.PTCP. The relevant parts of the lexical entries for the light verbs in (24) will then be:

(29) a. *acabo*: $(\uparrow_{m}\ \text{DEP VMARK}) = \text{DE}$, $(\uparrow_{m}\ \text{DEP VFORM}) = \text{INF}$, $(\uparrow_{m}\ \text{VFORM}) = \text{FIN}$

b. *fer*: $\neg(\uparrow_{m}\ \text{DEP VMARK})$, $(\uparrow_{m}\ \text{DEP VFORM}) = \text{INF}$, $(\uparrow_{m}\ \text{VFORM}) = \text{INF}$

The c-structure will annotate all of the VPs with $\uparrow=\downarrow$ for f-structure, but will assign to them a DEP-value in m-structure:

(30)



The forms can then be managed, and this solution will clearly also work for Hindi.

There is however a potential problem, which is that it was later argued by Frank & Zaenen (2002) that m-structure ought to come off f-structure rather than c-structure directly. With this change, form-determination becomes more complicated. Their solution, which involves rather complex stipulation, works for French auxiliaries, but as discussed by Andrews (2018b), it does not seem very plausible for the richer system of light verbs found in some of the other Romance languages such as Catalan. But we will not pursue this further here, and consider instead the next problem.

This is that if both the main verbs and the light verbs are construed as having PRED-features, the f-structure annotations will produce a PRED-value clash. Within mainstream LFG there have been three proposed solutions. The first was proposed in an earlier form by Alsina (1996: 189), and then in a later, more formal form by Alsina (1997: 235–237). Although it was criticized extensively by Andrews & Manning (1999: 28–34), I think it can be further revised to reduce the force of some of their criticisms.

The core of Alsina's proposal is the idea that light verbs have an empty argument position into which the pred-value of their semantic complement is substituted. A schematic illustration is:

(31) 'cause⟨[P-A] [P-P] P*⟨...[ ]...⟩⟩'

'[P-A]' and '[P-P]' represent the proto-agent and proto-patient roles of Dowty (1991), 'P*' the unspecified predicate that is to be plugged in, and the underbar the fact that in the 'direct causative' construction, the patient of the causative verb is to be identified with some argument of the caused verb. Given (32a) as the subordinate verb to be plugged in, a possible result is (32b):

(32) a. 'read⟨[P-A] [P-P]⟩'
b. 'cause⟨[P-A] [P-P] read⟨[P-A] [P-P]⟩⟩'

Alsina does not present this in an attribute-value notation where the usual methods for unification in LFG apply, but this is clearly a triviality. In what follows, it will be useful to assume that the empty predicate slot in the light verb is the value of an attribute such as parg, in order to formalize the construction of a complex predicate such as (32b) in a more conventional notation.

The next component is the idea that the '↑=↓' annotation on the VP complement of a light verb is either interpreted in a special way (Alsina 1996) or replaced by something a bit different (Alsina 1997). We take the second approach. Here, these VPs are annotated with the novel annotation $\uparrow_H{=}\downarrow$, which is interpreted as follows. The two most important provisions are that the pred-values are not shared between the levels, which can be accomplished with the LFG device of 'restriction', and second, the pred-value of the VP is plugged into to parg-value of the light verb's pred. This can be formalized as follows:

(33) $\uparrow_H{=}\downarrow \quad = \quad \uparrow\backslash_{\text{PRED}} = \downarrow\backslash_{\text{PRED}}$
$(\uparrow \text{PRED PARG}) = (\downarrow \text{PRED})$

This treatment is close to that proposed later for Urdu by Butt & King (2006), the difference being that they also propose a different approach to argument structure and linking.

Alsina's treatment as exposited is a bit less clear than it could have been, because he attaches $\uparrow_H$ to both the light V and its semantic complement VP, which isn't necessary, as noticed implicitly by Butt & King (2006: 241). Manipulating argument-structure in c-structure rules might seem somewhat odd, but these constructions are difficult and seem to resist fully conventional treatments.

The final ingredient is a linking theory. Alsina's and Butt's analyses both require a linking theory that will apply to assembled syntactic structures rather than individual lexical entries. This is a substantial change from the original conception of Lexical Mapping Theory, which was supposed to apply to items listed in the lexicon. Alsina's and Butt's approaches differ in detail, but the basic idea is that the argument structure positions are assigned grammatical relations in accordance with prominence hierarchies, so that the most prominent will be expressed as SUBJ unless the verb is passive, in which case it is expressed as an oblique. The linking theories for complex predicates, including that of Andrews & Manning (1999) furthermore remained somewhat informal until recently, with the proposals of Lowe (2016) to use glue semantics, and Andrews (2018b) to use the 'Kibort-Findlay Mapping Theory' as developed in Asudeh et al. (2014) and Findlay (2016). We will however not pursue linking theory here, but rather review some follow-up proposals to the original analyses.

Andrews & Manning (1999) proposed to reanalyze the material in a way that was in some respects not so different from the original analyses, but set within a rather substantial reorganization of LFG. Rather than there being the two central levels of c-structure and f-structure, it was proposed that all attributes are in the first instance assigned to c-structure, nodes, and then differentially shared by annotations stated in terms of classes of attributes that share in different ways, some more aggressively than others. The bar-features of $\overline{\mathrm{N}}$ theory, for example, would be shared between mother and daughter in only certain coordinate structure and modificational configurations. category features more widely (between N (=N^0) and NP (=N^2), for example). Clause union complex predicates would then have sharing of the grammatical functions SUBJ, OBJ and OBJ_θ and others (which were called the ρ-projection) between the upper and lower VPs, while XCOMPs would not. The morphological features would however not be shared, effectively including in the analysis a kind of morphological projection, of the original kind, coming off of c-structure, rather than f-structure.

This approach reflects a difference in philosophy from Alsina's: he proposes that light verbs and the predicates of their semantic complements combine in a fundamentally different way from ordinary complementation, producing a genuine 'complex predicate', from which follow the peculiarities of linking and the evidence for clause union. Andrews and Manning did not share this intuition. In their account, the light verb constructions appear in very similar configurations to those of the complement structures, the main difference being that the former share grammatical relations while the latter do not,[10] but have their se-

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[10] The VP complements of the light verbs are introduced as values of an attribute ARG, which might in principle be the same as XCOMP, as long as the latter is not in the ρ projection. This issue is not discussed in the text. In the earlier version of this approach presented in Andrews & Manning (1993), ARG had to be a different attribute than XCOMP.

mantic complements introduced by a different attribute, ARG, that is on a different projection than the f-structural attribute XCOMP, but the mode of semantic composition is fundamentally the same.

This could be defended on the basis that there do not appear to be major semantic differences between the structures where ARG is motivated versus the ones without clitic climbing that call for XCOMP. By contrast, many of the complex predicates investigated by Butt and Mohanan really do seem to involve closer combination between the light verb and the heavy verb, as indicated by Butt's introduction of aspects of Jackendoff's conceptual structures. This leads to a further issue, the treatment of auxiliaries. Butt (2010) argues strongly that auxiliaries are not light verbs, on the basis of having different general behavior and historical trajectories. But in Romance languages, they tend to show the typical behavior of the light verbs, including clitic climbing, and the capacity to condition the form of their apparent complements, and the non-auxiliary light verbs seem to have the semantics of ordinary complement structures in other languages. Catalan *voler*, for example, with restructuring, seems to have essentially the same meaning as English *want*, which does not show clear evidence of restructuring from the perspective of LFG.[11] By contrast, the Urdu light verb contrast between *paṛ* 'fall' and *ḍaal* 'put' signifies contrast between accidental and volitional action, respectively (Butt 1995: 108–109), in a way that is not well captured by the usual kind of semantic composition proposed for complements.

There are three further analyses to consider, Butt and King's 2006 analysis of Urdu, Lowe's (2016) rather different analysis of the same language, and Andrews' (2018b) analysis of Romance. Butt and King's treatment is very similar to the modified version of Alsina's analysis proposed here, but differs in one important respect: it does not use linking theory, but rather uses restriction to prevent the SUBJ and OBJ_{GOAL} (grammatical function of the causee agent) from being shared between the two levels, but uses an equation to identify their value (Butt & King 2006: 241, ex. 8). This might generalize to Romance, but faces a problem in both Romance and Hindi (also, presumably, Urdu), which is that it does not explain the evidence (from anaphora in Urdu, and subject-oriented adverbs in Catalan) that the causee agent is not a subject. In a sentence such as (10a), for example, the subject-bound anaphor *apnaa* is sitting in a clause nucleus whose SUBJ-value is *Saddaf ko*, so it is not clear why it cannot be bound by it, even though the

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[11] However Grano (2015) argues within Minimalism that English *want* does have restructuring (and similarly for even more superficially biclausal constructions in Modern Greek). But his arguments are based mainly on the inability of various modifiers to appear, as can be explained by the absence of certain functional projections (or perhaps semantic operators), rather than shared f-structures, which is the basis for clause-union in LFG.

f-structure in which this happens is not actually part of the f-structure of the matrix S, due to the operation of restriction.

The 1999 analysis of Andrews and Manning and the 2006 analysis of Butt and King lack a feature that is relatively typical for LFG, which is that the f-structure of a c-structure constituent contains the f-structures of all of that constituent's subconstituents. We might call this property 'monotonicity of f-structure (with respect to c-structure)'. When this property is discarded, analyses involving functional uncertainty can fail in ways that are difficult to predict, which might provide a reason for preferring other kinds of analyses if they are available. A further, related point is that 'forgetting' much of the abstract structure of subconstituents is an essential characteristic of HPSG with its head-feature constraint. It is plausibly a good idea to develop LFG in ways that are clearly distinct from HPSG. The next two analyses retain f-structure monotonicity.

The second one is that of Lowe (2016) of Urdu, which neither uses restriction nor proposes any changes to the LFG framework, but makes use of two different ideas. The first is to treat the light verbs as not having PRED-features, but introducing grammatical features such as [PERMISSIVE +]. This is workable for Urdu-Hindi, because the inventory of light verbs is clearly closed, and they are semantically bleached, but less plausible for Romance, because the inventory is larger, and, as we have previously discussed, not so sharply delimited, and many of the verbs have considerable lexical content, as discussed in the previously mentioned Solà (2002). On the other hand, given glue semantics, it is not clear exactly what the PRED-features are accomplishing, so this might not really be a problem. Given that there is no problem of conflicting PRED-features, a rather clever glue semantics trick is used to get the right interpretation, which cannot be explained properly in the limited space available here. Given the use of a morphological projection or similar device, the analysis solves all problems except for the dependence on the c-structure for scopal interpretation in Romance. In particular, since the causee agent NP is in no way at any level a value of SUBJ, there is no problem with either the phenomena of anaphora in Urdu-Hindi or the floating quantifiers in Catalan. Lowe (2016) also provides an extremely thorough discussion and critique of all previous analyses of complex predicates in LFG.

The final analysis, that of Andrews (2018b), solves the problem of hierarchical interpretation without using a distinct morphological projection, but also obeys f-structure monotonicity. It has significant similarities to the analyses of both Andrews & Manning (1999) and Butt & King (2006). It require some modification to the LFG framework, although a considerably less extensive one than Andrews and Manning's approach. The basic idea is to apply the concept of 'distributive attribute' and 'hybrid object' from Dalrymple & Kaplan (2000) to sets with a single member, so that a complex predicate structure is taken to be a hybrid object with the semantic complement as a set-member:

(34)
$$\left[\begin{array}{l} \textsc{pred}\ \text{`}\textsc{let}\text{'} \\ \ldots \\ \left\{\left[\begin{array}{l}\textsc{pred}\ \text{`}\textsc{write}\text{'}\\ \ldots\end{array}\right]\right\} \end{array}\right]$$

This provides appropriate places to locate the morphologically required features, without requiring a new projection, and also a structure to determine the semantic interpretation, at the cost of requiring a certain amount of stipulation to distinguish the features that need to be shared versus those that cannot be. The Kibort-Findlay Mapping Theory is used to get appropriate interpretation of the arguments of the verb without having to treat the causee agent as a SUBJ-value.

5 Morphologically integrated complex predicates

These are constructions which might be analysed as derivational morphology, but for various reasons have invited analysis as morphologically compacted versions of the previous constructions. The two main examples are Ishikawa (1985) for Japanese, and Alsina (1997) for Chicheŵa, extending their analyses for the previously discussed complex predicate constructions (in the authors' terminology) to the current ones.

5.1 Ishikawa and Matsumoto on Japanese

To analyse Japanese *-(s)ase-* causatives,[12] Ishikawa uses the technique from earlier LFG work such as Simpson (1983) of allowing word-level phrase-structure rules to introduce stems or affixes with a grammatical function. For example, the verb stem *aruk-ase* in example (35a) below is given the tree structure (35b):

(35) Japanese (Ishikawa 1985: 98)

a. John ga Mari ni/o aruk-ase-ta
John NOM Mary DAT/ACC walk-cause-PST
'John caused Mary to walk.'

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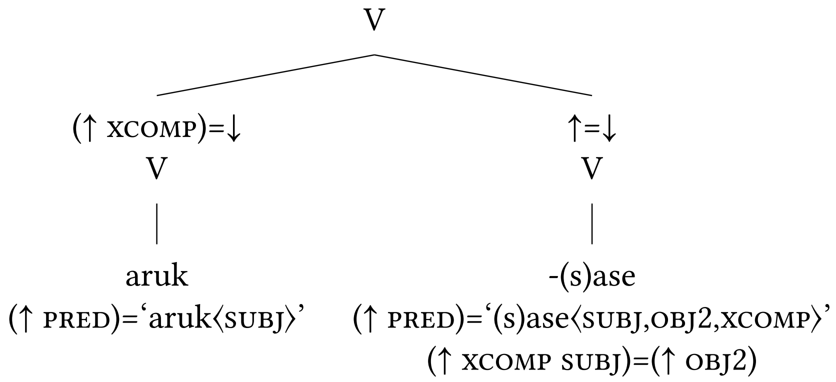
[12] The initial *s* appears after stems ending in a vowel, but is absent after a consonant.

b.



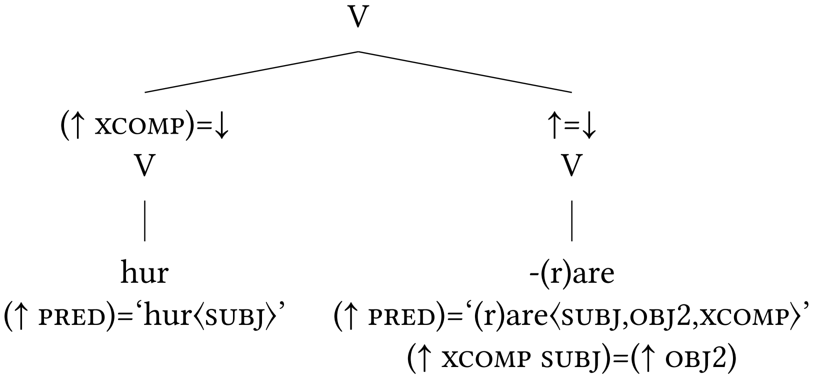
The difference between dative and accusative on the causee agent is semantically significant, treated as whether the grammatical function is iobj2 (currently designated as obj$_{\theta}$) for the dative or obj for the accusative.

Ishikawa extends this analysis to the ‘indirect’ or ‘adversative’ passive, in which the subject is characterized as suffering the effect of the action (Kuno 1973: 303):

(36) Japanese (Ishikawa 1985: 106)
John ga ame ni hur-are-ta
John nom rain dat fall-pass-dat
‘John suffered from rain falling.’

The annotated c-structure for this is:

(37)



There has been a dispute as to whether the adversative passive must always add a new argument, or can be similar in appearance to the regular passive, but expressing adversity to the overt (promoted) subject. Kuno says no, while Ishikawa (1985: 114–124) says yes, although the arguments are complex, and depend on too many details of Japanese for further discussion here.

Matsumoto (1996) provides a similar analysis, but implemented somewhat differently, for causatives, and also certain desideratives. For the latter, he argues that desideratives which take the desired event object as an accusative have a biclausal structure, while the ones where this object is nominative are monoclausal:

(38) Japanese (Matsumoto 1996: 103)

a. boku wa hon o yomi-tai
I TOP book ACC read-want
'I want to read the book.'

b. boku wa hon ga yomi-tai
I TOP book NOM read-want
'I want to read the book.'

The argument that Matsumoto makes is complex, and depends on the possibilities for passivization. One point is that the desiderative forms an adjective rather than a verb, and adjectives as such cannot be passivized. However there is a way out: adjectives of subjective state can be verbalized by adding the suffix *-gar*, meaning 'to show signs of being in the state'. These derived verbs are natural with non-first person subjects, which the original adjectives are not. Although these derived verbs take accusative objects, there is a difference in passivization: the ones whose base forms reject *ga*-marked objects are also the ones that are acceptable in the passive. These are the ones where the subject in some sense wants to 'have' the object:

(39) Japanese (Matsumoto 1996: 107)

a. boku wa sono hon o/ga yomi-tai
I TOP the book ACC/NOM read-want
'I want to read the book.'

b. boku wa kare o/*ga machi-tai
I TOP him ACC/NOM wait-want
'I want to wait for him.'

It is the verbal forms derived from the desideratives that accept *ga* on their patients that can be passivized:

(40) Japanese

a. sono hon wa minna ni yomi-ta-gar-arete-iru
the book TOP all DAT read-want-VBLZ-PASS-ASP
'The book is in such a state that everybody wants to read it.'

b. *kare wa minna ni machi-ta-gar-arete-iru
He top all dat wait-want-vblz-pass-asp
'He is in such a state that everybody wants to wait for him.'

'Long passives' are possible in some but not all of the languages with the complex predicate constructions discussed in the previous section (present in Italian and Catalan, but not in Spanish), but the contrast between these examples does indicate that there are two different constructions. Matsumoto also discusses differences in adjunct interpretation and verbal anaphora to justify the proposed distinction between biclausal and monoclausal.

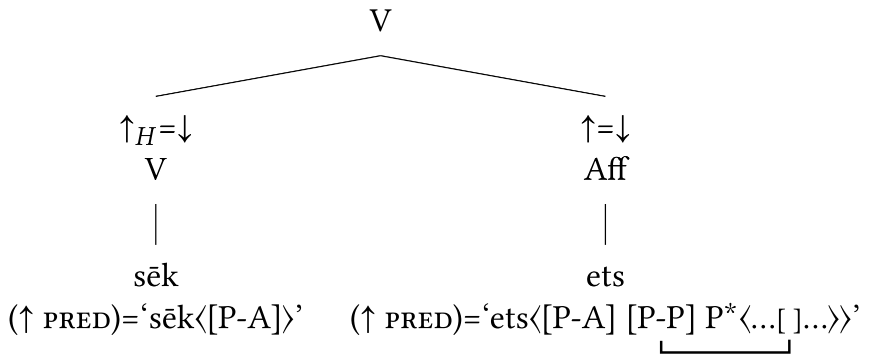
Unfortunately, there does not appear to have been much follow-up to compare Ishikawa's and Matsumoto's analyses with the later ones of Bantu and Hindi-Urdu, to which we turn next.

5.2 Alsina on Bantu, and similar constructions

Alsina (1997) presents an analysis of causatives in Chicheŵa, based on the same account of argument structure and predicate-composition as presented in Alsina (1996). The difference from the treatment of Catalan is in the c-structure: in both cases, the c-structures are monoclausal, but in Chicheŵa, the causative element is treated as an affix to the Caused verb stem, rather than an independent morphological stem, as in Catalan. Alsina provides convincing evidence for this difference.

The c-structures are identical to those proposed by Ishikawa and Matsumoto for Japanese, but the annotations are different: they are the same as they would be for Catalan (assuming my claim that we only need the special annotation for the semantic complement, not the head, and adjusting the lexical entries to fit Alsina's linking theory):

(41)



The analysis actually works a bit better for this construction than the Romance one, because we do not have to worry about conditioning the subordinate verb form, and the problem of different orderings having different semantic interpretations does not arise.

This form of analysis has been extended more widely to other ‘valence change’ constructions, including reciprocals in Chicheŵa (Alsina 1997), passives and antipassives in a variety of languages (Manning 1994, 1996a), and causatives and applicatives in Australian languages (Austin 2005). Complex-predicate-based analyses of morphologically based valence change do not however appear to have been much pursued in recent years. The most recent LFG analysis of passives is, for example, within the Kibort-Findlay Mapping Theory (Findlay 2016), and does not use a complex predicate analysis.

Typology seems to provide some warrant for questioning these analyses. Passive constructions (or, more precisely, constructions in various languages that are often called ‘passive’) do often involve auxiliary verbs in what might plausibly be complex predicate constructions, but those normally called antipassives are to the best of my knowledge always morphological, and apparent complement structures that are actually complex predicates seem likewise to be nonexistent for reflexives and reciprocals. Another intriguing asymmetry arises with causatives and applicatives. As discussed by Austin (2005), it is not unusual for morphological causatives and applicatives to use the same formative.

Austin analyses these in various Australian languages as having the applicative/causative morpheme introduce a light verb AFFECT, with the difference between causative and applicative senses being based on different patterns of argument identification. Sample causative and applicative combinations are (Austin 2005: 32–33):

(42) a. Causative:
AFFECT < Ext Arg Int Arg PRED < Arg >>
+vol −vol −vol
e.g. ‘The man turned the child.’

b. Applicative:
AFFECT < Ext Arg Int Arg PRED < Ext Arg Goal/Loc >>
+vol −vol +vol −vol
e.g. ‘The man laughed at the child.’

In the causative, the agentive argument of the AFFECT predicate is identified with the unaccusative argument of the embedded predicate, while in the applicative, the agentive arguments of the two predicates are identified, and also the second argument of AFFECT and a locative/directional argument of the embedded verb.

This captures the idea that applicatives of such verbs often express a meaning to the effect that the locative/directional is affected by the action.

There is however perhaps a typological issue with the analysis: the causative is often expressed by constructions that look like and often seem to actually be complement constructions, but this is not the case for applicatives, whose sense is however sometimes expressed by serial verb constructions, as we consider in the next section. This typological difference suggests a fundamental structural one, but there is also evidence for a relationship, in that the same formative is sometimes used for both. What I suggest is that the AFFECT concept is common to both, with argument sharing as proposed by Austin, but that the structural relations are different. We can partially express them using the 'Natural Semantic Metalanguage' (NSM) approach of Anna Wierzbicka and her colleagues (Wierzbicka 2006, Goddard 2011), which can be regarded as being a technique for expressing meanings in simple terms that are found to be highly translatable.[13] In the case of causatives, the sense is:[14]

(43) X does something to Y
Because of this, <Caused Event>

In the case of applicatives, there does not seem to be any caused event distinct from what X does to Y, rather what X does *constitutes* X doing something to Y. For this I suggest the following:

(44) <Applied event, performed by X involving Y>
This is X doing something to Y.

This is not of course anywhere near a full explanation of the differences between the constructions, but it is perhaps a start. In particular, it seems plausible that the identity relationship expressed in (44) is not something that is normally expressed by complement structures.

Neither these contemporary analyses of morphological causatives and valence change operations, nor the earlier ones by Ishikawa and Matsumoto, in which they are morphologically expressed XCOMP structures, have received much discussion in recent years.

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[13] Andrews (2016) is an attempt to express the basic ideas of NSM in a form that might make some sense to people trained in formal semantics.

[14] NSM accounts (called 'explications') of the causative tend to include 'after this' after 'because of this', but I suggest that this is better treated as an inference licensed by a law that effects come after their causes (at least in the local timeline of an individual, ignoring scenarios from science fiction).

6 Serial Verb Constructions

Our last type is SERIAL VERB CONSTRUCTIONS (SVCs). Perhaps the first issue that arises with these is the rather controversial one of defining them. I will here roughly follow Aikhenvald (2006b) in defining them as structures where:

(45) a. There is some evidence of at least partial clause union.
     b. There is no explicit marking of subordination or coordination.

(45a) is an indication that SVCs are complex predicates or at least control structures, while (45b) has no clear status in a formal syntactic analysis of these constructions, but is plausibly very important for their functional characteristics and tendencies in diachronic development, since they do not provide much in the way of overt cues as to what their syntactic structure is.

SVCs have not received much attention in the LFG literature, the main exceptions being the treatment of Tariana in Andrews & Manning (1999),[15] the treatment of Dagaare and Akan (with observations about other languages) in Bodomo (1997), and the recent analysis of Barayin in Lovestrand (2018). In this section, I will consider these three languages, and then take a brief look at Misumalpan causatives, treated as complex predicates by Andrews & Manning (1999), but argued to be something different in Andrews (2018a).

6.1 Tariana

Tariana SVCs[16] consist of a sequence of verbs inflected identically for person, with some further grammatical markers appearing once, in a number of positions. A fundamental division in these constructions is between the 'symmetric' SVCs, which look and act like coordinated verbs (but without any overt coordinator), and the 'asymmetric' ones, which are diverse, but many of them are semantically similar to Romance complex predicate structures, and have some capacity to occur embedded in each other. Andrews & Manning (1999) took this as a basis for analysing the two with similar feature-structures, but differing in the c-structures. A particularly striking piece of evidence for the monoclausality of these constructions is the phenomenon of 'concordant dependent inflection', whereby the caused verb shows subject agreement with the causer, presumably on the basis that this is the subject of the entire construction, rather than the causee agent, its own agent. This is illustrated in the following example:

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[15] With an update to the framework of Andrews (2018b) in Andrews (2018a).

[16] For a descriptive account see Aikhenvald (2003, 2006a).

(46) Tariana (elicited, Aikhenvald p.c.)
nu-na=tha nu-ra nu-sata dineiru
1SG-want=FRUSTR 1SG-order 1SG-ask money
'I want to order (him) to ask for money.'
(Modal on causative)

In the Andrews and Manning analysis, the light verb shares both the f-projection and the a-projection (roughly equivalent to f-structure and argument structure) with the c-structure mother, while its semantic complement shares only the f-structure, and is introduced into the a-structure as the value of an attribute ARG. In the later version of Andrews (2018a), the light verb has ↑=↓, while the main verb is introduced as a set member.

The various other kinds of analyses we considered would work for Tariana as well as they do for their original subject material, and there would be no need to involve a morphological projection to control the government of the forms of the semantic complement verbs by the light verbs.

6.2 Dagaare and Akan

Most Tariana SVCs can be treated as either syntactically coordinate structures (symmetric SVCs) or as an expression of Romance-type restructuring predicates (asymmetric SVCs), with a different technique of morphological expression. But Dagaare and Akan, two major languages of Ghana discussed by Bodomo (1996, 1997), have additional SVC constructions that do not submit to such analyses, and require something different. These are also considerably more similar than Tariana SVCs to the constructions commonly called SVCs in many other languages.

Bodomo (1997: 80–84) discusses a number of types. One of their characteristics is that in some of the cases, such as action-causation, no plausible suspect for being the 'light verb' can be identified:[17]

(47) Dagaare
a. Benefactive:
o da tong la toma ko ma
3SG PST work(V) FACT work(M) give me
'S/he worked for me.'
b. Action-Causation ('Causative'):
o da daa ma la lɔɔ
3SG PST push me FACT cause-fall
'S/he pushed me down.'

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[17] *la* is the 'Factive' particle in Dagaare, marking positive affirmations (Bodomo 1997: 65–69).

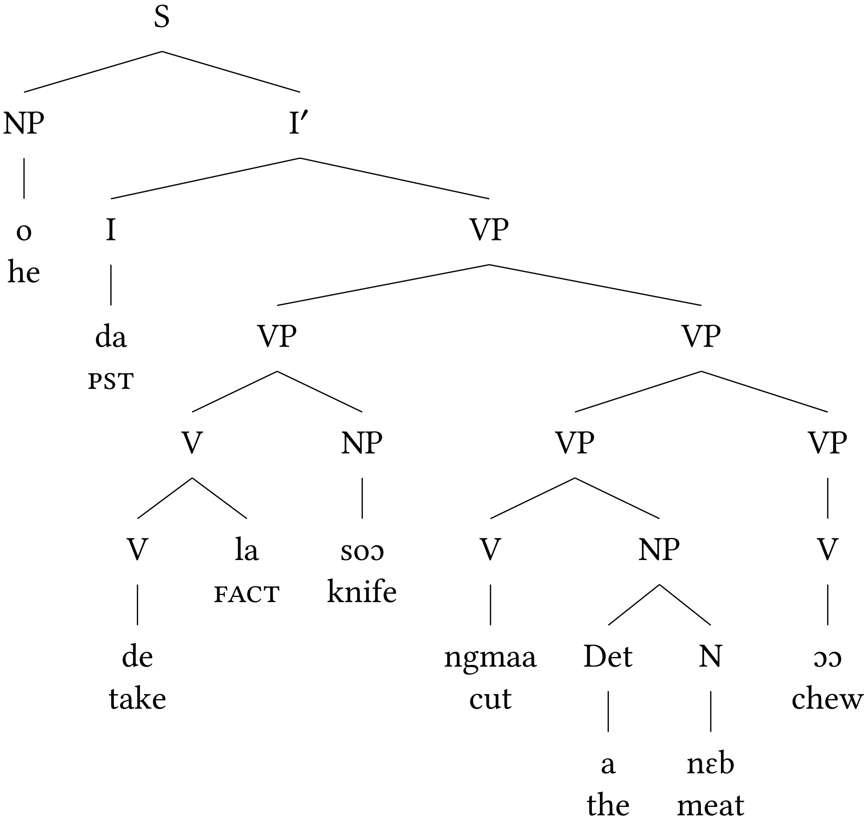
c. Inceptive *take* serialization:
o de la gan ko ma
3sg take fact book give me
‘S/he gave me a book.’

d. Instrumental *take* serialization:
o da de la sɔɔ ngmaa a nɛb ɔɔ
3sg pst take fact knife cut def meat chew
‘S/he cut the meat with a knife and ate it.’

e. Deictic (Directional/Associated Motion)
o da zo wa-ɛ la
3sg pst run come.prf fact
‘S/he ran here/S/he came by running.’

At the level of c-structure, Bodomo proposes flat binary VP structures without specifying what would happen in examples such as (47d) above that might involve nesting, as I suggest below:

(48)



My proposed account is that the upper pair of VP’s constitute instrumental serialization, while the pair embedded under the rightmost member of the upper are a collocation (a type not listed in (47) meaning ‘eat’). Bodomo is however not clear about this, and a flat structure of three VPs sitting under one would be consistent with the text.

For the f-structure analysis, he follows Alsina, with the modification that since it is frequently impossible to regard one of the verbs as light and another as heavy, the two PRED-values are integrated into a ‘PREDCHAIN’ value in a manner that can be formalized in various ways (no specific one is chosen).

The semantics is treated with a ‘cell theory’ that is part of the ‘Sign Model’ of Hellan & Dimitrova-Vulchanova (1996), which does not appear to have ever been published, but seems broadly compatible with many recent ideas about the aspectual constitution of verb meanings. Events have a variety of properties, including an obligatory Core component, and optional Initiation and Termination components. Although there is no published account of the entire theory, the approach seems broadly consistent with that taken by Butt, and could plausibly be implemented by unification, or in the Davidsonian Event semantics used in the Kibort-Findlay Mapping theory (Asudeh et al. 2014, Findlay 2016).

In the causation-action construction, for example, the first verb specifies a ‘action’ component (what is done), the second a ‘causation’ component (what happens because of what is done). If we take the general approach to complex predicates proposed in Andrews (2018b), we could have a VP expanding to two VPs, each producing an element of a set, with a ‘syncategoremantic’ meaning constructor (one introduced by the c-structure rules) setting these up as the action and causation subevents of the main event:

(49)
$$\begin{array}{lccc} \text{VP} & \longrightarrow & \text{VP} & \text{VP} \\ & & \downarrow\in\uparrow & \downarrow\in\uparrow \\ & & \downarrow=\%F & \downarrow=\%G \end{array}$$

$$\lambda e.\exists e_1(\mathit{Action}(e,e_1)) \wedge \exists e_2(\mathit{Result}(e,e_2)) :$$
$$((\%F_\sigma\ \textsc{ev}) \multimap \%F_\sigma) \multimap ((\%G_\sigma\ \textsc{ev}) \multimap \%G_\sigma) \multimap (\uparrow_\sigma\ \textsc{ev}) \multimap \uparrow_\sigma$$

This takes two predicates over events, and creates a single predicate that is true of an event if it contains action and result subevents. This is only an initial suggestion of how a worked out analysis might proceed, but I think it demonstrates that Bodomo’s work provides an excellent basis to start out from.

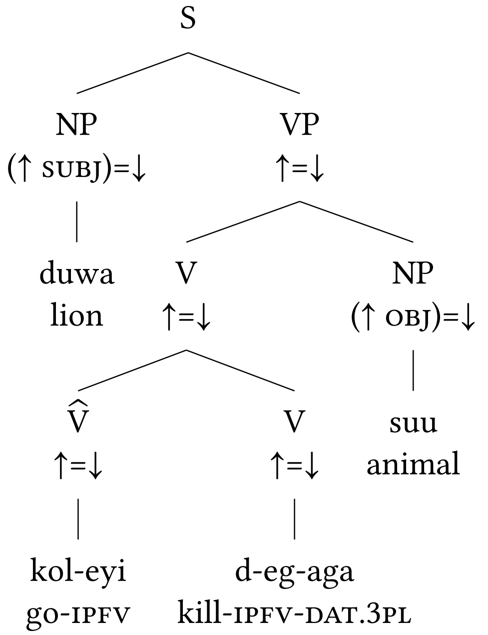
6.3 Barayin

Barayin SVCs are analysed in considerable detail by Lovestrand (2018), using a combination of a very carefully worked out major revision of the LFG version of X-bar theory from Bresnan et al. (2016), and a development of the ‘connected s-structure' (semantic structures) pioneered in Asudeh et al. (2014) and Findlay (2016). The latter allows serial verbs to make various contributions to meaning, sufficient for the range of these structures in Barayin, without needing to build apparent complement structures as appears to happen in Romance, and, to a lesser extent, Tariana.

The apparent syntactic form of the constructions is argued to be a 'nonprojecting word' (Toivonen 2001) left-adjoined to the V, a typical example being:

(50) Barayin

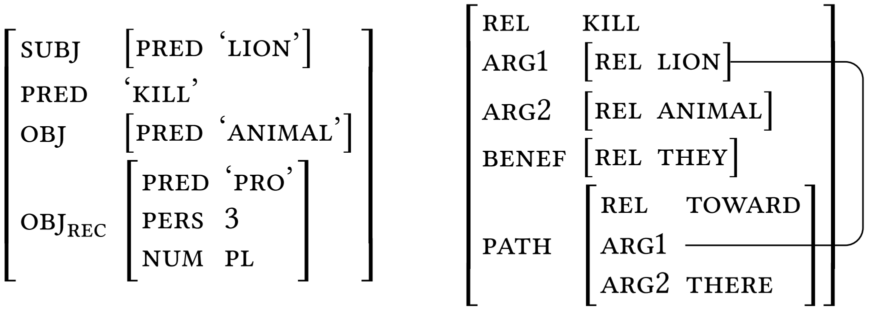
a.



b. duwa kol-eyi d-eg-aga suu
lion go-IPFV kill-IPFV-DAT.3PL animal
'The lion went and killed an animal for them.'

The f- and s-structures of this example would be (not explicitly provided by Lovestrand, but evident from other examples and the annotations for SV *kol-o* (Lovestrand 2018: 221):

(51)



In the semantics of the SV (first member of the SVC construction), there is also a not-fully-formalized provision that the motion along the path can either be simultaneous with or previous to the action of the main verb.

The potential problem of pred-clash is averted by the proposal that the SVs have no pred-feature, which is workable because there are only a limited number of SVs, producing the following kinds of constructions, each discussed by Lovestrand:

(52)
  a. Deictic (Associated Motion with deictic motion verbs such as *kol-o* 'go' as in the examples above).
  b. Manner (*gor-o* 'run' or another manner of motion verb).
  c. Stand (*juk-o* 'stand', incohative or indicating change in the narrative).
  d. Take (*pid-o* 'take', indicating the agent grasping the patient).

Even if the inventory of possible SVs turned out to be at least somewhat open, that fact that there does not appear to be any recursion in the construction means that the extra pred could be managed somehow, perhaps by a variant of the 'EP' proposal of Lovestrand (2020). A further unique and interesting feature of this analysis is that it has been fully implemented in the XLE system. The use of the connected s-structures has significant resemblances to both Butt's use of Jackendoff's Lexical-Conceptual Structures, and Bodomo's use of the unfinished Cell Theory. This is clearly a promising area for future work.

6.4 Misumalpan

The last case I will consider is some so-called serial verb constructions in the Misumalpan languages Miskitu and Sumu, presented as a kind of complex predicate in Andrews & Manning (1999). The constructions at issue have the form of consecutive clauses, expressing a chain of events, but they are interpreted in a range of ways similar to more standard SVC structures with no marking of the verbs (Salamanca 1988). This range of interpretations can be said to justify considering them as SVC constructions regardless of whether we consider their marking pattern to be in accord with (45) or not.

A fairly typical example is:

(53) Misumalpan (Hale 1991: 26, Andrews & Manning 1999: 93)
witin ai pruk-an kahw-ras
he me hit-obv.actual.3 fall-neg
'He hit me and I did not fall down.' (Consecutive Reading)
'He didn't knock me down.' (Causative SVC reading)

The suffix *-an* above is the 'obviative actual', obviative indicating that the subject of the clause whose verb has the marking is different from that of the next, 'actual' being a tense. In the consecutive reading, the clauses indicate different events that apply in sequence, and the negative affix applies to the second event. In the causative SVC reading, the first clause is the event that causes the second to happen, and the negative affix applies to the entire, complex event.

Andrews & Manning (1999) analyse these constructions as involving a rather unusual pattern of attribute sharing, while Andrews (2018a) argues that no unusual syntactic structures are required, and that the interpretations can be obtained by the use of glue semantics.

7 Conclusion

LFG analyses of complex predicates have been concerned primarily with the symmetrical sharing of attributes between different levels, and with the issues of combining the argument structures of multiple verbs into a single one that is associated with one set of grammatical relations. A remaining challenge is a theme that is more dominant in Minimalist analyses, which is the involvement of 'reduced projections', where some of the verbs do not appear to have all of the functional projections that an independent main verb would have (Grano 2015, Wurmbrand 2017). Negation, for example, is frequently impossible for the lower component of a complex predicate (as in Romance), but this is not the case in Urdu (Butt 1995: 49). There is clearly more to be done in this area, perhaps by an elaboration of functional projections in c-structure, of types in glue semantics, or a combination of both.

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Chapter 8

Coordination

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Coordination is a rich and complex topic. To avoid repeating what has been written in many excellent textbooks and reference guides, this chapter takes a non-standard approach. It starts by presenting the very basics of coordination in LFG, it provides pointers to agreement phenomena related to coordination, and then it proceeds to discuss selected less well-known coordination phenomena and their treatment in LFG, including: non-constituent coordination, coordination of unlike categories, coordination of unlike grammatical functions and coordination involving ellipsis.

1 Introduction

This section starts by introducing two key concepts of coordination in LFG: sets and hybrid objects. Next, it briefly introduces distributivity, a key concept of coordination, on the basis of feature resolution (for non-distributive attributes) and dependent sharing (for grammatical functions, which belong to distributive attributes). Finally, it presents single conjunct agreement as an alternative to resolved agreement (under feature resolution).

Over time, different conventions have been used in f-structures. To avoid potential confusion, the f-structures presented in this chapter have been normalized: as a result, while f-structures in this chapter consistently use the same conventions, they may look different than in original papers. Furthermore, to save space, some f-structures have been simplified by removing attributes which are not relevant in a given context (such as SPEC, for instance).

The following convention is used in c-structure rules in this chapter: if a category on the right-hand side has no annotation, it is assumed to have the (co-)head annotation (↓=↑).

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Except for (189), all examples used in this chapter are either English or Polish.

1.1 Coordination basics: sets and hybrid objects

A basic LFG coordination rule is given in (1), where XP is a variable over categories: every instance of XP in (1) must be replaced by the same category (for example NP).

(1) $$\begin{array}{lllll} \text{XP} & \longrightarrow & \text{XP} & \text{Conj} & \text{XP} \\ & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

While the rule in (1) can only join two conjuncts, its slightly modified version in (2) can join more than two conjuncts: XP^{+} corresponds to one or more occurrences of XP.[1] Furthermore, the rule in (2) includes an optional preconjunction (such as both in *both... and...* or either in *either... or...*):[2]

(2) $$\begin{array}{llllll} \text{XP} & \longrightarrow & \text{(PreConj)} & \text{XP}^{+} & \text{Conj} & \text{XP} \\ & & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

While there are various patterns of coordination (one conjunction, as many conjunctions as conjuncts, one fewer conjunction than the number of conjuncts, etc.), the basic annotations are the same: any (pre)conjunctions are co-heads (↓=↑, omitted above following the convention that lack of annotation is equivalent to having ↓=↑ annotation), while conjuncts are members of the set (↓∈↑) corresponding to the coordinate structure.

Let us consider structures created by these rules, using the simplified lexical entries below:

(3)			
	John	N	(↑ pred)=‘John’
	Mary	N	(↑ pred)=‘Mary’
	and	Conj	(↑ conj)=and
	both	PreConj	(↑ preconj)=both (↑ conj)$=_c$ and

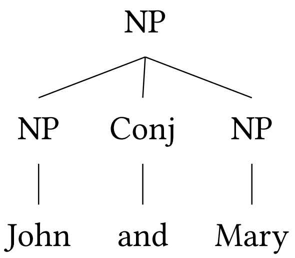
The structures in (4)–(5) can be generated by both rules in (1) and (2), while the structures with the preconjunction in (6)–(7) can only be generated by the rule in (2).

---

[1] Punctuation between non-final conjuncts is ignored in (2).

[2] While (2) overgenerates (*both... and...* can only be used with two conjuncts), some speakers can use *either... or...* with more than two conjuncts (e.g. *either X, Y or Z*).

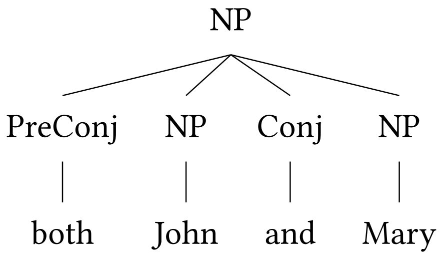
(4)



(5)

$$\left[\begin{array}{ll}\multicolumn{2}{l}{\left\{\left[\textsc{pred}\ \text{‘}\textsc{John}\text{’}\right], \left[\textsc{pred}\ \text{‘}\textsc{Mary}\text{’}\right]\right\}} \\ \textsc{conj} & \textsc{and}\end{array}\right]$$

(6)



(7)

$$\left[\begin{array}{ll}\multicolumn{2}{l}{\left\{\left[\textsc{pred}\ \text{‘}\textsc{John}\text{’}\right], \left[\textsc{pred}\ \text{‘}\textsc{Mary}\text{’}\right]\right\}} \\ \textsc{preconj} & \textsc{both} \\ \textsc{conj} & \textsc{and}\end{array}\right]$$

The f-structures representing coordination are hybrid objects. This is because they contain two types of objects: a set containing the individual conjuncts (sets are represented using curly brackets; set elements may be typeset horizontally or vertically) as well as attributes pertaining to the coordinate structure as a whole (these include the attributes CONJ and PRECONJ[3] representing the conjunction and the preconjunction, respectively).

1.2 Non-distributivity and feature resolution

As mentioned above, the lexical entries in (3) are simplified. The importance of hybrid objects is clearer when more features are represented in the f-structure, so let us extend the lexical entries in (8) by adding the NUM(ber) feature (while still ignoring other features):

(8) *John* N (↑ PRED)=‘JOHN’
(↑ NUM)=SG
Mary N (↑ PRED)=‘MARY’
(↑ NUM)=SG

---

[3] Some works use different attribute names, for instance COORD-FORM and PRECOORD-FORM.

As shown in (9),[4] even though both conjuncts are singular, the coordinate subject as a whole is plural – as a consequence, the verb requires plural agreement:

(9) [[John] and [Mary]] sing/*sings.

(10) *sing* V $(\uparrow \textsc{pred})=\text{‘}\textsc{sing}\langle(\uparrow \textsc{subj})\rangle\text{’}$
$(\uparrow \textsc{subj num}) =_c \textsc{pl}$
sings V $(\uparrow \textsc{pred})=\text{‘}\textsc{sing}\langle(\uparrow \textsc{subj})\rangle\text{’}$
$(\uparrow \textsc{subj num}) =_c \textsc{sg}$

(11) shows how this is reflected in the f-structure: while individual conjuncts are singular (their value of NUM is SG), the entire coordination is plural (its NUM is PL):

(11)
$$\left[\begin{array}{l} \left\{ \begin{bmatrix} \textsc{pred} & \text{‘John’} \\ \textsc{num} & \textsc{sg} \end{bmatrix}, \begin{bmatrix} \textsc{pred} & \text{‘Mary’} \\ \textsc{num} & \textsc{sg} \end{bmatrix} \right\} \\ \textsc{num} \quad \textsc{pl} \\ \textsc{conj} \quad \textsc{and} \end{array}\right]$$

To obtain such a representation, the equation (↑ NUM)=PL must be placed somewhere in the grammar. While normally it would be part of more complex feature resolution rules for number,[5] it is put below in the simplified rule handling NP coordination, see (12).

(12)
$$\begin{array}{llllll} \text{NP} & \longrightarrow & \text{(PreConj)} & \text{NP}^{+} & \text{Conj} & \text{NP} \\ & & & \downarrow\in\uparrow & \downarrow=\uparrow & \downarrow\in\uparrow \\ & & & & (\uparrow \textsc{num})=\textsc{pl} & \end{array}$$

The prerequisite for this equation to work as desired is that the NUM attribute must be non-distributive. This means that such an equation does not distribute to individual conjuncts (which would clash with (↑ NUM)=SG in their lexical entries), but instead it applies to the topmost f-structure corresponding to the entire coordinate phrase, see (11).

Apart from NUM(ber), some typical non-distributive attributes (or features) include GEND(er) and PERS(on). As mentioned above for NUM(ber), such non-distributive attributes are subject to feature resolution: rules specifying which value of these attributes is appropriate for the entire coordinate phrase, given the values of these attributes of particular conjuncts. Feature resolution rules are different for various attributes and may differ across languages. See Haug 2023 [this volume] for more discussion and references.

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[4] Square brackets in examples indicate the boundaries of coordination and individual conjuncts.

[5] Such rules should consider the type of the conjunction (*and* vs. *or*). Even with *and*, it is not always the case that the number should be plural: *my doctor and best friend* can refer to one or two individuals.

1.3 Distributivity and dependent sharing

The rules in (1)–(2) can also be used to join categories other than NPs. For instance, (13) involves coordination of two sentences, while (14) involves two instances of coordination, at two different levels: NP coordination (*John and Mary*) described above (with the more specialised rule in (12)), and coordination of verbal phrases (*sing and walk*).

(13) [[John sings] and [Mary walks]].

(14) [[John] and [Mary]] [[sing] and [walk]].

In (14) the coordinated nominal subject (*John and Mary*, see its partial f-structure in (11)) is a shared dependent of the coordinated verbal phrases (*sing and walk*, see (15)).

(15)
$$\left[\begin{array}{l}\left\{\left[\textsc{pred}\ \text{`}\textsc{sing}\langle\textsc{subj}\rangle\text{'}\right],\left[\textsc{pred}\ \text{`}\textsc{walk}\langle\textsc{subj}\rangle\text{'}\right]\right\}\\ \textsc{conj}\ \ \textsc{and}\end{array}\right]$$

Since grammatical functions are distributive, no special rules are required to handle examples with a shared dependent such as (14). The equation ($\uparrow$ subj)=$\downarrow$ assigning the subj grammatical function to the NP in (16) distributes to each element of the set corresponding to the VP.[6] As a result, (11) becomes the subject of both conjuncts in (15), yielding (17) which involves structure sharing, indicated using boxed indices ($\boxed{1}$).

(16)
$$\begin{array}{llcc}\text{S} & \longrightarrow & \text{NP} & \text{VP}\\ & & (\uparrow \textsc{subj}){=}\downarrow & \end{array}$$

(17)
$$\left[\begin{array}{l}\left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{sing}\langle\boxed{1}\rangle\text{'}\\ \textsc{subj}\ \boxed{1} & \left[\begin{array}{l}\left\{\left[\begin{array}{ll}\textsc{pred}&\text{`John'}\\ \textsc{num}&\textsc{sg}\end{array}\right],\left[\begin{array}{ll}\textsc{pred}&\text{`Mary'}\\ \textsc{num}&\textsc{sg}\end{array}\right]\right\}\\ \textsc{num}\ \ \textsc{pl}\\ \textsc{conj}\ \ \textsc{and}\end{array}\right]\end{array}\right],\left[\begin{array}{ll}\textsc{pred}&\text{`}\textsc{walk}\langle\boxed{1}\rangle\text{'}\\ \textsc{subj}&\boxed{1}\end{array}\right]\right\}\\ \textsc{conj}\ \ \textsc{and}\end{array}\right]$$

---

[6] Most recent analyses would use IP instead of S and I′ instead of VP. However, since these distinctions are not the main focus of this chapter, the rules and c-structures from the literature are not normalised.

1.4 Single conjunct agreement

Single conjunct agreement (SCA) is an alternative agreement strategy available under coordination in some languages. Instead of agreeing with the entire coordinate phrase under feature resolution, under SCA the agreement target (for example: the verb) agrees with one of the conjuncts of its agreement controller (for verbs, typically the subject), usually the closest conjunct – this is known as closest conjunct agreement (CCA). Though furthest conjunct agreement (FCA) is also attested, it is rather rare (compared to CCA).

(18) is a Polish example showing resolved agreement (*szli* 'walked' is plural masculine) as opposed to agreement with the closest conjunct (*szła* 'walked' is singular and feminine):

(18) Polish
Szli/szła [[Marysia] i [Janek]].
walked.3.pl.m1/3.sg.f Marysia.sg.f and Janek.sg.m1
'Janek and Marysia walked.'

See Haug 2023 [this volume] for more discussion of SCA and references.

2 Non-constitutent coordination

When discussing coordination, typically what is discussed is coordination of constituents (typically of the same category and corresponding to the same grammatical function). Kaplan & Maxwell (1988) is the first published LFG analysis of such coordination.

Maxwell & Manning (1996) is a seminal LFG work discussing non-constituent coordination (NCC) where conjuncts do not correspond to constituents. Instead, each conjunct corresponds to a sequence of constituents (or possibly their parts), with no strict requirement of parallelism between conjuncts. Maxwell & Manning (1996: 1) provide the following "grab-bag of other cases of coordination commonly negatively classified as non-constituent coordination" which are outside of the scope of Kaplan & Maxwell (1988), labelling (19) as "conjunction reduction" (CR), (20) as "Right-Node Raising" (RNR), (21) as "Gapping", (22) as "Ellipsis" and (23) as "non-symmetric coordination":

(19) Bill gave [[the girls spades] and [the boys recorders]].
(Maxwell & Manning 1996: (2a))

(20) [[Bill likes], and [Joe is thought to like]] cigars from Cuba.
(Maxwell & Manning 1996: (2b))

(21) [[Bill gave a rhino to Fred], and [Sue a camera to Marjorie]]. (Maxwell & Manning 1996: (2c))

(22) [[Bill likes big cars], and [Sally does too]]. (Maxwell & Manning 1996: (2d))

(23) Bill [[went] and [took the test]]. (Maxwell & Manning 1996: (2e))

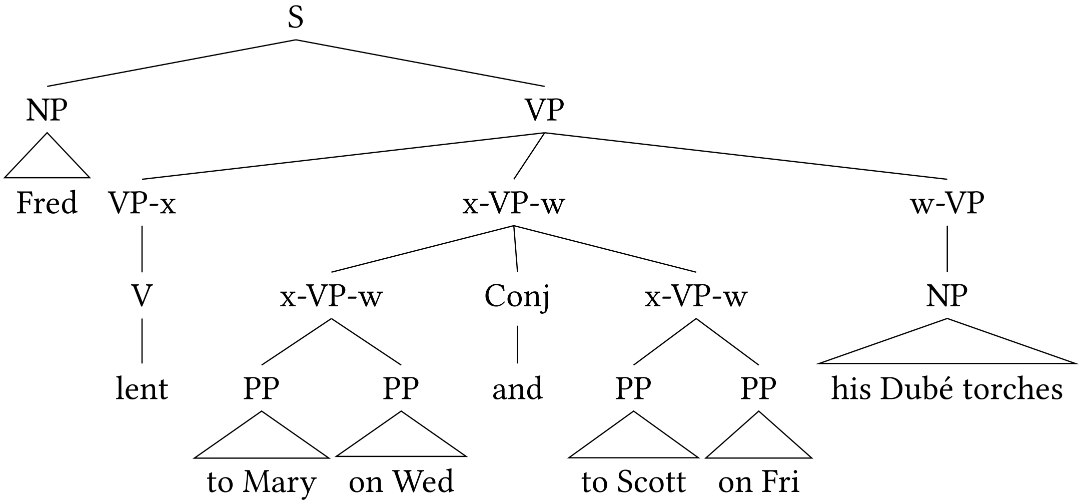
In order to account for instances of CR and RNR, Maxwell & Manning (1996: 3) propose to extend the analysis of coordination by allowing "the coordination of partial expansions of c-structure rules", namely partial expansions of VP rules (such as (26) discussed below), pointing out that this solution makes it possible to "maintain the simple and classic rule for coordination that only identical things are allowed to coordinate".[7]

2.1 Basics of the Maxwell & Manning (1996) analysis

Let us consider (24), where the NCC (*to Mary on Wednesday and to Scott on Friday*)[8] is surrounded by shared material: the subject (*Fred*) and the main verb (*lent*) on the left and the object on the right (*his Dubé torches*). (25) is the tree corresponding to (24).

(24) Fred lent [[to Mary on Wednesday] and [to Scott on Friday]] his Dubé torches.

(25)



(Maxwell & Manning 1996: (15))

---

[7] It can also be used to reanalyse unlike category coordination as same category coordination, see Section 3.1.

[8] *Wednesday* and *Friday* are abbreviated in trees and f-structures to *Wed* and *Fri*, respectively.

The following modified rules can be read off the tree in (25):[9]

(26) VP ⟶ VP-x x-VP-w w-VP

(27) VP-x ⟶ V

(28) x-VP-w ⟶ x-VP-w Conj x-VP-w

(29) x-VP-w ⟶ PP PP

(30) w-VP ⟶ NP

However, the rules above are not complete because f-descriptions are missing. While the rule in (31) could normally be used, in order to handle the NCC in (24), the rules in (28)–(30) must be annotated with f-descriptions as shown in (32)–(34):

(31)
$$\begin{array}{cccccc} \text{VP} & \longrightarrow & \text{V} & \text{PP} & \text{PP}^* & \text{NP} \\ & & & (\uparrow \textsc{obl}){=}\downarrow & \downarrow{\in}(\uparrow \textsc{adj}) & (\uparrow \textsc{obj}){=}\downarrow \end{array}$$

(32)
$$\begin{array}{ccccc} \text{x-VP-w} & \longrightarrow & \text{x-VP-w} & \text{Conj} & \text{x-VP-w} \\ & & \downarrow{\in}\uparrow & & \downarrow{\in}\uparrow \end{array}$$

(33)
$$\begin{array}{cccc} \text{x-VP-w} & \longrightarrow & \text{PP} & \text{PP} \\ & & (\uparrow \textsc{obl}){=}\downarrow & \downarrow{\in}(\uparrow \textsc{adj}) \end{array}$$

(34)
$$\begin{array}{ccc} \text{w-VP} & \longrightarrow & \text{NP} \\ & & (\uparrow \textsc{obj}){=}\downarrow \end{array}$$

There is an important difference between “standard” rules such as (31) and modified rules aimed at handling NCC. While in (31) subsequent dependents have appropriate grammatical function annotations ((↑ OBL)=↓ for the oblique PP, ↓∈(↑ ADJ) for the modifier PP and (↑ OBJ)=↓ for the NP object), the corresponding NCC partial categories in (26), x-VP-w and w-VP, have no annotation, which is interpreted by default as the co-head annotation (↓=↑). As a consequence, the annotations assigning appropriate grammatical functions are instead equivalently placed in (33) (for x-VP-w which rewrites to an oblique PP followed by a modifier PP) and in (34) (for w-VP which rewrites to an NP object). Thanks to the different placement of f-descriptions,[10] such modified rules can account for NCC, unlike the “standard” VP rule in (31).

---

[9] While Maxwell & Manning (1996) use “and” in their rules, it was replaced with “Conj” for consistency.

[10] Moving f-descriptions in this way is crucial in some analyses of other phenomena, including coordination of different grammatical functions (Section 4) and gapping (Section 5.3).

To better understand the analysis of Maxwell & Manning (1996), let us consider its procedural intuition by inspecting partial f-structures created by these rules.

Each conjunct of NCC builds its partial f-structure using the rule in (33): (35) corresponds to the first conjunct (*to Mary on Wednesday*), (36) to the second (*to Scott on Friday*).

(35)
$$\left[\begin{array}{ll} \textsc{obl} & \left[\textsc{pred}\ \text{`}\textsc{Mary}\text{'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{4}\rangle\text{'} \\ \textsc{obj} & \boxed{4}\left[\textsc{pred}\ \text{`}\textsc{Wed}\text{'}\right]\end{array}\right]\right\}\end{array}\right]$$

(36)
$$\left[\begin{array}{ll} \textsc{obl} & \left[\textsc{pred}\ \text{`}\textsc{Scott}\text{'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{6}\rangle\text{'} \\ \textsc{obj} & \boxed{6}\left[\textsc{pred}\ \text{`}\textsc{Fri}\text{'}\right]\end{array}\right]\right\}\end{array}\right]$$

Next, (35) and (36) are added as set elements using the coordination rule in (32).[11]

(37)
$$\left[\begin{array}{l} \left\{\left[\begin{array}{ll} \textsc{obl} & \left[\textsc{pred}\ \text{`}\textsc{Mary}\text{'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{4}\rangle\text{'} \\ \textsc{obj} & \boxed{4}\left[\textsc{pred}\ \text{`}\textsc{Wed}\text{'}\right]\end{array}\right]\right\}\end{array}\right], \left[\begin{array}{ll} \textsc{obl} & \left[\textsc{pred}\ \text{`}\textsc{Scott}\text{'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{6}\rangle\text{'} \\ \textsc{obj} & \boxed{6}\left[\textsc{pred}\ \text{`}\textsc{Fri}\text{'}\right]\end{array}\right]\right\}\end{array}\right]\right\} \\ \textsc{conj}\quad \textsc{and} \end{array}\right]$$

Next, the VP rule in (26) unifies the partial f-structures of 3 co-heads: (38) corresponds to VP-x; (37) is the set corresponding to NCC in x-VP-w; (39) is created by the w-VP rule in (34). As mentioned in Section 1.3 when discussing (14), grammatical functions are distributive; so is PRED. Note that being a distributive feature is consistent with being an instantiated feature: when PRED is distributed, it is uniquely instantiated in each conjunct.[12] As a result, (38) and (39) distribute over (37), yielding the f-structure in (40).

(38)
$$\left[\textsc{pred}\ \text{`}\textsc{lend}\langle\textsc{subj},\textsc{obj},\textsc{obl}\rangle\text{'}\right]$$

(39)
$$\left[\textsc{obj}\ \left[\textsc{pred}\ \text{`}\textsc{Dubé torches}\text{'}\right]\right]$$

(40)
$$\left[\begin{array}{l} \left\{\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{2},\boxed{3}\rangle\text{'} \\ \textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`}\textsc{Dubé torches}\text{'}\right] \\ \textsc{obl} & \boxed{3}\left[\textsc{pred}\ \text{`}\textsc{Mary}\text{'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{4}\rangle\text{'} \\ \textsc{obj} & \boxed{4}\left[\textsc{pred}\ \text{`}\textsc{Wed}\text{'}\right]\end{array}\right]\right\}\end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{2},\boxed{5}\rangle\text{'} \\ \textsc{obj} & \boxed{2} \\ \textsc{obl} & \boxed{5}\left[\textsc{pred}\ \text{`}\textsc{Scott}\text{'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{6}\rangle\text{'} \\ \textsc{obj} & \boxed{6}\left[\textsc{pred}\ \text{`}\textsc{Fri}\text{'}\right]\end{array}\right]\right\}\end{array}\right]\right\} \\ \textsc{conj}\quad \textsc{and} \end{array}\right]$$

---

[11] Coordination of partial expansions such as in (32) is handled by the general coordination rule in (1).

[12] This makes it possible to account for multiclausal coordination phenomena such as NCC, coordination of different grammatical functions (Section 4.4), SGF (Section 5.1) and gapping (Section 5.3).

One element is missing in (40): the shared subject (*Fred*), see the tree in (25). Assuming a rule for S such as in (16), the annotation (↑ SUBJ)=↓ distributes the NP subject over the partial f-structure in (40), yielding the complete f-structure in (41).

(41)
$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{lend}\langle\boxed{1},\boxed{2},\boxed{3}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\left[\textsc{pred}\ \text{`Fred'}\right] \\ \textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`Dubé torches'}\right] \\ \textsc{obl} & \boxed{3}\left[\textsc{pred}\ \text{`Mary'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{on}\langle\boxed{4}\rangle\text{'} \\ \textsc{obj} & \boxed{4}\left[\textsc{pred}\ \text{`Wed'}\right] \end{array}\right]\right\} \end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{lend}\langle\boxed{1},\boxed{2},\boxed{5}\rangle\text{'} \\ \textsc{subj} & \boxed{1} \\ \textsc{obj} & \boxed{2} \\ \textsc{obl} & \boxed{5}\left[\textsc{pred}\ \text{`Scott'}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{on}\langle\boxed{6}\rangle\text{'} \\ \textsc{obj} & \boxed{6}\left[\textsc{pred}\ \text{`Fri'}\right] \end{array}\right]\right\} \end{array}\right] \right\} \\ \textsc{conj}\quad \textsc{and} \end{array}\right]$$

An important thing to note about the Maxwell & Manning (1996) analysis of NCC is that it creates multiclausal structures.[13] This means that it is equivalent to a coordination of two VPs, with two instances of a given verb – it is clear in (41), where the set corresponding to coordination contains two clauses with different instantiations of LEND as the main verb.

2.2 Interaction with verbal coordination

(42) demonstrates an interesting issue arising when NCC (*to Mary on Wednesday and to Sue on Friday*) co-occurs with verbal coordination, which is also represented as a set:

(42) John [[gave a book] or [lent a record]] [[to Mary on Wednesday] and [to Sue on Friday]]. (Maxwell & Manning 1996: (43))

Strictly speaking, (42) is more complex than necessary to show the issue at hand:[14] *[[gave a book] or [lent a record]]* is another instance of NCC, which means that more complex c-structure rules are needed to handle this example. (43) is the "standard" VP rule which is split into partial VP rules in (44)–(48) in order to handle NCC in (42).

(43)
$$\begin{array}{llllll} \text{VP} & \longrightarrow & \text{V} & \text{NP} & \text{PP} & \text{PP*} \\ & & & (\uparrow \textsc{obj}){=}\downarrow & (\uparrow \textsc{obl}){=}\downarrow & \downarrow{\in}(\uparrow \textsc{adj}) \end{array}$$

---

[13] Multiclausal structures also arise under gapping (Section 5.3), in some instances of coordination of different grammatical functions (Section 4.4) and when unlike category coordination is reanalysed as NCC (Section 3.1).

[14] The same issue arises in a modified version of (24) with simple coordination of verbs (*gave or lent*):

(i) Fred [[gave] or [lent]] [[to Mary on Wednesday] and [to Scott on Friday]] his Dubé torches.

(44) $\text{VP} \longrightarrow \text{VP-x} \quad \text{x-VP}$

(45) $$\text{VP-x} \longrightarrow \underset{\downarrow\in\uparrow}{\text{VP-x}} \quad \text{Conj} \quad \underset{\downarrow\in\uparrow}{\text{VP-x}}$$

(46) $$\text{VP-x} \longrightarrow \text{V} \quad \underset{(\uparrow \textsc{obj})=\downarrow}{\text{NP}}$$

(47) $$\text{x-VP} \longrightarrow \underset{\downarrow\in\uparrow}{\text{x-VP}} \quad \text{Conj} \quad \underset{\downarrow\in\uparrow}{\text{x-VP}}$$

(48) $$\text{x-VP} \longrightarrow \underset{(\uparrow \textsc{obl})=\downarrow}{\text{PP}} \quad \underset{\downarrow\in(\uparrow \textsc{adj})}{\text{PP}^*}$$

The procedural intuition of the analysis of (42) involves unifying two partial f-structures in the VP rule in (44), both of which happen to be sets: (49) corresponds to VP-x (*gave a book or lent a record*) built using the rules in (45)–(46), while (50) corresponds to x-VP (*to Mary on Wednesday and to Sue on Friday*) built using (47)–(48).

(49) $$\left[\begin{array}{l} \left\{ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{give}\langle\textsc{subj},\boxed{2},\textsc{obl}\rangle\text{’} \\ \textsc{obj} & \boxed{2}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{book}\text{’}\end{bmatrix} \end{bmatrix}, \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{lend}\langle\textsc{subj},\boxed{3},\textsc{obl}\rangle\text{’} \\ \textsc{obj} & \boxed{3}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{record}\text{’}\end{bmatrix} \end{bmatrix} \right\} \\ \textsc{conj} \quad \textsc{or} \end{array}\right]$$

(50) $$\left[\begin{array}{l} \left\{ \begin{bmatrix} \textsc{obl} & \begin{bmatrix}\textsc{pred} & \text{‘Mary’}\end{bmatrix} \\ \textsc{adj} & \left\{ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{on}\langle\boxed{4}\rangle\text{’} \\ \textsc{obj} & \boxed{4}\begin{bmatrix}\textsc{pred} & \text{‘Wed’}\end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}, \begin{bmatrix} \textsc{obl} & \begin{bmatrix}\textsc{pred} & \text{‘Sue’}\end{bmatrix} \\ \textsc{adj} & \left\{ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{on}\langle\boxed{5}\rangle\text{’} \\ \textsc{obj} & \boxed{5}\begin{bmatrix}\textsc{pred} & \text{‘Fri’}\end{bmatrix} \end{bmatrix} \right\} \end{bmatrix} \right\} \\ \textsc{conj} \quad \textsc{and} \end{array}\right]$$

As discussed in Section 2.1, when a set is unified with a non-set f-structure, the non-set f-structure is distributed over the set. Maxwell & Manning (1996) discuss the issue of unifying two sets[15] on the basis of example (42), where the first set contains elements labelled as f_1 (*gave a book*) and f_2 (*lent a record*), see the f-structure in (49), while the second set contains f_3 (*to Mary on Wednesday*) and f_4 (*to Sue on Friday*), see (50).

Maxwell & Manning (1996) point out that a possible but undesired result of unifying (49) and (50) is set union, yielding an f-structure containing a set with 4 elements. This is schematically shown in (51), while the corresponding partial f-structure is given in (52).

(51) $\uparrow\{f_1,f_2,f_3,f_4\}$

---

[15] The issue of unifying two sets also surfaces in other coordination phenomena, including multi-clausal coordination of different grammatical functions (Section 4.4) and gapping (Section 5.3).

(52)
$$\left[\begin{array}{l}\left\{\begin{array}{l}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{give}\langle\textsc{subj},\boxed{2},\textsc{obl}\rangle\text{'}\\ \textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`}\textsc{book}\text{'}\right]\end{array}\right], \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{3},\textsc{obl}\rangle\text{'}\\ \textsc{obj} & \boxed{3}\left[\textsc{pred}\ \text{`}\textsc{record}\text{'}\right]\end{array}\right],\\ \left[\begin{array}{ll}\textsc{obl} & \left[\textsc{pred}\ \text{`Mary'}\right]\\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{4}\rangle\text{'}\\ \textsc{obj} & \boxed{4}\left[\textsc{pred}\ \text{`Wed'}\right]\end{array}\right]\right\}\end{array}\right], \left[\begin{array}{ll}\textsc{obl} & \left[\textsc{pred}\ \text{`Sue'}\right]\\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{5}\rangle\text{'}\\ \textsc{obj} & \boxed{5}\left[\textsc{pred}\ \text{`Fri'}\right]\end{array}\right]\right\}\end{array}\right]\end{array}\right\}\\ \textsc{conj}\quad \textsc{or}\neq\textsc{and}\end{array}\right]$$

(52) is ill-formed for three reasons.[16] First, it is incomplete: f_1 and f_2 have a missing OBL(ique) argument. Secondly, it is incoherent: f_3 and f_4 have no PRED subcategorising for their OBL arguments. Finally, it is inconsistent due to conflicting values of the CONJ attribute: f_1 and f_2 are conjoined with *or* (($\uparrow$ CONJ)=OR), while f_3 and f_4 are conjoined with *and* (($\uparrow$ CONJ)=AND). Unifying these f-descriptions results in a clash ($\neq$), see (52).

Maxwell & Manning (1996) explain that the desired result is to distribute one set over the other, which yields a set containing 2 elements, each of which also contains 2 elements. There are two ways in which this can be done.

The result of distributing the first set (containing f_1, f_2) over the second (containing f_3, f_4) is schematically shown in (53). This yields the partial f-structure in (54), where the top-level conjunction is AND (it joins f_3 and f_4), while the conjunction in embedded sets is OR (it joins f_1 and f_2). The sentence in (55) provides a natural language intuition of the f-structure in (54) (with the subject added in brackets, since its contribution is not present in (54)).

(53) $\uparrow\{f_3\{f_1',f_2'\},f_4\{f_1'',f_2''\}\}$

(54)
$$\left[\begin{array}{l}\left\{\begin{array}{l}\left[\begin{array}{l}\left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{give}\langle\textsc{subj},\boxed{2},\boxed{3}\rangle\text{'}\\ \textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`}\textsc{book}\text{'}\right]\\ \textsc{obl} & \boxed{3}\left[\textsc{pred}\ \text{`Mary'}\right]\\ \textsc{adj} & \left\{\boxed{4}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{5}\rangle\text{'}\\ \textsc{obj} & \boxed{5}\left[\textsc{pred}\ \text{`Wed'}\right]\end{array}\right]\right\}\end{array}\right], \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{9},\boxed{3}\rangle\text{'}\\ \textsc{obj} & \boxed{9}\left[\textsc{pred}\ \text{`}\textsc{record}\text{'}\right]\\ \textsc{obl} & \boxed{3}\\ \textsc{adj} & \left\{\boxed{4}\right\}\end{array}\right]\right\}\\ \textsc{conj}\quad\textsc{or}\end{array}\right],\\ \left[\begin{array}{l}\left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{give}\langle\textsc{subj},\boxed{2},\boxed{6}\rangle\text{'}\\ \textsc{obj} & \boxed{2}\\ \textsc{obl} & \boxed{6}\left[\textsc{pred}\ \text{`Sue'}\right]\\ \textsc{adj} & \left\{\boxed{7}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{8}\rangle\text{'}\\ \textsc{obj} & \boxed{8}\left[\textsc{pred}\ \text{`Fri'}\right]\end{array}\right]\right\}\end{array}\right], \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{9},\boxed{6}\rangle\text{'}\\ \textsc{obj} & \boxed{9}\\ \textsc{obl} & \boxed{6}\\ \textsc{adj} & \left\{\boxed{7}\right\}\end{array}\right]\right\}\\ \textsc{conj}\quad\textsc{or}\end{array}\right]\end{array}\right\}\\ \textsc{conj}\quad\textsc{and}\end{array}\right]$$

---

[16] These problems persist after the f-structure of the subject (*John*) is distributed over all set elements.

(55) (John) [[gave a book or lent a record] to Mary on Wednesday] and [[gave a book or lent a record] to Sue on Friday].

By contrast, (56) schematically shows the opposite situation, where the second set (containing f_3, f_4) is distributed over the first set (containing f_1, f_2). This yields the partial f-structure in (57), where the top-level conjunction is OR (it joins f_1 and f_2), while the conjunction in embedded sets is AND (it joins f_3 and f_4). (58) provides the natural language intuition of (57).

(56) $\uparrow\{f_1\{f_3',f_4'\},f_2\{f_3'',f_4''\}\}$

(57)
$$\left[\begin{array}{l}
\left\{\begin{array}{l}
\left[\begin{array}{l}
\left\{
\left[\begin{array}{ll}
\textsc{pred} & \text{`}\textsc{give}\langle\textsc{subj},\boxed{2},\boxed{3}\rangle\text{'}\\
\textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`}\textsc{book}\text{'}\right]\\
\textsc{obl} & \boxed{3}\left[\textsc{pred}\ \text{`}\textsc{Mary}\text{'}\right]\\
\textsc{adj} & \left\{\boxed{4}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{5}\rangle\text{'}\\ \textsc{obj} & \boxed{5}\left[\textsc{pred}\ \text{`}\textsc{Wed}\text{'}\right]\end{array}\right]\right\}
\end{array}\right],
\left[\begin{array}{ll}
\textsc{pred} & \text{`}\textsc{give}\langle\textsc{subj},\boxed{2},\boxed{6}\rangle\text{'}\\
\textsc{obj} & \boxed{2}\\
\textsc{obl} & \boxed{6}\left[\textsc{pred}\ \text{`}\textsc{Sue}\text{'}\right]\\
\textsc{adj} & \left\{\boxed{7}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{on}\langle\boxed{8}\rangle\text{'}\\ \textsc{obj} & \boxed{8}\left[\textsc{pred}\ \text{`}\textsc{Fri}\text{'}\right]\end{array}\right]\right\}
\end{array}\right]
\right\}\\
\textsc{conj}\ \ \textsc{and}
\end{array}\right],\\
\left[\begin{array}{l}
\left\{
\left[\begin{array}{ll}
\textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{9},\boxed{3}\rangle\text{'}\\
\textsc{obj} & \boxed{9}\left[\textsc{pred}\ \text{`}\textsc{record}\text{'}\right]\\
\textsc{obl} & \boxed{3}\\
\textsc{adj} & \left\{\boxed{4}\right\}
\end{array}\right],
\left[\begin{array}{ll}
\textsc{pred} & \text{`}\textsc{lend}\langle\textsc{subj},\boxed{9},\boxed{6}\rangle\text{'}\\
\textsc{obj} & \boxed{9}\\
\textsc{obl} & \boxed{6}\\
\textsc{adj} & \left\{\boxed{7}\right\}
\end{array}\right]
\right\}\\
\textsc{conj}\ \ \textsc{and}
\end{array}\right]
\end{array}\right\}\\
\textsc{conj}\ \ \textsc{or}
\end{array}\right]$$

(58) (John) [gave a book [to Mary on Wednesday and to Sue on Friday]] or [lent a record [to Mary on Wednesday and to Sue on Friday]].

As shown above, due to the fact that there are two ways of distributing one set over the other, (42) has two possible interpretations, depending on whether the scope of disjunction is narrow ((53)–(54)) or wide ((56)–(57)). While this may not be immediately obvious, there is a significant difference in truth conditions between these two interpretations.

In (54) where disjunction has narrow scope, each woman (Mary, Sue) is given a book or lent a record, while in (57) where disjunction has wide scope, both women (Mary and Sue) are given a book or lent a record. This is why (57) could be referred to as the symmetric reading – if Mary is given a book, Sue is also given a book (and vice versa); the same applies to being lent a record. By contrast, (54) does not require such symmetry: this reading is true when Mary (but not Sue) is given a book and Sue (but not Mary) is lent a record (or the other way round). While (54) is true in all situations when (57) is true, the opposite does not hold: there are scenarios when (54) is true but (57) is not.

While the grammar produces both solutions discussed above for (42), there are different views on which of these is more natural. As reported in Maxwell & Manning (1996: 13): “Blevins (1994) argues that the wide scope reading for the disjunction is the most natural interpretation, but we tend to think the opposite”.

3 Coordination of unlike categories

While it has been claimed that coordination can only join identical categories (Chomsky (1957: 36), Williams (1981); more recently Bruening & Al Khalaf (2020)), many works have challenged such claims, showing that there is no such requirement (Peterson (1981), Sag et al. (1985), Bayer (1996); more recently Patejuk & Przepiórkowski (2023)).

When discussing unlike category coordination, the following examples are often used:

(59) Pat is [[a Republican] and [proud of it]]. (Sag et al. 1985: 117, (2b))

(60) Pat is [either [stupid] or [a liar]]. (Sag et al. 1985: 117, (2a))

(61) Pat has become [[a banker] and [very conservative]]. (Sag et al. 1985: 118, (3a))

(62) I consider John [[stupid] and [a fool]]. (Peterson 1981: (35))

(63) I consider that [[a rude remark] and [in very bad taste]]. (Sag et al. 1985: 118, (3b))

(64) We walked [[slowly] and [with great care]]. (Sag et al. 1985: 140, (57))

Except (64), which is an example of coordination of modifiers, all examples above involve predicative complements. Modifiers and predicative complements are the two most popular example types discussed in the literature on unlike category coordination.

There are also examples where unlike category coordination corresponds to a non-predicative argument. As discussed in Patejuk & Przepiórkowski (2023) on the basis of examples below, some predicates require an argument defined in terms of semantics rather than syntactic categories: expressing location (RESIDE), manner (TREAT), duration (LAST) etc. Such phrases may also act as modifiers: (64) is an example of a manner modifier.

(65) [[That place] and [behind these shops]] are where many families reside.

(66) Do you treat the four museums [[individually] or [as a collective]]?

(67) Immunity may last [[10 years] or [longer]]

There are also non-predicative arguments which are not defined semantically. (68) is a famous example often used in the context of unlike category coordination.

(68) You can depend on [[my assistant] and [that he will be on time]]. (Sag et al. 1985: 165, (124b))

However, (68) is controversial/problematic because it involves a subcategorisation violation. While the conjunct closer to the head obeys its subcategorisation requirements, (69), the other conjunct does not, see (70) – neither as a complement of the preposition ON, nor as a direct complement of the verb:

(69) You can depend on my assistant.

(70) *You can depend (on) that he will be on time.

Normally each conjunct is expected to satisfy the subcategorisation requirements of the verb it depends on – this is the case in two other famous examples from Sag et al. (1985):

(71) Pat remembered [[the appointment] and [that it was important to be on time]]. (Sag et al. 1985: 165, (123a))

(72) [[That Himmler appointed Heydrich] and [the implications thereof]] frightened many observers. (Sag et al. 1985: 165, (123b))

The rest of this section focuses on examples which satisfy this constraint, so it will not cover subcategorisation violations such as (68).

3.1 Unlike category coordination or ellipsis

One way to approach the phenomenon of unlike category coordination is to assume that ellipsis is involved, so that what is coordinated are not unlike categories, but larger categories of the same type: for instance two (or more) categories such as S, CP or VP – with ellipsis of the verb in one of the conjuncts (typically the second).

Maxwell & Manning (1996: 3) point out that the solution they propose for non-constituent coordination (NCC, discussed in Section 2) could be used to avoid unlike category coordination in examples such as *John is a republican and proud of it* by "coordinating partial VPs rather than attempting to coordinate an NP and an AP", see the structures in (73)–(74).[17]

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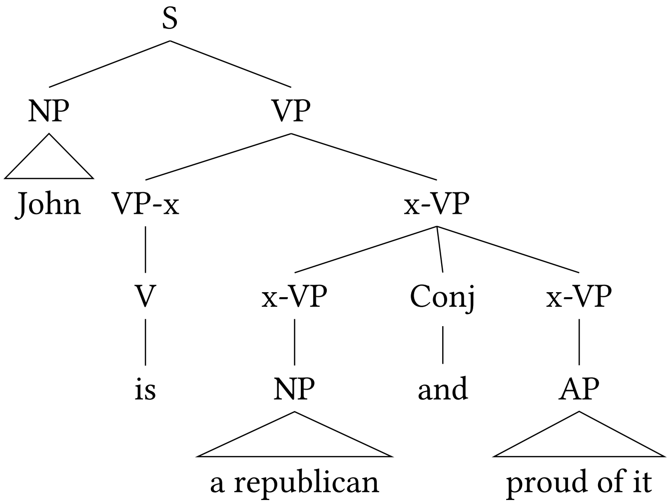
[17] The contribution of *of it* is consistently omitted in the following f-structures.

(73)



(Maxwell & Manning 1996: (14))

(74)

$$\left[\begin{array}{l}\left\{\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{be}\langle\boxed{2}\rangle\boxed{1}\text{’}\\ \textsc{subj}\ \boxed{1} & \left[\textsc{pred}\ \text{‘}\textsc{John}\text{’}\right]\\ \textsc{xcomp}\ \boxed{2} & \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{republican}\langle\boxed{1}\rangle\text{’}\\ \textsc{subj} & \boxed{1}\end{array}\right]\end{array}\right], \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{be}\langle\boxed{3}\rangle\boxed{1}\text{’}\\ \textsc{subj} & \boxed{1}\\ \textsc{xcomp}\ \boxed{3} & \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{proud}\langle\boxed{1}\rangle\text{’}\\ \textsc{subj} & \boxed{1}\end{array}\right]\end{array}\right]\right\}\\ \textsc{conj}\quad \textsc{and}\end{array}\right]$$

As explained in Section 2, such an analysis produces multiclausal f-structures, as shown in (74).

While reanalysing unlike category coordination as same category coordination of larger categories seems to be a possibility in some cases, there are situations where it has undesired consequences such as having a different reading. As observed in Dalrymple (2017), examples with modifiers such as *simultaneously* and *alternately* have different readings depending on whether unlike category coordination is involved (see the bracketings in (75) and (77)), or an “ellipsis-based”[18] analysis is involved (compare (76) and (78), respectively):

(75) Fred is simultaneously [[a professor] and [ashamed of his work]]. (Dalrymple 2017: (16a))

(76) Fred [[is simultaneously a professor] and [~~is simultaneously~~ ashamed of his work]]. (Dalrymple 2017: (16b))

(77) Fred is alternately [[in a good mood] and [suicidal]]. (Dalrymple 2017: (17a))

(78) Fred [[is alternately in a good mood] and [~~is alternately~~ suicidal]]. (Dalrymple 2017: (17b))

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[18] This includes the NCC reanalysis proposed by Maxwell & Manning (1996).

In the case of *John is a republican and proud of it*, the truth conditions are the same no matter whether this string is analysed as coordination of unlike categories (giving rise to a monoclausal structure where the predicative complement corresponds to unlike category coordination of an NP and an AP, see (79)) or as same category coordination of VPs, as in (74), which is equivalent to multiclausal *John [[is a republican] and [~~is~~ proud of it]].*

(79)
$$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{be}\langle\boxed{2}\rangle\boxed{1}\text{’} \\ \textsc{subj}\ \boxed{1} & \left[\textsc{pred}\ \text{‘}\textsc{John}\text{’}\right] \\ \textsc{xcomp}\ \boxed{2} & \left[\begin{array}{l} \left\{\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{republican}\langle\boxed{1}\rangle\text{’} \\ \textsc{subj} & \boxed{1} \end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{proud}\langle\boxed{1}\rangle\text{’} \\ \textsc{subj} & \boxed{1} \end{array}\right]\right\} \\ \textsc{conj}\quad \textsc{and} \end{array}\right] \end{array}\right]$$

However, there is a clear difference when negation is involved. Consider the string *John is not a republican and proud of it.* Under the NCC reanalysis of unlike category coordination proposed in Maxwell & Manning (1996), this sentence involves a coordination of two negated VPs – this corresponds to (80) which involves a conjunction of two negated predicates, schematically shown in (81).

(80) John [[is not a republican] and [~~is not~~ proud of it]].

(81) $[\neg A \wedge \neg B]$

By contrast, under the analysis where genuine coordination of unlike categories is involved, as in (82), the semantics, schematically shown in (83), involves a negation of a conjunction – under De Morgan's laws, this is equivalent to a disjunction of negations.

(82) John is not [[a republican] and [proud of it]].

(83) $\neg[A \wedge B] \equiv [\neg A \vee \neg B]$

As a consequence, the two analyses of the string *John is not a republican and proud of it* have different meanings. Under the NCC analysis in (80), it can only mean (it has only one reading where it is true): John is not a republican, he is not proud of it ($[\neg A \wedge \neg B]$). Apart from this reading, the following two readings are also available under the unlike category coordination analysis in (82): John is a republican, he is not proud of it ($[A \wedge \neg B]$); John is not a republican, he is proud of it ($[\neg A \wedge B]$). Even though these two are possible readings of this string, they are not available under the NCC analysis.

An analogous issue arises in examples with modifiers such as (64). When negation is present (*We did not walk slowly and with great care*), different analyses also have different meanings. While NCC in (84) has the meaning in (81) which has only one reading (he did not walk slowly, he did not walk with great care), unlike category coordination in (85) has the meaning in (83) where two more readings are possible (he walked slowly, he did not walk with great care; he did not walk slowly, he walked with great care).

(84) We [[did not walk slowly] and [~~did not walk~~ with great care]].

(85) We did not walk [[slowly] and [with great care]].

As shown above, while some examples of unlike category coordination can be reanalysed as conjunction reduction without undesired side-effects (such as distorted, bad semantics), it is not the case that all instances of unlike category coordination can be reanalysed as conjunction reduction (using the analysis designed for NCC). Let us therefore proceed to the discussion of how genuine unlike category coordination can be handled in LFG.

3.2 Categories and c-structure labels

Once the false assumption that coordination can only join elements corresponding to the same category is rejected, the following question immediately arises: when unlike categories are coordinated, what is the category of the coordinate phrase as a whole? Over time, there have been various answers to this question – these are discussed below.

Peterson (2004) proposed that the category of unlike category coordination is the same as the category of the first conjunct, as in the rule in (86):[19]

(86) $\text{X} \longrightarrow \underset{\downarrow\in\uparrow}{\text{X}} \quad \text{Conj} \quad \underset{\downarrow\in\uparrow}{\text{X}}$ (Peterson 2004: (20))

As pointed out in Dalrymple (2017: 38): “This analysis makes the incorrect prediction that the distribution of an unlike category coordination structure matches the distribution of the category of the first conjunct.”[20]

While Peterson (2004) makes unlike category coordination endocentric in the sense that the topmost category is the same as one of the conjuncts, Patejuk

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[19] While Peterson (2004) uses the C category for the conjunction, it was replaced with Conj in (86) for the sake of consistency as well as to avoid potential confusion (C is typically used for complementisers).

[20] As noted in Bruening & Al Khalaf (2020), Peterson (2004) focuses on cases where the coordinate phrase follows the selector, so the first conjunct is closest to the selector. However, there are cases where coordination precedes the selector (see (72)), so the first conjunct would be farthest from the selector (rather than closest). While this issue can be resolved by assuming that it is the conjunct closest to the selector that corresponds to the topmost category, the point made in Dalrymple (2017) would still hold.

(2015) proposed to use a special category for unlike category coordination (XP or UP), making it exocentric: the rule in (87) uses YP and ZP as variables for different categories.

(87) $$\begin{array}{lllll} \text{XP} & \longrightarrow & \text{YP} & \text{Conj} & \text{ZP} \\ & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$ (Patejuk 2015: (4.8))

This proposal is complemented by the use of the distributive CAT attribute in f-structure, making it possible to impose category constraints at this level of representation – rather than using CAT predicate (see Section 3.5.1) and c-structure labels. Under the analysis of Patejuk (2015), the f-structure in (88) corresponds to *John is a republican and proud (of it).*

(88) $$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{be}\langle\boxed{2}\rangle\boxed{1}\text{'} \\ \textsc{subj}\ \boxed{1} & \left[\textsc{pred}\ \text{`John'}\right] \\ \textsc{xcomp}\ \boxed{2} & \left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{republican}\langle\boxed{1}\rangle\text{'} \\ \textsc{subj} & \boxed{1} \\ \textsc{cat} & \textsc{n} \end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{proud}\langle\boxed{1}\rangle\text{'} \\ \textsc{subj} & \boxed{1} \\ \textsc{cat} & \textsc{adj} \end{array}\right] \right\} \\ \textsc{conj}\quad \textsc{and} \end{array}\right] \end{array}\right]$$

According to Dalrymple (2017: 38): "the proposal does not allow the possibility of imposing the category requirements that were shown to be necessary […], since on this view all unlike category coordinations have the same category. It also makes it difficult to enforce category-function correlations and to control the distribution of phrases of different categories, since there is no relation between the category of the unlike category coordination structure and the categories of the conjuncts." This criticism only holds as far as c-structure is concerned (so when the CAT predicate is used, which operates on c-structure labels; see Section 3.5.1). Under the proposal of Patejuk (2015), the categorial constraints discussed in Dalrymple (2017) are imposed at the level of f-structure using the CAT attribute. As shown in (88), conjuncts corresponding to the XCOMP grammatical function have different categories: the value of CAT is N for the noun *republican* and ADJ for the adjective *proud*.

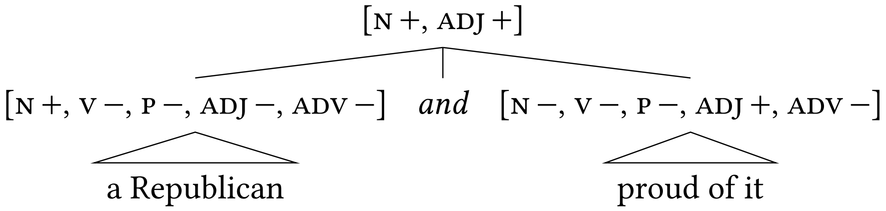
Dalrymple (2017) offers a novel, feature-based solution for choosing the c-structure label of unlike category coordination. While it is conceptually similar to the proposal of Sag et al. (1985), it does not involve controversial feature decomposition (see Bayer (1996) for an extensive critique) as features directly correspond to basic syntactic categories, see (89):

(89) (Dalrymple 2017: (43))

Abbreviation	Feature matrix
N	[N +, V −, P −, ADJ −, ADV −]
V	[N −, V +, P −, ADJ −, ADV −]
P	[N −, V −, P +, ADJ −, ADV −]
Adj	[N −, V −, P −, ADJ +, ADV −]
Adv	[N −, V −, P −, ADJ −, ADV +]

These feature matrices correspond to lexical categories. The category of a coordinate phrase is resolved in a different way (Dalrymple 2017: 48): “the category of a coordinate phrase has the value + for a category feature if there is some conjunct with the value + for that feature”. This makes it possible to provide a simple, elegant account of unlike category coordination: the c-structure in (90) corresponds to *a Republican and proud of it*, where the label of unlike category coordination is [N +, ADJ +].

(90)



(Przepiórkowski & Patejuk 2021: (5))

However, as noted in Przepiórkowski & Patejuk (2021: 208, fn. 4), under such an analysis of coordination, same category coordination has a different category than its conjuncts. For instance, in the case of NP coordination, while the category of all NP conjuncts is [N +, V −, P −, ADJ −, ADV −], the category of the coordinate NP is [N +].

Also, Dalrymple (2017) does not discuss how functional categories such as CP (complementizer phrase) or InfP (infinitival phrase) would be distinguished under this account, which is relevant for unlike category coordination (such as CP and NP, CP and PP, etc.).

Przepiórkowski & Patejuk (2021) offer an alternative solution to the problem of the category of coordination of unlike categories. The analysis proposed in Dalrymple (2017) is limited to categories, while some instances of unlike category coordination require additional constraints, such as appropriate case, complementizer or preposition form (see Section 3.5.2). As a consequence, in order to account for unlike category coordination, it is not enough to state categorial constraints using the built-in CAT predicate (see Section 3.5.1). Przepiórkowski & Patejuk (2021) propose to remove c-structure labels altogether (which is formally equivalent to having just one label) and instead use CAT attribute in f-structure for imposing categorial restrictions (as in Patejuk (2015)). As an example, Przepiórkowski & Patejuk (2021) propose the rule in (91) as a replacement for the rule in (92):

(91) $$\bullet \quad \longrightarrow \quad \begin{array}{c}\bullet\\ (\downarrow \text{\textsc{cat}}) =_c \text{P}\\ \uparrow=\downarrow\end{array} \quad \begin{array}{c}\bullet\\ (\downarrow\text{\textsc{cat}}) \in_c \{\text{P},\text{N}\}\\ (\uparrow \text{\textsc{obj}})=\downarrow\end{array}$$

(Przepiórkowski & Patejuk 2021: (35))

(92) $$\text{P}' \quad \longrightarrow \quad \begin{array}{c}\text{P}\\ \uparrow=\downarrow\end{array} \quad \begin{array}{c}\{\text{NP}|\text{PP}\}\\ (\uparrow \text{\textsc{obj}})=\downarrow\end{array}$$

(Przepiórkowski & Patejuk 2021: (32))

Under this proposal, as in Patejuk (2015), all constraints (related to categories and other features such as case, complementizer or preposition form, etc.) are imposed in f-structure.[21] However, unlike in Patejuk (2015), there is no need for arbitrary c-structure labels for unlike category coordination (such as XP or UP), which was criticised in Dalrymple (2017).

Summing up, this subsection presented different approaches to the problem of choosing the topmost category corresponding to coordination of unlike categories.

3.3 Categories and grammatical functions

Since imposing constraints in f-descriptions relies on grammatical functions to identify the element to be constrained, there is the key question of which grammatical function is appropriate when coordinating unlike categories.

Answering this question can be non-trivial, partially because the choice of the appropriate grammatical function can be controversial even outside of coordination. While LFG considers grammatical functions as primitives of the theory, independent of the position in the c-structure and/or the c-structure category, there have been some discussions and controversy concerning certain grammatical functions. See Belyaev 2023 [this volume] for discussion and references.

Probably the least controversial (though not uncontroversial) grammatical functions include the subj(ect) and the obj(ect). Still, there are different definitions of obj: some (e.g. Patejuk (2015)) choose to define it as the grammatical function which changes to subj when undergoing passivisation, while others (e.g. Börjars & Vincent (2008)) do not consider this as a necessary characteristic.

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[21] While Patejuk (2015) uses complex off-path constraints to formalise disjunctive constraints, Przepiórkowski & Patejuk (2021) propose to reuse the local variable notation, which results in simpler and more readable constraints – see the discussion in Section 3.5.2.

There has been a lot of debate about complement clauses. Dalrymple & Lødrup (2000) argue that different grammatical functions may be appropriate for complement clauses in different languages, considering obj(ect) and comp ((non-object) closed clausal complement) and proposing criteria for distinguishing these. By contrast, Alsina et al. (2005) argue for getting rid of comp and using obl(ique) instead for non-object complement clauses (among other argument types). Furthermore, Alsina et al. (2005) suggest that it should also be possible to get rid of xcomp (open clausal complement).

On the basis of data from Polish and English, Patejuk & Przepiórkowski (2014a) argue that using xcomp for open (controlled) clausal complements can be problematic, because it is possible to coordinate infinitival phrases (open, controlled) with non-predicative nominals which are closed (do not require control):

(93) Polish
Chcę [[pić] i [papierosa]].
want drink.inf and cigarette.acc
'I want to drink and a cigarette.' (Patejuk & Przepiórkowski 2014a: (1))

(94) My uncle said to hell with that and taught me [[karate], and [to fire weapons]]. (Patejuk & Przepiórkowski 2014a: (27))

Patejuk & Przepiórkowski (2014a) argue that such examples provide independent motivation to get rid of the xcomp: while it would be suitable for the controlled infinitival conjunct (its subject is structure-shared with the matrix subject), it is not suitable for the nominal conjunct which is not controlled and does not have a subject.

Patejuk & Przepiórkowski (2014a) propose an analysis in terms of unlike category coordination, choosing obj as the grammatical function corresponding to coordination in (93).[22] An important novel feature of this analysis is making it possible to establish control into selected conjuncts. This is achieved using the controller attribute (see Section 3.5.2 for detailed discussion), as shown in (95)[23] which corresponds to (93).

(95)
$$\left[\begin{array}{ll}
\text{PRED} & \text{`WANT}\langle\boxed{1},\boxed{2}\rangle\text{'}\\
\text{SUBJ} & \boxed{1}\left[\text{PRED `I'}\right]\\
\text{OBJ} & \boxed{2}\left[\begin{array}{l}\left\{\left[\begin{array}{ll}\text{PRED} & \text{`DRINK}\langle\boxed{1}\rangle\text{'}\\ \text{SUBJ} & \boxed{1}\\ \text{CONTROLLER} & \boxed{1}\end{array}\right], \left[\begin{array}{ll}\text{PRED} & \text{`CIGARETTE'}\\ \text{CASE} & \text{ACC}\\ \text{CONTROLLER} & \boxed{1}\end{array}\right]\right\}\\ \text{CONJ}\quad\text{AND}\end{array}\right]
\end{array}\right]$$

(Patejuk & Przepiórkowski 2014a: (26))

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[22] If the ability to be passivised is a defining feature of obj, this argument should be an obl in Polish.

[23] The conj attribute was added to this f-structure.

Building on the proposals of Alsina et al. (2005) and Patejuk & Przepiórkowski (2014a), Patejuk & Przepiórkowski (2016) reexamine the repertoire of grammatical functions in LFG, providing additional arguments for getting rid of COMP and XCOMP. They show that it is possible to coordinate categories that would normally correspond to open and closed complements (which again leads to the issue of control into selected conjuncts).

While Patejuk & Przepiórkowski (2016) focus on the discussion of arguments, an analogous observation can be made with respect to adjuncts, where a similar distinction is often made, splitting adjuncts into closed, not controlled (ADJ) and open, controlled (XADJ). In the Polish examples in (96)–(98), the first conjunct would normally be classified as closed (ADJ), while the second conjunct would be open (XADJ). To account for such coordination, a common grammatical function should be identified for such dependents:[24]

(96) Polish
Wychodziliśmy [[szybko] i [unikając spojrzeń innych]].
left.1.PL.M1 quickly and avoiding gazes others
'We were leaving quickly and avoiding peoples' gazes.'

(97) Polish
Przyjechaliśmy do Kotoru [[dosyć późno] i [głodni jak wilki]]…
returned.1.PL.M1 to Kotor pretty late and hungry.NOM.PL.M1 like wolves
'We returned to Kotor pretty late and hungry as wolves…' (Google)

(98) Polish
Gdy [[niechętnie] i [zażenowany]] wchodził za Nirą…
when reluctantly and embarrassed.NOM.SG.M1 entered.3.SG.M1 after Nira
'When, reluctantly and hungry, he entered following Nira…' (NKJP)[25]

This observation is consistent with the general proposal of Patejuk & Przepiórkowski (2016: 549), who conclude that the repertoire of grammatical functions in LFG could be limited to just three: SUBJ(ect), OBJ(ect) (defined as the item that can

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[24] In Polish, the verb agrees with its subject (which may be implicit, as in (96)–(98)), while predicative adjectives agree with their controller (which may also be implicit, as in (97)–(98)).

[25] NKJP is the National Corpus of Polish (Przepiórkowski et al. (2011, 2012); http://nkjp.pl).

undergo passivisation) and OBL(ique) which serves as the elsewhere grammatical function: "All other dependents, including adjuncts, may be called OBLiques, as in Alsina (1996)." Control into selected conjuncts of OBLiques would be handled in the same way as in (95).

Kaplan (2017) proposes that examples such as (99), analysed as unlike category coordination in Patejuk & Przepiórkowski (2016), see the f-structure in (100), could instead be analysed as non-constituent coordination (NCC, Maxwell & Manning (1996); see Section 2 and Section 3.1), compare the f-structure in (101).[26]

(99) The majority want [[peace] and [to live a comfortable life]].
(Patejuk & Przepiórkowski 2016: (9))

(100)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{want}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\left[\textsc{pred}\ \text{`}\textsc{majority}\text{'}\right] \\ \textsc{obj} & \boxed{2}\left[\begin{array}{l} \left\{ \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{peace}\text{'}\\ \textsc{controller} & \boxed{1}\end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{live}\langle\boxed{1},\boxed{3}\rangle\text{'}\\ \textsc{subj} & \boxed{1}\\ \textsc{obj} & \boxed{3}\left[\textsc{pred}\ \text{`}\textsc{life}\text{'}\right]\\ \textsc{controller} & \boxed{1}\end{array}\right]\right\} \\ \textsc{conj}\quad \textsc{and}\end{array}\right]\end{array}\right]$$

(101)
$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{want}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\left[\textsc{pred}\ \text{`}\textsc{majority}\text{'}\right] \\ \textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`}\textsc{peace}\text{'}\right]\end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{want}\langle\boxed{1},\boxed{3}\rangle\text{'} \\ \textsc{subj} & \boxed{1} \\ \textsc{xcomp} & \boxed{3}\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{live}\langle\boxed{1},\boxed{4}\rangle\text{'}\\ \textsc{subj} & \boxed{1}\\ \textsc{obj} & \boxed{4}\left[\textsc{pred}\ \text{`}\textsc{life}\text{'}\right]\end{array}\right]\end{array}\right]\right\} \\ \textsc{conj}\quad \textsc{and}\end{array}\right]$$

(Kaplan 2017: (29))

While (100) involves one instance of the predicate WANT with a coordinate object, the NCC strategy in (101) involves coordination of identical larger categories (VPs), which results in a multiclausal analysis: there are two instances of the predicate WANT, each with a different non-coordinate complement (OBJ vs. XCOMP).

Kaplan (2017: 138) explains that normally the lexical entry in (102) cannot give rise to the f-structure in (101) because "Disjunction in LFG normally has wide scope. Thus either the OBJ frame or the XCOMP frame would be distributed to both elements of the coordination set, and in each case one of the elements will fail the completeness/coherence tests."

(102) *want* (↑ PRED)='WANT⟨SUBJ,OBJ⟩' (Kaplan 2017: (24))
∨ [(↑ PRED)='WANT⟨SUBJ,XCOMP⟩'
(↑ XCOMP SUBJ)=(↑ SUBJ)]

---

[26] The contribution of *comfortable* is ignored in (100)–(101).

Kaplan (2017) offers two solutions to this problem. The first is to use the lexical entry in (103) which uses functional uncertainty for grammatical functions (obj or xcomp) plus an off-path constraint attached to xcomp establishing the subject control relation:

(103) *want* (↑ pred)=‘want⟨subj,{obj | $\underset{(\rightarrow\ \text{subj})=(\leftarrow\ \text{subj})}{\text{xcomp}}$ }⟩’

(Kaplan 2017: (28))

There are two potential challenges for (103): it uses functional uncertainty constructively (disjunction over grammatical functions in pred) and it uses off-path constraints constructively (introducing a defining control equation). However, as mentioned in Patejuk & Przepiórkowski (2014a), while off-path constraints are non-constructive in XLE (Crouch et al. 2011), the native platform for implementing LFG grammars, this does not need to be the case in theoretical analyses (they point out that drafts of the following works allow constructive off-path constraints: Bresnan et al. (2016), Dalrymple et al. (2019)).

The second solution proposed by Kaplan (2017: 138, fn. 9) is to introduce a new built-in template, distrib (see the discussion of (134) in Section 3.5.2), which makes it possible to “declare the disjunctive entry for *want* [(102)] as a narrow-scope distributive property”.

Both solutions proposed in Kaplan (2017) make it possible to reanalyse simple cases of unlike category coordination as NCC (building on Maxwell & Manning (1996)), though without the requirement of strict identity of grammatical functions (due to the possibility of using different lexical entries for different conjuncts). However, these solutions suffer from the same problems as NCC: they cannot handle more complex cases of unlikes (involving negation or modifiers, see the discussion in Section 3.1). There are no such issues with the analysis assuming unlike category coordination.

3.4 Coordinating predicative complements with participles

In early LFG work (Bresnan 1982, Kaplan & Bresnan 1982) the auxiliary be is analysed as a raising verb. The f-structure in (104)[27] corresponds to the sentence *The elephant was worshipped by the child*, which involves passive voice: be is the main verb (having a pred attribute, with be as its value), taking a raised subject and a verbal complement (vcomp) corresponding to the passive lexical verb.

---

[27] Two errors in the original f-structure (Joan Bresnan, pc) were corrected in (104) by adding: the non-semantic subj in the pred of be; structure-sharing of the subj of be and the subj of worship.

(104)
$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{be}\langle\boxed{2}\rangle\boxed{1}\text{’} \\ \textsc{subj} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{elephant}\text{’}\end{bmatrix} \\ \textsc{vcomp} & \boxed{2}\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{worship}\langle\boxed{1},\boxed{3}\rangle\text{’} \\ \textsc{subj} & \boxed{1} \\ \textsc{obl}_{\textsc{ag}} & \boxed{3}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{child}\text{’}\end{bmatrix} \end{bmatrix} \\ \textsc{tense} & \textsc{past} \end{bmatrix}$$

(Bresnan 1982: Figure 1.4b)

The early LFG analysis of progressive constructions is very similar. Kaplan & Bresnan (1982) analyse the sentence *A girl is handing the baby a toy* using the lexical entries for the present participle *handing* and the auxiliary *is* in (105)–(106).[28] These would give rise to the (simplified) f-structure in (107) where the auxiliary is the main verb (note that its PRED value is PROG, unlike in the passive (104)), taking a raised subject and a verbal complement (VCOMP) corresponding to the lexical verb.

(105) *handing* V $(\uparrow \textsc{pred})=\text{‘}\textsc{hand}\langle(\uparrow \textsc{subj})(\uparrow \textsc{obj}2)(\uparrow \textsc{obj})\rangle\text{’}$
$(\uparrow \textsc{participle})=\textsc{present}$

(Kaplan & Bresnan 1982: (65))

(106) *is* V $(\uparrow \textsc{pred})=\text{‘}\textsc{prog}\langle(\uparrow \textsc{vcomp})\rangle(\uparrow \textsc{subj})\text{’}$
$(\uparrow \textsc{vcomp participle})=_c \textsc{present}$
$(\uparrow \textsc{vcomp subj})=(\uparrow \textsc{subj})$
$(\uparrow \textsc{subj num})=\textsc{sg}$

(Kaplan & Bresnan 1982: (70))

(107)
$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{prog}\langle\boxed{2}\rangle\boxed{1}\text{’} \\ \textsc{subj} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{girl}\text{’}\end{bmatrix} \\ \textsc{vcomp} & \boxed{2}\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{hand}\langle\boxed{1},\boxed{3},\boxed{4}\rangle\text{’} \\ \textsc{subj} & \boxed{1} \\ \textsc{obj} & \boxed{3}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{baby}\text{’}\end{bmatrix} \\ \textsc{obj}2 & \boxed{4}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{toy}\text{’}\end{bmatrix} \\ \textsc{participle} & \textsc{present} \end{bmatrix} \end{bmatrix}$$

Later, the standard LFG analysis of passive/progressive constructions has been to treat the lexical verb as the main verb, while the auxiliary only contributes a bundle of features (such as agreement features, tense, aspect, etc.) – it does not have its own PRED attribute. This results in a “flat” analysis (without embedding) of such constructions: (108) is the flat, monoclausal counterpart of (104), while (109) corresponds to (107).[29]

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[28] The PRED value in the lexical entry in (106) has been modified to include a non-semantic SUBJ.

[29] Instead of OBJ2 used in early works for the secondary object, as in (107), (109) uses $\textsc{obj}_\theta$.

(108)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{worship}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{elephant}\text{'}\end{bmatrix} \\ \textsc{obl}_{\textsc{ag}} & \boxed{2}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{child}\text{'}\end{bmatrix} \\ \textsc{tense} & \textsc{past} \\ \textsc{passive} & + \end{bmatrix}$$

(109)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{hand}\langle\boxed{1},\boxed{2},\boxed{3}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{girl}\text{'}\end{bmatrix} \\ \textsc{obj} & \boxed{2}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{baby}\text{'}\end{bmatrix} \\ \textsc{obj}_{\theta} & \boxed{3}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{toy}\text{'}\end{bmatrix} \\ \textsc{tense} & \textsc{present} \\ \textsc{aspect} & \textsc{prog} \end{bmatrix}$$

With predicative complements, the copula has been analysed over time as a raising verb – taking a subject and a predicative complement: open (XCOMP)[30] or closed (PREDLINK), depending on the analysis. There have also been analyses where the predicative item is the main predicate, while the copula only contributes certain features (having no PRED). See Dalrymple et al. (2004) for a comprehensive discussion of all the possibilities.

There is an interesting interaction between unlike category coordination and constructions with an auxiliary (such as passive/progressive constructions). As discussed in Peterson (1981, 2004), it is possible to coordinate a predicative complement with a present/passive participle, see (110)–(115). In order to avoid having to analyse such examples as an instance of ellipsis (conjunction reduction resulting in a multiclausal structure),[31] it is necessary to adopt a uniform analysis of the linking word (as the main verb or not).

In English, many examples of unlike category coordination of a predicative complement and a present participle are discussed in Peterson (1981). Using examples such as (112), among others, Peterson (1981) argues that these are not instances of ellipsis (conjunction reduction) but genuine coordination of unlike categories:

(110) The children were [[happy] and [smiling]]. (Peterson 1981: (9))

(111) John is [[awake] and [asking for you]]. (Peterson 1981: (10))

---

[30] While XCOMP is category neutral, in early LFG (Bresnan 1982, Kaplan & Bresnan 1982) different grammatical functions were used for different categories: ACOMP for adjectives, NCOMP for nouns, etc.

[31] This is also the case under the proposal of Kaplan (2017) to introduce the DISTRIB template, making it possible to treat disjunctive lexical entries as narrow-scope distributive properties (see (134) in Section 3.5.2).

(112) He was [both [happy] and [smiling]]. (Peterson 1981: (27))

Peterson (2004) provides more examples, including one with a passive participle, (114):

(113) Bill could be [[a plumber] and [making a fortune]]. (Peterson 2004: (8c))

(114) I imagined John [[a convicted felon] and [imprisoned for life]]. (Peterson 2004: (8g))

(115) The children are [[awake] and [asking for you]]. (Peterson 2004: (45))

Peterson (2004) provides the f-structure in (116) as the representation of (115):

(116)

$$\left[\begin{array}{ll}
\text{PRED} & \text{‘BE}\langle\boxed{2}\rangle\boxed{1}\text{’}\\
\text{SUBJ}\ \boxed{1} & \left[\text{PRED}\ \ \text{‘CHILDREN’}\right]\\
\text{XCOMP}\ \boxed{2} & \left[\begin{array}{l}\left\{\left[\begin{array}{ll}\text{PRED} & \text{‘AWAKE}\langle\boxed{1}\rangle\text{’}\\ \text{SUBJ} & \boxed{1}\end{array}\right], \left[\begin{array}{ll}\text{PRED} & \text{‘ASK}\langle\boxed{1},\boxed{3}\rangle\text{’}\\ \text{SUBJ} & \boxed{1}\\ \text{OBL}_{\text{GOAL}} & \boxed{3}\left[\text{PRED}\ \ \text{‘YOU’}\right]\end{array}\right]\right\}\\ \text{CONJ}\ \ \ \text{AND}\end{array}\right]\\
\text{TENSE} & \text{PRES}
\end{array}\right]$$

(Peterson 2004: (47))

While Peterson (2004) does not discuss the possibility of using the NCC analysis of Maxwell & Manning (1996) for unlike category coordination, it seems clear that he would not want to adopt it, because it results in a multiclausal f-structure representation, equivalent to VP-level coordination – an elliptical analysis that Peterson (2004) explicitly argues against.

Patejuk & Przepiórkowski (2014b) discuss similar data from Polish, focusing on the coordination of adjectives and passive participles such as in (117), where the first conjunct (*zrobiony* ‘made’) is a passive participle, the second (*bezpieczny* ‘safe’) is an adjective and the third (*zarejestrowany* ‘registered’) is a passive participle with a *by*-phrase:

(117) Polish

Nasz	pas	jest	[[dobrze	zrobiony],	[bezpieczny]
our	runway.NOM.SG.M3	is	well	made.NOM.SG.M3	safe.NOM.SG.M3

i	[zarejestrowany	przez	Urząd	Lotnictwa	Cywilnego]].
and	registered.NOM.SG.M3	by	Office.ACC	Aviation.GEN	Civil.GEN

‘Our runway is well made, safe and registered by the Civil Aviation Office.’ (Patejuk & Przepiórkowski 2014b: (1))

Using Polish negation data as independent evidence, Patejuk & Przepiórkowski (2014b) argue for a unified treatment of BYĆ 'be' as a raising verb taking a complement which can be an adjective, a passive participle, or a coordination of these – as in (117), which they analyse as (118). As a result, as in Peterson (2004), passive and predicative constructions use the embedded representation (as opposed to the flat representation using co-heads).

(118)

$$\begin{bmatrix}
\text{PRED} & \text{`BE}\langle\boxed{2}\rangle\boxed{1}\text{'} \\
\text{SUBJ}\ \boxed{1} & \begin{bmatrix}\text{PRED} & \text{`RUNWAY'}\end{bmatrix} \\
\text{XCOMP}\ \boxed{2} & \begin{bmatrix} \left\{\left(\begin{bmatrix} \text{PRED} & \text{`MAKE}\langle\boxed{1}\rangle \\ \text{SUBJ} & \boxed{1} \\ \text{ADJ} & \left\{\begin{bmatrix}\text{PRED} & \text{`WELL'}\end{bmatrix}\right\} \\ \text{PASSIVE} & + \end{bmatrix}, \begin{bmatrix} \text{PRED} & \text{`SAFE}\langle\boxed{1}\rangle\text{'} \\ \text{SUBJ} & \boxed{1} \end{bmatrix}, \begin{bmatrix} \text{PRED} & \text{`REGISTER}\langle\boxed{1},\boxed{3}\rangle \\ \text{SUBJ} & \boxed{1} \\ \text{OBL}_{\text{AG}} & \boxed{3}\begin{bmatrix}\text{PRED} & \text{`CAO'}\end{bmatrix} \\ \text{PASSIVE} & + \end{bmatrix} \right)\right\} \\ \text{CONJ}\quad \text{AND} \end{bmatrix}
\end{bmatrix}$$

(Patejuk & Przepiórkowski 2014b: (53))

3.5 Disjunctive constraints

The main remaining question related to unlike category coordination is how to impose disjunctive constraints (such as subcategorisation in examples discussed earlier). Over time, there have been two main approaches to this issue. They may also be used together.

3.5.1 CAT predicate

The first approach focuses on constraints related to c-structure categories, relying on the built-in CAT predicate for imposing such constraints, as defined in (119):

(119) $\text{CAT}(f, C)$ iff $\exists n \in \phi^{-1}(f) : \lambda(n) \in C$

"CAT(f, C) is true if and only if there is some node n that corresponds to f via the inverse ϕ correspondence (ϕ^{-1}) whose label (λ) is in the set of categories C." (Dalrymple (2017: (24)) after Kaplan & Maxwell (1996: 93))

Dalrymple (2017) shows how CAT can be used to account for disjunctive subcategorisation requirements of the verb BECOME: assuming that CAT is distributive, each conjunct must satisfy the constraint imposed by CAT. As a result, (120) ensures that the predicative complement (PREDLINK or XCOMP, depending on the analysis) of BECOME must be an adjectival phrase (AdjP), a nominal phrase (NP), or a coordination of these, as in (121).

(120) CAT(($\uparrow$ PREDLINK), {AdjP, NP}) (Dalrymple 2017: (26))

(121) Fred became [[a professor] and [proud of his work]].
(Dalrymple 2017: (6a))

The CAT predicate is designed specifically for imposing constraints on c-structure categories. However, as discussed earlier, accounting for unlike category coordination may require additional constraints, such as having a certain value of case, preposition or complementiser form, etc., or introducing control equations (see (93)–(94)).

Technically, features such as case, preposition form and complementiser form can be added to c-structure category labels, resulting in complex categories such as NP[case], PP[pform,case] or CP[compform], making it possible to impose extra constraints using the CAT predicate that is normally used only for category labels. However, there are some issues with such a solution. First, it requires copying f-structure information to c-structure, resulting in redundancy. More importantly, such a solution would not be sufficient for more complex phenomena such as structural case assignment to the object in Polish because its value of case depends on the presence or absence of negation on the verb assigning case. Simplifying, in Polish the structural object is accusative without negation, but it is genitive if negation is present. This requires more complex constraints.

Consider again the example in (93) (with the corresponding f-structure in (95)), where the object involves unlike category coordination. While the first conjunct (*pić* ‘drink’) is a controlled infinitival phrase (InfP), the second conjunct (*papierosa* ‘cigarette’) is an NP bearing accusative case (as structural case when there is no sentential negation). The simple CAT constraint in (122) restricts categories corresponding to the object of the verb CHCIEĆ ‘want’ to InfP or NP. The version using complex categories in (123) additionally restricts the case of the NP to accusative or genitive (the two possible values, as above).

(122) CAT((↑ OBJ), {InfP, NP})

(123) CAT((↑ OBJ), {InfP, NP[acc], NP[gen]})

While (122) does not restrict the value of case of the NP object in any way, (123) restricts it to accusative or genitive, but the crucial constraint making the value of case dependent on sentential negation is absent. Even with complex categories, it is not sufficient to use the CAT predicate to express more complex constraints necessary in unlike category coordination (such constraints are discussed in Section 3.5.2).

Dalrymple (2017) offers a novel solution to the issue of the category of unlike category coordination by replacing atomic c-structure labels (such as NP, AdjP, PP) with labels consisting of attribute-value structures (see Section 3.2). However, as discussed in Przepiórkowski & Patejuk (2021), such a solution would also not be able to handle more complex disjunctive subcategorisation requirements needed to account for unlike category coordination.

As an alternative, Przepiórkowski & Patejuk (2021) propose to remove category labels from c-structure and move category information to f-structure (see Section 3.2), so that all necessary constraints can be imposed at one level of representation: f-structure. This is discussed in more detail in Section 3.5.2.

3.5.2 F-structure constraints

The second type of disjunctive constraints is related to f-structure. In order to account for unlike category coordination, where each conjunct may satisfy a different set of constraints, such disjunctive constraints must be interpreted distributively, so that the disjunction is evaluated separately for each conjunct.

Consider (124): the object of UNDERSTAND involves unlike category coordination – its first conjunct is an NP, while the second conjunct is a CP with the complementizer THAT:

(124) I understand [[those concerns] and [that they are sincerely held]].
(Patejuk & Przepiórkowski 2023: (39))

Intuitively, the constraint in (125) should be appropriate to account for (124):

(125) $[(\uparrow \textsc{obj case}) =_c \textsc{acc} \vee (\uparrow \textsc{obj comp-form}) =_c \textsc{that}]$

However, as observed in Przepiórkowski & Patejuk (2012) when discussing structural case assignment to Polish subjects which also involves disjunction,[32] while the intended effect of such a disjunctive constraint is for it to be evaluated independently for each conjunct, so that different conjuncts may have different specifications, the actual effect is exactly the opposite: the disjunctive constraint is evaluated once (one disjunct is chosen) and the result is distributed to all conjuncts – as a consequence, all conjuncts must have the same specification. The following formulae from Patejuk (2015) formalise this contrast:

(126) a. $\forall x \in (\uparrow \textsc{gf})[A(x) \vee B(x)]$ (intended)

b. $\forall x \in (\uparrow \textsc{gf})\, A(x) \vee \forall x \in (\uparrow \textsc{gf})\, B(x)$ (actual)

---

[32] In Polish the subject requiring structural case can be – simplifying – nominative or, if it is a non-agreeing numeral, accusative, or a coordination of these. Apart from this, some predicates may take verbal subjects (InfP or CP) which may be coordinated with NPs bearing structural case.

The "liberal" solution offered in Przepiórkowski & Patejuk (2012: 485) is to "understand (non-)distributivity not as a property of features, but as a property of statements". This involves making statements distributive by default – non-distributive statements must be marked explicitly (with "@"). As Przepiórkowski & Patejuk (2012: 485) point out, "An interesting consequence of this proposal is that a given feature may behave distributively in some ways and non-distributively in others.", providing CASE as an example: while it is a non-distributive attribute in Polish, an additional distributive statement is used to ensure that each of the conjuncts bears an appropriate value of case.

The second solution described[33] in Przepiórkowski & Patejuk (2012: 486) is called "conservative" as it does not require any modifications to the LFG theory: it relies on the existing mechanism of off-path constraints. A distributive attribute (typically PRED, as below) is used as an anchor, so that the disjunctive constraint is distributed to each conjunct and evaluated independently: (127) is the off-path counterpart of (125), achieving its intended effect. This solution is presented in more detail in Patejuk & Przepiórkowski (2012a).

(127) $(\uparrow \textsc{obj}\ \underset{[(\leftarrow \textsc{case}) =_c \textsc{acc}\ \vee\ (\leftarrow \textsc{comp-form}) =_c \textsc{that}]}{\textsc{pred}})$

Note that (127) uses constraining equations. While "plain" (not off-path) constraints can be defining (=, introducing an attribute-value pair) or constraining ($=_c$, checking if a given attribute-value pair is present), there are different formal views on off-path constraints. Some works assume these are non-constructive, which means that off-path constraints can only be constraining, so it is not possible to have defining off-path constraints – this is consistent with how off-path constraints work in XLE.[34] However, some theoretical works assume that off-path constraints can be constructive (see the discussion of (103) in Section 3.3), making it is possible to use these for introducing new attribute-value pairs.

This issue (whether off-path constraints can be constructive or not) is of significant importance in the context of unlike category coordination, since some constraints are typically defining – this includes control equations in examples such as (93), where one of the conjuncts requires control. As explained in Patejuk & Przepiórkowski (2014a), the control equation in (128)[35] would produce an ill-formed, incoherent f-structure because the non-infinitival conjunct does not take a subject. The disjunctive constraint in (129), aiming to address this issue, would

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[33] As explained in Przepiórkowski & Patejuk (2012), this solution is the idea of Mary Dalrymple.

[34] https://ling.sprachwiss.uni-konstanz.de/pages/xle/doc/notations.html#N4.1.5b

[35] As mentioned in footnote 22, OBL may be more appropriate than OBJ for the coordinate phrase in (93).

also not work – as explained above, instead of being distributed as in (126a), it would be interpreted as in (126b): depending on which disjunct is chosen, one of the conjuncts would not satisfy the chosen constraint. (130) is the off-path version of (129) – whether it would have the intended effect depends on whether off-path constraints can be constructive.

(128) $(\uparrow \textsc{subj})=(\uparrow \textsc{obj subj})$

(129) $[(\uparrow \textsc{obj cat})=_c \textsc{inf} \ \wedge\ (\uparrow \textsc{subj})=(\uparrow \textsc{obj subj})] \ \vee\ (\uparrow \textsc{obj cat})\neq \textsc{inf}$

(130)
$$(\uparrow \textsc{obj} \underset{\begin{array}{c}[(\leftarrow \textsc{cat})=_c \textsc{inf} \ \wedge\ (\leftarrow \textsc{subj})=((\textsc{obj} \leftarrow)\ \textsc{subj})]\\ \vee \\ (\leftarrow \textsc{cat})\neq \textsc{inf}\end{array}}{\textsc{pred}})$$

To avoid the potential issue with (130) (since off-path constraints are non-constructive in XLE, this is a real issue for implemented grammars), Patejuk & Przepiórkowski (2014a) describe an alternative solution, again due to Mary Dalrymple: the idea is to use a dedicated attribute, CONTROLLER, to host the controller.

Let us consider again the example in (93), where the complement of CHCIEĆ ‘want’ consists of an infinitival phrase controlled by the subject and a noun phrase bearing structural case. Under this alternative proposal, instead of (128), the lexical entry of CHCIEĆ introduces the modified control equation in (131). As a consequence, the subject of CHCIEĆ is structure-shared with the CONTROLLER attribute of its OBJ complement. This does not trigger the coherence violation in the NP conjunct that is caused by (128).

(131) $(\uparrow \textsc{subj})=(\uparrow \textsc{obj controller})$

In the absence of (128) the InfP conjunct would be incomplete (its SUBJ needs to be filled), so the constraint in (132) is used instead to satisfy completeness. When used inside the InfP, (132) structure-shares the value of its CONTROLLER attribute with its SUBJ, providing the InfP complement of CHCIEĆ with a subject.

(132) $(\downarrow \textsc{controller})=(\downarrow \textsc{subj})$

Together, (131) and (132) make it possible to satisfy completeness by providing the InfP with a controller for its subject without violating coherence in non-infinitival conjuncts in examples such as (93).[36] This solution can also be used for unlike modifiers in (96)–(98).

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[36] The CONTROLLER attribute could also be used to host the controller of predicative complements, providing an alternative solution to the problem of predicative complements that have a subject of their own such as gerunds or CPs (Dalrymple et al. 2004). While standard open complement (XCOMP(-PRED)) analyses result in incoherence (two different values of SUBJ – one internal vs. one resulting from control), there would be no such problem when control is established via CONTROLLER.

It is worth noting that the CONTROLLER attribute introduced by (131) is represented in each conjunct, no matter whether a given conjunct requires control (as the infinitival conjunct in (93)) or not (as the nominal conjunct in (93)). CONTROLLER would be present even if there is no conjunct requiring control. If this is considered an issue, the restriction operator (\) can be used to remove the CONTROLLER attribute where is not necessary.

As mentioned above, the complement of CHCIEĆ 'want' may be an NP taking structural case (accusative or genitive, depending on the presence of sentential negation) or a controlled InfP. This is formalised in (133) using off-path constraints (non-constructive):

(133)
$$(\uparrow \text{OBJ} \quad \underset{\begin{array}{c} [(\leftarrow \text{CAT}) =_c \text{INF} \ \wedge \ (\leftarrow \text{SUBJ}) =_c ((\text{OBJ} \leftarrow)\ \text{SUBJ})] \\ \vee \\ [(\leftarrow \text{CAT}) =_c \text{N} \ \wedge \\ [[\neg((\text{OBJ} \leftarrow)\ \text{NEG}) \ \wedge \ (\leftarrow \text{CASE}) =_c \text{ACC}] \ \vee \\ [((\text{OBJ} \leftarrow)\ \text{NEG}) =_c + \ \wedge \ (\leftarrow \text{CASE}) =_c \text{GEN}]]] \end{array}}{\text{PRED}} \quad)$$

While off-path constraints make it possible to impose disjunctive constraints under coordination, the resulting constraints are rather complex and hard to read. If off-path constraints are non-constructive (as in XLE), this limitation forces a special way of imposing constraints (defining constraints must be used elsewhere, as shown above).

Alternative solutions include the "liberal" solution of Przepiórkowski & Patejuk (2012) discussed above (making distributivity a property of statements, so that statements are distributive by default, while non-distributive statements must be marked as such).

Kaplan (2017: 133–4, fn. 6) offers another alternative, proposing to formalise the idea of the "liberal" solution of Przepiórkowski & Patejuk (2012) by introducing DISTRIB, "an explicit operator declaring that an arbitrary description P is a distributive property when it is applied to an f-structure f that happens to be a set":

(134) $\text{DISTRIB}(f, v, P)$

Kaplan (2017: 134) adds: "In any invocation (perhaps notated as a built-in template call) f will be a designator (e.g. ↑) and P will be a formula with a variable v that is bound in the scope of P to either the non-set designated by f or to each of its elements in turn."

(135) is the DISTRIB template call corresponding to the off-path constraint in (127), while (136) is the counterpart of (133). (136) is compatible with the CONTROLLER-based approach to establishing control relations shown in (131)–(132).

(135) @distrib((↑ obj), %o, [(%o case)=$_c$ acc ∨ (%o comp-form)=$_c$ that])

(136) @distrib((↑ obj), %o,
[(%o cat)=$_c$ inf ∧ (↑ subj)=$_c$(%o subj)] ∨ [(%o cat)=$_c$ n ∧
[[¬(↑ neg) ∧ (%o case)=$_c$ acc] ∨ [(↑ neg) ∧ (%o case)=$_c$ gen]]])

However, since constraints imposed using distrib can be constructive, (137) can be used instead. It introduces a standard defining control equation ((↑ subj)=(%o subj) instead of (↑ subj)=$_c$(%o subj)), so there is no need to use the controller attribute.

(137) @distrib((↑ obj), %o,
[(%o cat)=$_c$ inf ∧ (↑ subj)=(%o subj)] ∨ [(%o cat)=$_c$ n ∧
[[¬(↑ neg) ∧ (%o case)=$_c$ acc] ∨ [(↑ neg) ∧ (%o case)=$_c$ gen]]])

The last alternative solution, proposed by Przepiórkowski & Patejuk (2021), is to reuse the formal device of local names (local variables) as a way of stating distributive properties – (138) is the counterpart of (127), while (139) corresponds to (133).

(138) (↑ obj)=%o ∧
[(%o case)=$_c$ acc ∨ (%o comp-form)=$_c$ that]

(139) (↑ obj)=%o ∧
[(%o cat)=$_c$ inf ∧ (↑ subj)=$_c$(%o subj)] ∨ [(%o cat)=$_c$ n ∧
[[¬(↑ neg) ∧ (%o case)=$_c$ acc] ∨ [(↑ neg) ∧ (%o case)=$_c$ gen]]]

As in the case of distrib proposed by Kaplan (2017), constraints imposed in this way can also be constructive, so – as in (137) – it is possible to use (139) with a defining control equation in order to avoid using the controller attribute to establish control.

While the "liberal" solution of Przepiórkowski & Patejuk (2012) makes statements (including disjunctive constraints) distributive (as in (126a); non-distributive properties need to be marked explicitly), the solutions proposed by Kaplan (2017) and Przepiórkowski & Patejuk (2021) are both "conservative" in the sense that statements are non-distributive (see (126b)) unless they are stated using the distrib template or local names, respectively.

4 Coordination of unlike grammatical functions

Coordination can be even more unlike than when unlike categories are involved: in some languages it is possible to coordinate unlike grammatical functions under some circumstances. This is very robust in Slavic, Romanian and Hungarian, but it is also possible, to a lesser extent, in other languages, including English. This phenomenon has been discussed in the literature under different names, including: "lexico-semantic coordination" (Sannikov 1979, 1980, Mel'čuk 1988), "hybrid coordination" (Chaves & Paperno 2007) and "heterofunctional coordination" (Przepiórkowski 2022). While this type of coordination is sometimes referred to as "wh-coordination" (Bîlbîie & Gazdik 2012) when the discussion is restricted to interrogative items (as in (140)),[37] there are many more possible types of conjuncts, corresponding to different types of quantifiers: the universal quantifier in (141), the existential quantifier (indefinite pronouns in (142), free choice pronouns in (143)), *n*-words in (144) (existential quantifier in scope of negation), etc. The basic generalisation is that this variety of coordination joins elements which belong to the same (restricted) semantic type, but they correspond to different grammatical functions.

(140) Polish
[[Kogo] i [komu]] przedstawił?
who.ACC and who.DAT introduced
'Who did he introduce to whom?' (Kallas 1993: 121, (241))

(141) Polish
Obiecać można [[wszystko] i [wszystkim]].
promise may everything.ACC and everyone.DAT
'One may promise everything to everyone.' (NKJP)

(142) Polish
[[Ktoś], [gdzieś] i [coś]] mocno pokiełbasił.
someone.NOM somewhere and something.ACC really messed up
'Someone really messed something up somewhere.' (NKJP)

(143) Polish
czy [[komukolwiek], [kiedykolwiek] i [do czegokolwiek]]
PRT anybody.DAT anytime and for anything
przydał się poradnik
come in handy guide
'Has a(ny) guide ever come in handy to anybody for anything?' (NKJP)

(144) Polish
[[nikogo] i [nic]] nie może tłumaczyć.
nobody.GEN and nothing.NOM NEG can excuse
'Nothing can excuse anybody.' (NKJP)

---

[37] All examples used in this section are in Polish. Except for (148), all examples are from Patejuk (2015). Some glosses and translations have been modified.

4.1 Is this really coordination?

When discussing coordination of different grammatical functions, a fundamental question arises: is this really coordination? For instance, in Polish the word *i* can be a conjunction, but it can also be an interjection or a particle. So perhaps the word that seems to be a conjunction in this construction is not a conjunction (but some other element) and such examples do not involve coordination. Patejuk & Przepiórkowski (2012b), Patejuk (2015), Patejuk & Przepiórkowski (2019) present a range of arguments showing that coordination of different grammatical functions is a genuine instance of coordination.

As Patejuk & Przepiórkowski (2019: 28) point out: "in all languages which allow for joining different grammatical functions the joining element has the same form as a conjunction". As shown below, different conjunctions may be used.

There are examples with unambiguous conjunctions, such as *oraz* in (145).

(145) Polish

[[kto]	oraz	[kiedy]]	miałby	płacić	za	postawiony	budynek
who.NOM	and	when	should	pay	for	erected	building

'Who and when would be supposed to pay for the erected building?' (NKJP)

There are examples such as (146) where other interpretations exist, but these are not appropriate in the given context. Apart from the conjunction, the only alternative interpretation of *lub* is as the imperative form of the verb LUBIĆ 'like', clearly not suitable in (146).

(146) Polish

Mile	widziane	odpowiedzi	merytoryczne,	bez	przypuszczeń
welcome		responses	substantive	without	speculating

[[kto]	lub	[czego]]	będzie	w	Wikipedii	szukał.
who.NOM	or	what.GEN	AUX	in	Wikipedia	seek

'Welcome are substantive responses, without speculating who will seek what in Wikipedia.' (NKJP)

Some conjunctions have special requirements – for instance, *ani* 'neither/nor' belongs to *n*-words, so it needs negation to be licenced. As shown in (147), removing negation results in ungrammaticality, which is consistent with the behaviour of the conjunction *ani*.

(147) Polish
Nigdy nie wyjeżdżałyśmy na wakacje, bo *(nie) miałyśmy [[z
never NEG leave for holidays because NEG had with
kim] ani [za co]]…
who.INS nor for what.ACC
‘We would never go on holiday because there was nobody we could go with and there was no money to go.’ (Joanna Bator, *Ciemno, prawie noc*, 119)

Some examples, apart from a conjunction, also include a preconjunction, as in (148).

(148) Polish
…kiedy wyjawisz [nie tylko [kto], ale i [dlaczego]] otrzymał
when disclose not only who.NOM but and why received
awans.
promotion
‘…when you explain not only who, but also why got promoted.’
(Patejuk & Przepiórkowski 2019: (9))

Finally, it is possible to coordinate more than two items – see (142) and (143).

Summing up, there is substantial evidence showing that different grammatical functions are joined with a conjunction and the construction in question is a variety of coordination.

4.2 How to represent such coordination?

Having established that coordination of different grammatical functions is indeed an instance of coordination, the next question is how it should be represented.

Patejuk & Przepiórkowski (2012b) offer an analysis with two possible representations: monoclausal (involving one clause, where all conjuncts are dependents of the same clause) or multiclausal (involving more than one clause, where conjuncts are dependents of different clauses; this is equivalent to clause-level coordination with ellipsis). It may be the case that the two different representations are needed in the same language, as in Polish.

Patejuk (2015) provides a critical review of various diagnostics/arguments for determining the right representation for coordination of different grammatical functions. While there are cases when it is necessary to adopt the multiclausal representation (for instance, when the conjuncts cannot belong to the same clause, see Section 4.4), it is hard to rule out the multiclausal representation elsewhere, unless it is assumed that ellipsis only operates under identity. Without this assumption, it is difficult to argue against arbitrary ellipsis mechanisms (which may be arbitrarily powerful). Due to this, it seems reasonable to assume that unless there are good reasons to adopt the multiclausal analysis, the monoclausal analysis should be preferred by default as the more economical representation.

The analysis presented below is the one proposed in Patejuk (2015) (which is an improved version of Patejuk & Przepiórkowski (2012b)). (149) is the topmost rule corresponding to the coordination of different grammatical functions; the two disjuncts on the right-hand side correspond to two different representations discussed in detail later: XPlxm_{type} is monoclausal (Section 4.3),[38] while XPlxb_{type} is bi/multiclausal (Section 4.4).

(149) $$\text{anyLEXSEM} \longrightarrow \left\{ \begin{array}{c|c} \text{XPlxm}_{type} & \text{XPlxb}_{type} \\ \downarrow\in(\uparrow \text{UDF}) & \end{array} \right\}$$

The category anyLEXSEM is mostly intended to be used as the initial[39] dependent of S (or CP): (150) is a modified version of (16). Since conjuncts inside anyLEXSEM have appropriate annotations (including GF), anyLEXSEM has no annotation (equivalent to ↓=↑).

(150) S ⟶ anyLEXSEM VP

4.3 Monoclausal

The monoclausal representation is appropriate for coordination of different grammatical functions when all conjuncts can be dependents of the same clause. This has been the case in all examples so far. However, conjuncts do not have to be dependents of the same head. There are examples where they depend on different heads, as in (144) and below:

(151) Polish

[[Skąd]	i	[jakie]]	otrzymujemy	informacje?
whence	and	what.ACC	receive	information.ACC

‘What information and from where do we receive?’ (NKJP)

---

[38] UDF (unbounded dependency function, Asudeh (2011)) is a discourse function used instead of TOPIC/FOCUS so as to avoid representing information structure concepts in f-structure.

[39] Examples such as (147) show that such coordination can also be used non-initially.

(152) Polish
[[Jakie] i [kto]] może ponieść konsekwencje?
what.ACC and who.NOM can bear consequences.ACC
'Who can suffer what consequences?' (Google)

(153) Polish
[[Ile] i [czego]] znaleźli?
how much.ACC and what.GEN found
'How much, and (of) what, did they find?' (NKJP)

In (144) the first conjunct (*nikogo* 'nobody') is the object of the infinitival complement (*tłumaczyć* 'excuse'), while the second conjunct (*nic* 'nothing') is the subject of the main verb (*może* 'can'). In (151) the first conjunct (*skąd* 'from where') is a modifier of the verb (*otrzymujemy* 'get'), while the second conjunct (*jakie* 'what') is a modifier of the verb's object (*informacje* 'information'). (152) is similar to (144) and (151): the first conjunct (*jakie* 'what') is a modifier of the object (*konsekwencje* 'consequences') of the infinitival complement (*ponieść* 'suffer'), while the second conjunct (*kto* 'who') is the subject of the main verb (*może* 'can'). (153) is different because one conjunct depends on the other:[40] while the first conjunct (*ile* 'how much') is the object of the verb (*znaleźli* 'found'), the second conjunct (*czego* 'what') is the nominal complement of *ile*.[41]

The formalisation of Patejuk (2015) relies on the following components:

(154)
$$\begin{array}{cccccc} \text{XPlxm}_{type} \longrightarrow & \text{XPlxmC}_{type} & [, & \text{XPlxmC}_{type}]^{*} & \text{Conj} & \text{XPlxmC}_{type} \\ & \downarrow\in\uparrow & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

(155)
$$\text{XPlxmC}_{type} \longrightarrow \left\{ \text{XPextr}_{type} \mid \text{XPlxm}_{type} \right\}$$

(156)
$$\begin{array}{ll} \text{XPextr}_{type} \longrightarrow & \text{XP}_{type} \\ & \uparrow=\downarrow \\ & ((\textsc{udf} \in^{*} \uparrow)\ \textsc{xpath}\ \textsc{gf}^{+})=\downarrow \end{array}$$

(157)
$$\text{XP}_{type} \equiv \{\text{NP}|\text{PP}|\text{ADVP}|\text{AP}\}_{type}$$

(158)
$$type \equiv \{\ all \mid any \mid int \mid neg\ \}$$

(159)
$$\textsc{xpath} \equiv \textsc{xcomp}^{*}$$

---

[40] ZNALEŹĆ 'find' cannot take a genitive partitive object, so *czego* cannot be analysed as its object: **Czego znaleźli?*

[41] In Polish, the numeral phrase is headed by the numeral which takes a nominal complement (with agreeing numerals, it has the same case while with non-agreeing numerals it is genitive).

(160) $\textsc{gf} \equiv \{\textsc{subj}|\textsc{obj}|\textsc{obj}_{\theta}|\textsc{obl}|\textsc{adj} \in\}$

All rules in (154)–(157) use the $_{type}$ variable defined in (158) – its value must be the same on both sides of the rule. (154) is the topmost rule corresponding to monoclausal (hence "m" in XPlxm) coordination of different grammatical functions ("lx" in XPlxm stands for "lexico-semantic", the term first used in Sannikov (1979, 1980) to refer to such coordination). XPlxm_{type} rewrites to a sequence of XPlxmC_{type} conjuncts (hence "C" in XPlxmC) – it is only possible to coordinate conjuncts belonging to the same semantic type (listed in (158)). (155) rewrites XPlxmC_{type} to XPextr_{type} (no embedding) or XPlxm_{type}, which makes it possible to embed such coordination. (156) rewrites XPextr_{type} to XP_{type} – the metacategory[42] defined in (157) as a disjunction of categories of the same $_{type}$.

Together with (149)–(150), these produce the following monoclausal f-structure for (151):

(161)
$$\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{receive}\langle\boxed{1},\boxed{2}\rangle\text{’} \\
\textsc{subj} & \boxed{1}\left[\textsc{pred}\ \ \text{‘}\textsc{pro}\text{’}\right] \\
\textsc{obj} & \boxed{2}\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{information}\text{’}\\ \textsc{case} & \textsc{acc}\\ \textsc{adj} & \left\{\boxed{3}\right\}\end{array}\right]\\
\textsc{adj} & \left\{\boxed{4}\right\}\\
\textsc{udf} & \left\{\left[\begin{array}{l} \left\{ \boxed{4}\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{whence}\text{’}\\ \textsc{type} & \textsc{int}\end{array}\right], \boxed{3}\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{what}\text{’}\\ \textsc{case} & \textsc{acc}\\ \textsc{type} & \textsc{int}\end{array}\right]\right\} \\ \textsc{conj}\ \ \textsc{and}\end{array}\right]\right\}
\end{array}\right]$$

(Patejuk 2015: (5.125))

To see how the monoclausal analysis of Patejuk (2015) works, let us consider its procedural intuition showing how (161) is built using the rules in (149)–(150) and (154)–(160).

(162) and (163) are the partial f-structures built by the words *skąd* and *jakie*, respectively:

(162)
$$\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{whence}\text{’}\\ \textsc{type} & \textsc{int}\end{array}\right]$$

(163)
$$\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{what}\text{’}\\ \textsc{case} & \textsc{acc}\\ \textsc{type} & \textsc{int}\end{array}\right]$$

---

[42] Unlike XPlxm_{type}, XPlxmC_{type} and XPextr_{type}, XP_{type} is a metacategory: ≡ is used instead of ⟶ as the rewrite symbol in the rule defining XP_{type}, so the right-hand side categories in (157) appear in c-structure instead of XP_{type}.

These words are interrogative (their lexical entries specify the value of the TYPE attribute as INT), so they correspond to categories ADVP$_{int}$ and AP$_{int}$, respectively. According to (157), each of these categories is an instance of XP$_{int}$ metacategory. Following (155)–(156), XPextr$_{int}$ rewrites to XP$_{int}$ and XPlxmC$_{int}$ to XPextr$_{int}$, so: XPlxmC$_{int}$ $\longrightarrow$ XPextr$_{int}$ $\longrightarrow$ XP$_{int}$. Next, the rule in (154) adds XPlxmC$_{int}$ conjuncts to a set, building the f-structure in (164), which contains the f-structures in (162) and (163) as set elements. Then the rule in (149) rewrites anyLEXSEM to XPlxm$_{int}$ with $\downarrow\in(\uparrow \textsc{udf})$ annotation. As a result, the f-structure in (164) is added as a member of the UDF set, see (165).

(164)
$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{whence}\text{’}\\ \textsc{type} & \textsc{int}\end{array}\right], \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{what}\text{’}\\ \textsc{case} & \textsc{acc}\\ \textsc{type} & \textsc{int}\end{array}\right]\right\}\\ \textsc{conj}\ \ \textsc{and}\end{array}\right]$$

(165)
$$\left[\begin{array}{ll} \textsc{obj} & \left[\textsc{adj}\ \left\{\boxed{3}\right\}\right]\\ \textsc{adj} & \left\{\boxed{4}\right\}\\ \textsc{udf} & \left\{\left[\begin{array}{l} \left\{ \boxed{4}\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{whence}\text{’}\\ \textsc{type} & \textsc{int}\end{array}\right], \boxed{3}\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{what}\text{’}\\ \textsc{case} & \textsc{acc}\\ \textsc{type} & \textsc{int}\end{array}\right]\right\}\\ \textsc{conj}\ \ \textsc{and}\end{array}\right]\right\} \end{array}\right]$$

It is now possible to see and explain the effect of the rule in (156), where XP$_{int}$ has two annotations. While $\uparrow=\downarrow$ builds the f-structures in (162)–(163), which are later used to build the coordinate f-structure in (164), $((\textsc{udf} \in^{*} \uparrow)\ \textsc{xpath}\ \textsc{gf}^{+})=\downarrow$ structure-shares the f-structure of each conjunct. $(\textsc{udf} \in^{*} \uparrow)$ is the path to the top-level f-structure containing the UDF attribute, XPATH defined in (159) produces any sequence (including zero) of XCOMPs (making it possible to embed the f-structure inside verb chains), while $\textsc{gf}^{+}$ produces any non-zero sequence of GFs defined in (160). Together, these equations make it possible to structure-share each conjunct inside the UDF set with any grammatical function that can be reached using this path. As a result of this annotation, in (165) the f-structure $\boxed{4}$ corresponding to *skąd* is structure-shared with the element of the ADJ set at the main level (via resolved $((\textsc{udf} \in^{*} \uparrow)\ \textsc{adj} \in)=\downarrow$ annotation, equivalent to $\downarrow \in ((\textsc{udf} \in^{*} \uparrow)\ \textsc{adj}))$, while the f-structure $\boxed{3}$ corresponding to *jakie* is structure-shared with the element of the ADJ set of the OBJ attribute at the main level (via resolved $((\textsc{udf} \in^{*} \uparrow)\ \textsc{obj}\ \textsc{adj} \in)=\downarrow$ annotation, equivalent to $\downarrow \in ((\textsc{udf} \in^{*} \uparrow)\ \textsc{obj}\ \textsc{adj}))$.

Finally, using the rule in (150), the partial f-structure in (165) corresponding to the coordination of different grammatical functions (*skąd i jakie* ‘where from and what’) is unified with the partial f-structure in (166) corresponding to the rest of the sentence (*otrzymujemy informacje* '(we) get information'), yielding the final f-structure in (161) – a monoclausal representation where all conjuncts belong to the same clause (even though they depend on different heads).

(166)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{receive}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\left[\textsc{pred}\ \ \text{`}\textsc{pro}\text{'}\right] \\ \textsc{obj} & \boxed{2}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{information}\text{'}\\ \textsc{case} & \textsc{acc}\end{array}\right]\end{array}\right]$$

4.4 Multiclausal (including biclausal)

The multiclausal representation, unlike the monoclausal one, is appropriate for instances of coordination of different grammatical functions where conjuncts are dependents of different clauses. Such a representation is suitable when conjuncts cannot be codependents (as in Polish where certain examples would otherwise be ungrammatical). While it may also be preferred for other reasons (as in English and other languages with optional arguments but without pro-drop), this will not be discussed here for reasons of space.

In Polish, there are two cases where the multiclausal analysis of coordination of different grammatical functions is necessary: coordination of the *yes*/*no* interrogative particle CZY with another interrogative item, as in (167), and coordination of relatives, see (168):

(167) Polish
Nie wiadomo było, [[czy] *(i) [kiedy]] wróci.
NEG know was PRT and when returns
'It was not clear whether and when (s)he/it would return.' (NKJP)

(168) Polish
SŁOWA tej księgi pozwalają budować człowieka [[któremu] *(i)
words this book let build man who.DAT and
[z którym]] jest dobrze żyć.
with whom is good live
'Words of this book let one build a man for and with whom it is good to live.' (NKJP)

Patejuk (2015) proposes two representations for multiclausal coordination of different grammatical functions: one involves as many clauses as conjuncts (Section 4.4.1), while the other always involves two clauses (Section 4.4.2). While only the "as many clauses as conjuncts" representation is appropriate for coordination of relatives, coordination of CZY with other interrogative items may be analysed using either representation. The difference is visible with more than two conjuncts, so let us consider an example with three conjuncts:

(169) Polish

[[Czy],	[kiedy]	i	[kto]]	zajmie się	drogami	[...]	nie	wiadomo.
PRT	when	and	who.NOM	take care	roads.INS		NEG	known

'It is not known, whether, who and when will take care of the roads.'

(NKJP)

4.4.1 As many clauses as conjuncts

These rules produce the representation where it is possible to have more than two clauses:

(170)
$$\begin{array}{cccccc} \text{XPlxb}_{rel} & \longrightarrow & \text{XPextrbicl}_{rel} & [,\ \text{XPextrbicl}_{rel}]^{*} & \text{Conj} & \text{XPextrbicl}_{rel} \\ & & \downarrow\in\uparrow & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

(171)
$$\begin{array}{cccccc} \text{XPlxb}_{int} & \longrightarrow & \text{PARTbicl}_{int} & [,\ \text{XPextrbicl}_{int}]^{*} & \text{Conj} & \text{XPextrbicl}_{int} \\ & & \downarrow\in\uparrow & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

(172)
$$\begin{array}{ccc} \text{PARTbicl}_{type} & \longrightarrow & \text{PART}_{type} \\ & & \uparrow=\downarrow \\ & & @\textsc{prodrop} \end{array}$$

(173)
$$\begin{array}{ccc} \text{XPextrbicl}_{type} & \longrightarrow & \text{XPextr}_{type} \\ & & \downarrow\in(\uparrow \textsc{udf}) \\ & & @\textsc{prodrop} \end{array}$$

(174)
$$\begin{array}{ccl} \textsc{prodrop} & \equiv & ((\uparrow \textsc{subj pred})=\text{`}\textsc{pro}\text{'}) \\ & & ((\uparrow \textsc{obj pred})=\text{`}\textsc{pro}\text{'}) \\ & & \dots \\ & & ((\uparrow \textsc{gf pred})=\text{`}\textsc{pro}\text{'}) \end{array}$$

(170)–(171) are the topmost rules handling bi/multiclausal (hence "b" in XPlxb, while "m" stands for "monoclausal" in XPlxm) coordination of different grammatical functions where XPlxb rewrites to a sequence of conjuncts: relative (XPextrbicl_{rel}) in (170), or interrogative in (171) – with PARTbicl_{int} (the *yes*/*no* interrogative particle CZY) as the first conjunct and XPextrbicl_{int} as the remaining conjuncts. According to (172)–(173), PARTbicl_{type} and XPextrbicl_{type} rewrite to PART_{type} and XPextr_{type}, respectively; both right-hand side categories contain calls to the PRODROP template defined in (174). It contains conjoined optional statements, so each call may optionally introduce various implicit arguments (in case these are not filled locally, which would violate completeness).

Together with (149)–(150) and (156)–(160), rules in (171)–(174) produce the following multiclausal f-structure for (169) (leaving out the contribution of *nie wiadomo*):

(175)
$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \text{PRED} & \text{`TAKE\_CARE}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{1}\left[\text{PRED `PRO'}\right] \\ \text{OBL} & \boxed{2}\left[\text{PRED `ROADS'}\right] \\ \text{CLAUSE-TYPE} & \text{INT} \end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{`TAKE\_CARE}\langle\boxed{3},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{3}\left[\text{PRED `PRO'}\right] \\ \text{OBL} & \boxed{2} \\ \text{ADJ} & \left\{\boxed{4}\right\} \\ \text{UDF} & \left\{\boxed{4}\left[\begin{array}{ll} \text{PRED} & \text{`WHEN'} \\ \text{TYPE} & \text{INT} \end{array}\right]\right\} \end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{`TAKE\_CARE}\langle\boxed{5},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{5} \\ \text{OBL} & \boxed{2} \\ \text{UDF} & \left\{\boxed{5}\left[\begin{array}{ll} \text{PRED} & \text{`WHO'} \\ \text{TYPE} & \text{INT} \end{array}\right]\right\} \end{array}\right] \right\} \\ \text{CONJ} \quad \text{AND} \end{array}\right]$$

(Patejuk 2015: (5.239))

To better understand this multiclausal analysis, let us consider its procedural intuition showing how the f-structure in (175) is built using the rules listed above.

(176)–(178) are the f-structures built by the words *czy* ‘whether’, *kiedy* ‘when’ and *kto* ‘who’ which correspond to categories PART$_{int}$, ADVP$_{int}$ and NP$_{int}$, respectively:

(176)
$$\left[\begin{array}{ll} \text{CLAUSE-TYPE} & \text{INT} \end{array}\right]$$

(177)
$$\left[\begin{array}{ll} \text{PRED} & \text{`WHEN'} \\ \text{TYPE} & \text{INT} \end{array}\right]$$

(178)
$$\left[\begin{array}{ll} \text{PRED} & \text{`WHO'} \\ \text{TYPE} & \text{INT} \end{array}\right]$$

According to (157), ADVP$_{int}$ and NP$_{int}$ are instances of the XP$_{int}$ metacategory. The rule in (173) rewrites XPextrbicl$_{int}$ to XPextr$_{int}$, while (156) rewrites XPextr$_{int}$ to XP$_{int}$ (so: XPextrbicl$_{int}$ $\longrightarrow$ XPextr$_{int}$ $\longrightarrow$ XP$_{int}$). The rule in (172) rewrites PARTbicl$_{int}$ to PART$_{int}$. The f-structures below built by these rules contain the contributions of calls to the PRODROP template as well as structure-sharing via UDF (resulting from the annotation in (156)): (179) corresponds to PARTbicl$_{int}$, while (180)-(181) correspond to XPextrbicl$_{int}$.

(179)
$$\left[\begin{array}{ll} \text{SUBJ} & \left[\text{PRED `PRO'}\right] \\ \text{CLAUSE-TYPE} & \text{INT} \end{array}\right]$$

(180)
$$\left[\begin{array}{ll} \text{SUBJ} & \left[\text{PRED `PRO'}\right] \\ \text{ADJ} & \left\{\boxed{4}\right\} \\ \text{UDF} & \left\{\boxed{4}\left[\begin{array}{ll} \text{PRED} & \text{`WHEN'} \\ \text{TYPE} & \text{INT} \end{array}\right]\right\} \end{array}\right]$$

(181) $$\left[\begin{array}{ll} \textsc{subj} & \boxed{5} \\ \textsc{udf} & \left\{ \boxed{5}\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{who}\text{’} \\ \textsc{type} & \textsc{int} \end{array}\right] \right\} \end{array}\right]$$

(179) consists of (176) (contributed by *czy*, the first conjunct) and an implicit subject introduced by the first optional equation in the PRODROP template defined in (174). (180) consists of (177) (contributed by *kiedy*, the second conjunct) added to the UDF set using (173) as $\boxed{4}$ and structure-shared using (156) as a member of the ADJ set of the main-level f-structure; it also contains an implicit subject introduced by PRODROP. (181) consists of (178) (contributed by *kto*, the third conjunct) added to the UDF set as $\boxed{5}$ and structure-shared with the value of the SUBJ attribute of the main-level f-structure. (181) does not contain any contributions of PRODROP – all statements in (174) are optional.

Using the rule in (171) which handles coordination of interrogative items corresponding to different grammatical functions, the f-structures in (179)–(181) are added to a set, yielding the f-structure in (182) which corresponds to XPlxb_{int}. The rule in (149) rewrites any LEXSEM to XPlxb_{int} without any annotation (so it is interpreted as ↓=↑ by default).

(182) $$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \textsc{subj} & \left[\textsc{pred}\ \text{‘}\textsc{pro}\text{’}\right] \\ \textsc{clause-type} & \textsc{int} \end{array}\right], \left[\begin{array}{ll} \textsc{subj} & \left[\textsc{pred}\ \text{‘}\textsc{pro}\text{’}\right] \\ \textsc{adj} & \left\{\boxed{4}\right\} \\ \textsc{udf} & \left\{ \boxed{4}\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{when}\text{’} \\ \textsc{type} & \textsc{int} \end{array}\right] \right\} \end{array}\right], \left[\begin{array}{ll} \textsc{subj} & \boxed{5} \\ \textsc{udf} & \left\{ \boxed{5}\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{who}\text{’} \\ \textsc{type} & \textsc{int} \end{array}\right] \right\} \end{array}\right] \right\} \\ \textsc{conj}\ \ \textsc{and} \end{array}\right]$$

(183) $$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{take\_care}\langle\textsc{subj},\boxed{2}\rangle\text{’} \\ \textsc{obl} & \boxed{2}\left[\textsc{pred}\ \text{‘}\textsc{roads}\text{’}\right] \end{array}\right]$$

Finally, using the rule in (150), the f-structure in (182) corresponding to the coordination of different grammatical functions (*czy, kiedy i kto* ‘whether, when and who’) is unified with the f-structure in (183) corresponding to the rest of the sentence (*zajmie się drogami* ‘will take care of the roads’), yielding (175) as the final f-structure for (169) – it is a multiclausal representation where each conjunct belongs to a different clause.

While the multiclausal representation presented above is simple (there are as many clauses as conjuncts), it has some shortcomings. Since each clause has its own call to the PRODROP template, this can result in multiple implicit pronouns, as in (175) where the first two clauses have different implicit subjects – even though they look the same, they are distinct entities. While this could be solved by coindexation, such a representation is not economical.

There is another issue related to economy of representation: while the *yes*/*no* interrogative particle CZY cannot be placed in the same clause as other interrogative items (such as *skąd* 'where' or *kto* 'who'), interrogative items other than CZY can be co-dependents, which means these could be placed in the same clause. This observation is the reason for exploring the alternative multiclausal (biclausal) representation discussed in Section 4.4.2 below.

4.4.2 Always two conjuncts

The following rules are used to obtain a biclausal representation of coordination of different grammatical functions – one that always involves two coordinated clauses: the first clause contains PARTbicl$_{int}$, while the second one contains XPextrbicl$_{int}$. If such coordination involves more than two conjuncts, as in (169), the second clause is analysed an instance of monoclausal coordination of different grammatical functions (XPlxm$_{type}$, see Section 4.3) – such cases involve embedded monoclausal coordination in the second conjunct.

(184)
$$\text{XPlxb}_{int} \longrightarrow \underset{\downarrow\in\uparrow}{\text{PARTbicl}_{int}}\quad \text{Conj}\quad \underset{\downarrow\in\uparrow}{\text{XPextrbicl}_{int}}$$

(185)
$$\text{XPextrbicl}_{type} \longrightarrow \left\{ \begin{array}{c|c} \text{XPextr}_{type} & \text{XPlxm}_{type} \\ \downarrow\in(\uparrow \text{ UDF}) & \downarrow\in(\uparrow \text{ UDF}) \\ \text{@PRODROP} & \text{@PRODROP} \end{array} \right\}$$

Together with (149)–(150), (154)–(160), (172) and (174), the rules in (184)–(185) produce the f-structure in (186) for (169). (186) consists of two clauses: the first one contains the *yes*/*no* interrogative particle CZY, while the second clause involves monoclausal coordination of *kiedy* 'when' and *kto* 'who' in the UDF attribute, whose elements are structure-shared with the relevant dependents of this clause (ADJ and SUBJ, respectively).

(186)
$$\left\{ \begin{bmatrix} \text{PRED} & \text{'TAKE\_CARE}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{1}\begin{bmatrix}\text{PRED} & \text{'PRO'}\end{bmatrix} \\ \text{OBL} & \boxed{2}\begin{bmatrix}\text{PRED} & \text{'ROADS'}\end{bmatrix} \\ \text{CLAUSE-TYPE} & \text{INT}\end{bmatrix}, \begin{bmatrix} \text{PRED} & \text{'TAKE\_CARE}\langle\boxed{3},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{3} \\ \text{OBL} & \boxed{2} \\ \text{ADJ} & \{\boxed{4}\} \\ \text{UDF} & \left\{\begin{bmatrix} \left\{\boxed{4}\begin{bmatrix}\text{PRED} & \text{'WHEN'}\\ \text{TYPE} & \text{INT}\end{bmatrix}, \boxed{3}\begin{bmatrix}\text{PRED} & \text{'WHO'}\\ \text{TYPE} & \text{INT}\end{bmatrix}\right\} \\ \text{CONJ} \quad \text{AND} \end{bmatrix}\right\} \end{bmatrix} \right\}$$

(Patejuk 2015: (5.244))

The f-structures produced by the words *czy*, *kiedy* and *kto* are the same as in (176)–(178).

While the f-structure corresponding to PARTbicl$_{int}$ is the same as in (179), the f-structure corresponding to XPextrbicl$_{int}$ is different from what is described in Section 4.4.1. According to the rule in (185), XPextrbicl$_{int}$ rewrites to XPextr$_{int}$ or XPlxm$_{int}$. (169) involves three conjuncts: the first one (*czy*) corresponds to PARTbicl$_{int}$, while the remaining two must be analysed as XPlxm$_{int}$ – as monoclausal coordination of different grammatical functions described in Section 4.3. Rules presented there produce the f-structure in (187) for *kiedy i kto*:

(187)
$$\begin{bmatrix} \textsc{subj} & \boxed{3} \\ \textsc{adj} & \left\{\boxed{4}\right\} \\ \textsc{udf} & \left\{\begin{bmatrix} \left\{\boxed{4}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{when}\text{'}\\ \textsc{type} & \textsc{int}\end{bmatrix}, \boxed{3}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{who}\text{'}\\ \textsc{type} & \textsc{int}\end{bmatrix}\right\} \\ \textsc{conj} \quad \textsc{and} \end{bmatrix}\right\} \end{bmatrix}$$

Using the topmost rule for biclausal coordination of different grammatical functions in (184), the f-structures corresponding to PARTbicl$_{int}$ and XPextrbicl$_{int}$, (179) and (187), respectively, are added to a set, producing the f-structure in (188) for *czy, kiedy i kto*.

(188)
$$\left\{ \begin{bmatrix} \textsc{subj} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{pro}\text{'}\end{bmatrix} \\ \textsc{clause-type} & \textsc{int} \end{bmatrix}, \begin{bmatrix} \textsc{subj} & \boxed{3} \\ \textsc{adj} & \left\{\boxed{4}\right\} \\ \textsc{udf} & \left\{\begin{bmatrix} \left\{\boxed{4}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{when}\text{'}\\ \textsc{type} & \textsc{int}\end{bmatrix}, \boxed{3}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{who}\text{'}\\ \textsc{type} & \textsc{int}\end{bmatrix}\right\} \\ \textsc{conj} \quad \textsc{and} \end{bmatrix}\right\} \end{bmatrix} \right\}$$

Finally, the f-structure in (188) corresponding to *czy, kiedy i kto* is unified with the f-structure in (183) corresponding to the rest of the sentence (*zajmie się drogami*), yielding the f-structure in (186) as the final representation of (169).

Unlike (175) discussed in Section 4.4.1, the representation in (186) is biclausal: the first clause contains the first conjunct (*czy*), while the second clause contains the remaining conjuncts (second *kiedy* and third *kto*) analysed as monoclausal coordination of different grammatical functions (Section 4.3). As a consequence, (186) uses only one implicit argument (the subject of the first clause), making it a more economic representation of (169) than (175).[43]

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[43] The place where the conjunction is represented is another difference between (175) and (186). While in (175) it joins the three clauses, in (186) it joins the last two conjuncts inside the UDF set in the second clause. Patejuk (2015: 131) addresses this issue by copying the conjunction from UDF to the clause level.

5 Coordination and ellipsis

This section discusses selected phenomena involving multiclausal structures and ellipsis. In German Subject Gap in Finite/Fronted (SGF) construction and Polish "intertwined" coordination a dependent is shared by clauses headed by different predicates, while gapping involves sharing at least the main predicate.

5.1 SGF: Subject Gap in Finite/Fronted construction

Frank (2002) offers an analysis of the German SGF:

(189) German
[[In den Wald ging der Jäger] und [fing einen Hasen]].
into the forest went the hunter and caught a rabbit
'The hunter went into the forest and caught a rabbit.'
(Frank 2002: (4), from Wunderlich 1988)

As shown in (189), SGF involves coordination of clauses (headed by different verbs) with a shared subject which is placed inside the first clause (rather than to the left or to the right of the coordinated clauses, which would make dependent sharing straightforward).

Examples such as (189) are handled using (190), a dedicated c-structure rule for CP-level coordination which optionally structure-shares the GDF (grammaticalised discourse function) inside the first conjunct so that it is distributed across all conjuncts. While, following Bresnan (2001), GDF is defined in (191) as SUBJ, TOPIC or FOCUS, in German SGF it is further restricted – it must be the subject, as explained in Frank (2002).

(190)
$$\text{CP} \longrightarrow \begin{array}{c}\text{CP}\\ \downarrow\in\uparrow\\ ((\downarrow \textsc{gdf})=(\uparrow \textsc{gdf}))\end{array} \quad \begin{array}{c}\text{Conj}\\ \\ \\ \end{array} \quad \begin{array}{c}\text{CP}\\ \downarrow\in\uparrow\\ \\ \end{array}$$

(191) $\textsc{gdf} \equiv \{\textsc{subj}|\textsc{topic}|\textsc{focus}\}$

The structures below,[44] created using (190), correspond to (189). Even though the NP *der Jäger* belongs exclusively to the first conjunct in the c-structure in (193), the corresponding f-structure fragment, $\boxed{1}$, is structure-shared by both conjuncts in (192).

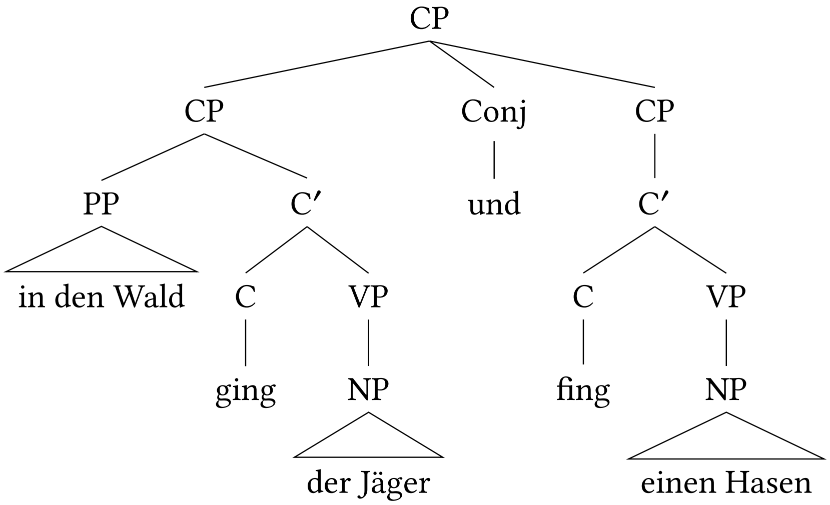
---

[44] (192)-(193) are a modified (normalised/translated) version of Frank (2002: (36)).

(192)

$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \text{PRED} & \text{`GO}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{1}\left[\text{PRED `HUNTER'}\right] \\ \text{OBL} & \boxed{2}\left[\begin{array}{ll} \text{PRED} & \text{`INTO}\langle\boxed{3}\rangle\text{'} \\ \text{OBJ} & \boxed{3}\left[\text{PRED `FOREST'}\right]\end{array}\right] \\ \text{TOPIC} & \boxed{2}\end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{`CATCH}\langle\boxed{1},\boxed{4}\rangle\text{'} \\ \text{SUBJ} & \boxed{1} \\ \text{OBJ} & \boxed{4}\left[\text{PRED `RABBIT'}\right]\end{array}\right] \right\} \\ \text{CONJ} \quad \text{AND} \end{array}\right]$$

(193)



5.2 Sharing "intertwined" dependents

Discussing coordination data from Polish,[45] Patejuk & Przepiórkowski (2015) offer an analysis of "intertwined" dependents – dependents which are interpreted as shared by all conjuncts, even though they are placed inside the first conjunct, like the subject in German SGF discussed in Section 5.1. However, there are fewer restrictions in Polish – unlike in German, it seems that any dependent may be shared: subject in (194), object in (195) and even particles such as *się*, as in (196) where it is a reciprocal marker (RECP).

(194) Polish
[[Przyjechali żandarmi] i [chodzili od domu do
came.PL.M1 soldier.NOM.PL.M1 and walked.PL.M1 from house to
domu]].
house
'Soldiers came and walked from house to house.' (NKJP)

---

[45] Except for (203)–(204), all examples in Section 5.2 are from Patejuk & Przepiórkowski (2015).

(195) Polish
[[Zakleiła kopertę] i [wepchnęła do torebki]].
sealed.SG.F envelope.ACC and stuffed.SG.F into handbag
'She sealed the envelope and stuffed it into the handbag.' (NKJP)

(196) Polish
[[Całowali się] i [przytulali]]!
kissed.PL.M1 RECP|RECP and hugged.PL.M1
'They were kissing and hugging each other!' (Google)

While (194) and (195) could also be analysed as involving an implicit argument (an instance of pro-drop) in the second conjunct coreferent (via coindexation) with the appropriate argument (subject or object) in the first conjunct, this does not apply to (196). This is because *się* is analysed as a marker: it is not put on the list of arguments (the verbs in (196) only take a subject), so it cannot be analysed as an implicit argument.

As discussed in Patejuk & Przepiórkowski (2015), *się* has many functions in Polish: it can be a reflexive/reciprocal marker, an impersonal marker, or it can be "inherent" – a semantically contentless particle that is required lexically by certain predicates. In (196) the shared *się* has the same function (reciprocal) with respect to both predicates (KISS and HUG) – this is glossed as RECP|RECP where | separates functions. In (197) the shared marker has a different function in each conjunct – as shown in (198), the first conjunct requires inherent *się* (INH), while the second conjunct takes reflexive *się* (REFL):

(197) Polish
[[Śmiali się] i [pukali w głowy]].
laughed.PL.M1 INH|REFL and knocked.PL.M1 in heads
'They were laughing and asking if somebody is nuts.' (literally: 'They were laughing and knocking themselves on their heads.')

(198) Polish
[[Śmiali się] i [pukali się w głowy]].
laughed.PL.M1 INH and knocked.PL.M1 REFL in heads

On the basis of examples such as (197), Patejuk & Przepiórkowski (2015) argue that the SGF analysis would not be appropriate: not only because *się* is not an argument (it is analysed as a marker, so it is not on the list of arguments), but also because it is a weak, unstressed form (as opposed to the pronoun *siebie* 'self'), so it cannot bear discourse functions such as TOPIC or FOCUS. Also, while the SGF analysis involves distributing a designated grammatical function of the first conjunct (the subject) over the entire coordination, Patejuk & Przepiórkowski (2015) show that structure sharing the f-structure contribution corresponding to *się* would not be appropriate in (197), because the first conjunct requires a different type of *się* than the second conjunct, as shown in (198).

In Patejuk & Przepiórkowski (2015), the word *się* introduces two kinds of constraints: (↑ SIE PRESENT) = +, a defining equation marking that this word is present in the f-structure, and a constraining equation ensuring that the type of *się* is specified elsewhere (by the verb, if it is required lexically, or constructionally for impersonal *się*). Verbs that lexically require *się* also introduce two constraints: a constraining equation requiring the presence of this marker, (↑ SIE PRESENT) $=_c$ +, and a defining equation specifying the type of *się*: (↑ SIE REFL) = + for reflexive *się* and (↑ SIE INH) = + for inherent *się*. If one were to adopt an SGF-like analysis by structure-sharing the SIE attribute of the first conjunct with the entire coordination, the result would be incorrect. This is because the SIE attribute contains the contribution of *się* as well as the verb in the first conjunct, so it would not yield an appropriate analysis of (197): the second verb would have multifunctional *się* (inherent and reflexive), instead of having inherent *się* in the first conjunct and reflexive *się* in the second conjunct. In principle, this problem with the SGF-like analysis could be worked around by using the constraint (↓ SIE PRESENT)=(↑ SIE PRESENT) instead of (↓ SIE)=(↑ SIE) when sharing *się*.

However, instead of an SGF-like analysis, Patejuk & Przepiórkowski (2015) propose an alternative solution by introducing a rule handling coordination with "intertwined" dependents, see (199), where such dependents (DEP) are placed in the c-structure at the same level as the conjuncts (IP) and the conjunction (Conj). This way, the f-structure contribution of DEP, possibly disjunctive or underspecified, can be resolved independently for each conjunct, making it possible to account for examples such as (197). The rules in (199)–(200) produce the structures in (201)–(202) corresponding to (197).[46]

(199)
$$\begin{array}{lccccc} \text{IPtop} & \longrightarrow & \text{IP} & \text{DEP} & \text{Conj} & \text{IP} \\ & & \downarrow\in\uparrow & & & \downarrow\in\uparrow \end{array}$$

(200)
$$\begin{array}{lcccccccc} \text{DEP} & \longrightarrow & \{ & \text{ARG} & | & \text{MOD} & | & \text{RM} & \} \\ & & & (\uparrow \textsc{gf}){=}\downarrow & & \downarrow \in (\uparrow \textsc{adjunct}) & & & \end{array}$$

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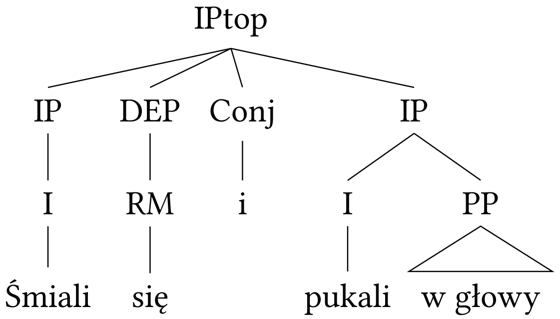
[46] Additional constraints are used to structure-share the implicit subject (see also: (195)–(196)).

(201)



(202)

$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \text{PRED} & \text{`LAUGH}\langle\boxed{1}\rangle\text{'} \\ \text{SUBJ} & \boxed{1}\left[\begin{array}{ll}\text{PRED} & \text{`PRO'}\\ \text{CASE} & \text{NOM}\\ \text{NUM} & \text{PL}\end{array}\right] \\ \text{SIE} & \left[\begin{array}{ll}\text{INH} & +\\ \text{PRESENT} & +\end{array}\right]\end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{`KNOCK}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{1} \\ \text{OBL} & \boxed{2}\left[\begin{array}{ll}\text{PRED} & \text{`HEAD'}\\ \text{PFORM} & \text{W}\end{array}\right] \\ \text{SIE} & \left[\begin{array}{ll}\text{REFL} & +\\ \text{PRESENT} & +\end{array}\right]\end{array}\right] \right\} \\ \text{CONJ}\quad\text{AND}\end{array}\right]$$

(Patejuk & Przepiórkowski 2015: (64))

The defining equation (↑ SIE PRESENT) = + introduced by *się* is distributed across coordination in (201), together with the constraining equation requiring that the type of *się* is specified ((↑ SIE {REFL|RECP|INH}) $=_c$ +). The latter is resolved independently for each conjunct: the type of *się* is specified by the lexical entry of the verb; it is inherent (INH) in the first conjunct, while in the second it is reflexive (REFL), as shown in (202).

The analysis of Patejuk & Przepiórkowski (2015) could be used for German SGF: while the c-structure would be different, the corresponding f-structure would be the same.

Apart from the analysis of shared *się*, there is one more situation which clearly distinguishes between the effects of the analysis of Patejuk & Przepiórkowski (2015) and an SGF-like analysis: when a shared dependent displays case syncretism that is disambiguated by predicates requiring different values of case, as in the following example:

(203) Polish

[[Marysia	lubi	Janka]],	a	[Zosia	nienawidzi]].
Marysia.NOM	likes	Janek.ACC/GEN	and	Zosia.NOM	hates

‘Marysia likes Janek, while Zosia hates him.’

In this example, the first verb (*lubi* ‘likes’) requires an accusative object (in the absence of sentential negation), while the second verb (*nienawidzi* ‘hates’) requires a genitive object – the form *Janka* is syncretic between accusative and genitive, so it can be used as the object of both predicates, despite their different case requirements.

Except for word order, (203) is analogous to (204) (originally from Dyła (1984)):

(204) Polish
Kogo [[Janek lubi] a [Jerzy nienawidzi]]?
who.ACC/GEN Janek.NOM likes and Jerzy.NOM hates
'Who does Janek like and Jerzy hate?' (Dalrymple et al. 2009: (10))

Dalrymple et al. (2009) offer an analysis of (204) which involves a complex CASE attribute (instead of atomic values used so far for CASE), making it possible to account for case syncretism and feature indeterminacy. The lexical entry of the noun *kogo* (the same applies to *Janka* in (203)) contains a disjunctive specification of case: (↑ CASE {ACC|GEN}) = +, while lexical entries of verbs assign appropriate values of case to their object: (↑ OBJ CASE ACC) = + for *lubi* (when there is no sentential negation) and (↑ OBJ CASE GEN) = + for *nienawidzi*. Under such an analysis, the f-structure in (205) corresponds to (204).[47]

(205)

$$\left[\begin{array}{l} \left\{ \left[\begin{array}{ll} \text{PRED} & \text{`LIKE}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{1}\left[\begin{array}{ll}\text{PRED} & \text{`JANEK'}\\ \text{CASE} & \text{NOM}\end{array}\right] \\ \text{OBJ} & \boxed{2}\left[\begin{array}{ll}\text{PRED} & \text{`WHO'}\\ \text{CASE} & \left[\text{ACC}\ +\right]\end{array}\right]\end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{`HATE}\langle\boxed{3},\boxed{4}\rangle\text{'} \\ \text{SUBJ} & \boxed{3}\left[\begin{array}{ll}\text{PRED} & \text{`JERZY'}\\ \text{CASE} & \text{NOM}\end{array}\right] \\ \text{OBJ} & \boxed{4}\left[\begin{array}{ll}\text{PRED} & \text{`WHO'}\\ \text{CASE} & \left[\text{GEN}\ +\right]\end{array}\right]\end{array}\right] \right\} \\ \text{CONJ} \quad \text{AND} \end{array}\right]$$

Coming back to (203): under an SGF-like analysis the accusative object of the first conjunct is distributed over the entire coordination, so the object of the first conjunct would be marked for accusative case, while the object of the second conjunct would be marked for accusative and genitive case – this is undesired. By contrast, under the account of Patejuk & Przepiórkowski (2015) case is assigned independently in each conjunct (rather than being copied from the first conjunct), so the f-structure representation of (203) would be analogous to (205): the object of the first conjunct would only be marked for accusative case, while the object of the second conjunct would only bear genitive case.

5.3 Gapping

Gapping is a variety of clause-level coordination where certain elements of the first conjunct (the non-gapped conjunct, the conjunct without a gap) are shared

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[47] In Dalrymple et al. (2009) NPs lexically specify impossible values of CASE as −. To save space, these attribute-value pairs are omitted in (205). For OBJ these are: NOM −, DAT −, INST −, LOC −, VOC −.

(marked with underline) with the second conjunct (the gapped conjunct, the conjunct with some gap(s)). Minimally the main verb is shared, as in (206), but some of its dependents may also be shared, as in (207) where the direct object (*an apple*) is also shared.

(206) [[Marge gave an apple to Lisa], and [Homer a donut to Bart]]. (Patejuk & Przepiórkowski 2017: (1))

(207) [[Marge gave an apple to Lisa], and [Homer to Bart]]. (Patejuk & Przepiórkowski 2017: (2))

5.3.1 Basics of the Patejuk & Przepiórkowski (2017) analysis

Patejuk & Przepiórkowski (2017) offer an LFG analysis of gapping which relies on two key features: the set-based representation of coordination and distribution. The material in the first conjunct (the verb and all its dependents) is split into two parts: shared and non-shared. The shared material is distributed over the coordination of non-shared material, namely the set which contains non-shared material from the first conjunct and the partial f-structure produced by dependents in the second conjunct.

The analysis relies on the rules shown in (208)–(211). (208) is the main coordination rule for gapping where IP1 is the non-gapped conjunct (defined in (209)),[48] while IP is the gapped conjunct (see (210)).[49] Each dependent (DEP, see its definition in (211)) of the non-gapped conjunct (IP1) may be shared or not. This is achieved using the annotation (↑ (LOCAL))=↓ on DEP in (209), which resolves to one of two possible annotations: ↑=↓ distributes the DEP over the entire coordination (so that it is shared by all conjuncts: non-gapped and gapped), while (↑ LOCAL)=↓ makes it belong to the non-gapped conjunct only (it is not distributed over coordination in gapping). Finally, each dependent (DEP, in IP1 and IP) is assigned appropriate f-structure annotation (including GF) in (211).

(208)
$$\begin{array}{llcccc}
\text{IP} & \longrightarrow & \text{IP1} & [,\ \text{IP}]^{*} & \text{Conj} & \text{IP} \\
 & & \uparrow=\downarrow & \downarrow\in\uparrow & & \downarrow\in\uparrow \\
 & & (\downarrow \textsc{local}) \in \uparrow & & &
\end{array}$$

(209)
$$\begin{array}{llcc}
\text{IP1} & \longrightarrow & \text{DEP}^{*}, & \text{I} \\
 & & (\uparrow (\textsc{local})) = \downarrow &
\end{array}$$

---

[48] IP1 may contain negation: sentential negation is a prefix in Polish (though it may be separated from the verb by whitespace), so it is part of I. However, negation in the gapped conjunct is not a prefix (there is no verb, it is gapped) and it comes as the last element – this is why (210) contains an extra NEG.

[49] The optional NEG (sentential negation) in (210) is required by Polish examples such as (226).

(210) $\text{IP} \longrightarrow [\text{DEP}^{*},\ (\text{I})]\ \ (\text{NEG})$

(211) $$\text{DEP} \equiv \left\{ \begin{array}{c|c|c|c} \text{NP} & \text{PP} & \text{InfP} & \ldots \\ (\uparrow \{\textsc{subj}|\textsc{obj}\}) = \downarrow & (\uparrow \textsc{obl}) = \downarrow & (\uparrow \textsc{xcomp}) = \downarrow & \end{array} \right\}$$

Together, these rules give rise to (212) as the f-structure corresponding to (206).

(212) $$\left[\begin{array}{ll} \multicolumn{2}{l}{\left\{ \boxed{0} \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{give}\langle\boxed{1},\boxed{2},\boxed{3}\rangle\text{'} \\ \textsc{subj} & \boxed{1}\left[\textsc{pred}\ \text{`Marge'}\right] \\ \textsc{obj} & \boxed{2}\left[\textsc{pred}\ \text{`}\textsc{apple}\text{'}\right] \\ \textsc{obl} & \boxed{3}\left[\textsc{pred}\ \text{`Lisa'}\right] \end{array}\right], \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{give}\langle\boxed{4},\boxed{5},\boxed{6}\rangle\text{'} \\ \textsc{subj} & \boxed{4}\left[\textsc{pred}\ \text{`Homer'}\right] \\ \textsc{obj} & \boxed{5}\left[\textsc{pred}\ \text{`}\textsc{donut}\text{'}\right] \\ \textsc{obl} & \boxed{6}\left[\textsc{pred}\ \text{`Bart'}\right] \end{array}\right] \right\}} \\ \textsc{conj} & \textsc{and} \\ \textsc{local} & \boxed{0} \end{array}\right]$$

(Patejuk & Przepiórkowski 2017: (19))

What follows is a procedural intuition of this analysis, showing how (212) is constructed.

(213) is the partial f-structure corresponding to the first (non-gapped) conjunct, constructed using the rules in (209) and (211). Using (211), each dependent of the first conjunct is assigned an appropriate GF, as shown in (214)–(216): *Marge* is the SUBJ(ect), *an apple* is the OBJ(ect), *to Lisa* is an OBL(ique). According to (209), the main verb is shared (by default, it has the co-head annotation: ↓=↑), while each of its dependents (DEP) may be shared or not. In (206) the annotation of all dependents resolves to (↑ LOCAL)=↓, so they are not shared. This results in the partial f-structure in (213) corresponding to IP1.

(213) $$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{give}\langle\textsc{subj},\textsc{obj},\textsc{obl}\rangle\text{'} \\ \textsc{local} & \boxed{0}\left[\begin{array}{ll} \textsc{subj} & \left[\textsc{pred}\ \text{`Marge'}\right] \\ \textsc{obj} & \left[\textsc{pred}\ \text{`}\textsc{apple}\text{'}\right] \\ \textsc{obl} & \left[\textsc{pred}\ \text{`Lisa'}\right] \end{array}\right] \end{array}\right]$$

(214) $\left[\textsc{subj}\ \left[\textsc{pred}\ \text{`Marge'}\right]\right]$

(215) $\left[\textsc{obj}\ \left[\textsc{pred}\ \text{`}\textsc{apple}\text{'}\right]\right]$

(216) $\left[\textsc{obl}\ \left[\textsc{pred}\ \text{`Lisa'}\right]\right]$

(217) is the partial f-structure corresponding to the second (gapped) conjunct, constructed using the rules in (210) and (211). Using (211), each dependent (DEP) is assigned an appropriate GF, as shown in (218)–(220). According to (210), all dependents (DEP) of the gapped conjunct (IP) have the default co-head annotation, so their partial f-structures are unified, yielding (217) as the partial f-structure corresponding to IP (gapped conjunct).

(217) $$\begin{bmatrix} \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Homer}\text{’}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{donut}\text{’}\end{bmatrix} \\ \textsc{obl} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Bart}\text{’}\end{bmatrix} \end{bmatrix}$$

(218) $$\begin{bmatrix} \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Homer}\text{’}\end{bmatrix} \end{bmatrix}$$

(219) $$\begin{bmatrix} \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{donut}\text{’}\end{bmatrix} \end{bmatrix}$$

(220) $$\begin{bmatrix} \textsc{obl} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Bart}\text{’}\end{bmatrix} \end{bmatrix}$$

The final step is to apply the gapping coordination rule in (208). While it does two things at the same time, this will be presented as two separate steps for the sake of exposition. The first effect of (208) is to produce (221) – the partial f-structure corresponding to the coordination of non-shared material from both conjuncts. As a result of the (↓ LOCAL) ∈ ↑ annotation on the non-gapped conjunct (IP1) in (208), the content of its LOCAL attribute is added to the set (see (213) for the f-structure of the non-gapped conjunct); the standard ↓∈↑ annotation on the gapped conjunct (IP) adds its f-structure (see (217)) to the set.

(221) $$\left[\begin{array}{l} \left\{ \boxed{0}\begin{bmatrix} \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Marge}\text{’}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{apple}\text{’}\end{bmatrix} \\ \textsc{obl} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Lisa}\text{’}\end{bmatrix} \end{bmatrix}, \begin{bmatrix} \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Homer}\text{’}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{donut}\text{’}\end{bmatrix} \\ \textsc{obl} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{Bart}\text{’}\end{bmatrix} \end{bmatrix} \right\} \\ \textsc{conj} \quad \textsc{and} \end{array}\right]$$

The second effect of (208), resulting from the ↓=↑ annotation on IP1, is to distribute the partial f-structure in (213), corresponding to the shared material from the first conjunct,[50] over the f-structure in (221) which corresponds to the coordination of non-shared material from both conjuncts. The result of this operation is (212): the final f-structure for (206).

5.3.2 Distribution under gapping: Interactions with other phenomena

Patejuk & Przepiórkowski (2017) discuss interactions between the proposed analysis of gapping, which relies on distribution, and other phenomena, including subject-verb agreement, case assignment and unlike category coordination.

Unlike in (206)–(207), where the verb form used in the first conjunct (*gave*) would also be appropriate in the second conjunct (if it was present), there are examples where different agreement features would be required in different conjuncts, as in (222) from Polish, see the corresponding f-structure in (223):

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[50] Apart from the main predicate, this includes the LOCAL attribute – this is the desired result (Section 5.3.2).

(222) Polish

[[Lisa	lubiła	Nelsona],	a	[Nelson	(lubił)	Lisę]].
Lisa.NOM.F	liked.F	Nelson.ACC.M1	and	Nelson.NOM.M1	liked.M1	Lisa.ACC.F

'Lisa liked Nelson and Nelson (liked) Lisa.'

(Patejuk & Przepiórkowski 2017: (28))

(223)

$$\left[\begin{array}{l}
\left\{ \boxed{0} \left[\begin{array}{ll} \text{PRED} & \text{`LIKE}\langle\boxed{1},\boxed{2}\rangle\text{'} \\ \text{SUBJ} & \boxed{1}\left[\begin{array}{ll}\text{PRED} & \text{`LISA'}\\ \text{CASE} & \text{NOM}\\ \text{GEND} & \text{F}\end{array}\right] \\ \text{OBJ} & \boxed{2}\left[\begin{array}{ll}\text{PRED} & \text{`NELSON'}\\ \text{CASE} & \text{ACC}\\ \text{GEND} & \text{M1}\end{array}\right]\end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{`LIKE}\langle\boxed{3},\boxed{4}\rangle\text{'} \\ \text{SUBJ} & \boxed{3}\left[\begin{array}{ll}\text{PRED} & \text{`NELSON'}\\ \text{CASE} & \text{NOM}\\ \text{GEND} & \text{M1}\end{array}\right] \\ \text{OBJ} & \boxed{4}\left[\begin{array}{ll}\text{PRED} & \text{`LISA'}\\ \text{CASE} & \text{ACC}\\ \text{GEND} & \text{F}\end{array}\right]\end{array}\right]\right\} \\
\text{CONJ} \quad \text{AND} \\
\text{LOCAL} \quad \boxed{0}
\end{array}\right]$$

(Patejuk & Przepiórkowski 2017: (29))

The key feature of the analysis presented above is that it distributes the verb from first conjunct over the entire coordination – as a result, all constraints imposed by the verb are distributed. Assuming a standard account of S-V agreement, where it is handled in the lexical entries of verbs (requiring the subject to satisfy certain agreement constraints, as in (224) where the subject must be singular and feminine), such requirements are distributed to each conjunct, so the subject of each conjunct must satisfy these requirements.

(224) $(\uparrow \text{SUBJ NUM}) =_c \text{SG} \wedge (\uparrow \text{SUBJ GEND}) =_c \text{F}$

This is problematic in (222), where the verb *lubiła* 'liked' in the first conjunct requires a singular feminine subject. While *lubiła* is compatible with *Lisa* in the first conjunct, it is not appropriate for *Nelson* in the second (gapped) conjunct. Though *Nelson* is singular, it is masculine – so it would be compatible with the masculine verb form *lubił*.

Patejuk & Przepiórkowski (2017) offer a solution, presenting it as conceptually similar to single conjunct agreement (see Section 1.4), where, instead of agreeing with the entire subject, the verb may agree with a designated conjunct as the agreement target. The proposed solution accounts for potential mismatches in S-V agreement between the first conjunct (without a gap) and the gapped conjunct using the LOCAL attribute, which contains the non-shared material from the first conjunct. (225) below is a modified version of (224).

(225) $[\%\textsc{s} = (\uparrow \textsc{subj}) \vee \%\textsc{s} = (\uparrow \textsc{local}\ \textsc{subj})] \wedge$
$[(\%\textsc{s}\ \textsc{num}) =_c \textsc{sg} \wedge (\%\textsc{s}\ \textsc{gend}) =_c \textsc{f}]$

While (224) uniformly requires the subject to be singular and feminine, (225) has a disjunctive specification of the agreement target (%s). The constraint in (225) is distributed to all conjuncts, where it is resolved independently. When %s resolves to (↑ subj), (225) has the same effect as (224), requiring the subject of the given conjunct to satisfy these constraints – it is not satisfied in the second conjunct of (222). However, when %s resolves to (↑ local subj) in the second conjunct, the relevant agreement requirements are trivially satisfied, because they are checked against the subj inside the local attribute (see the f-structure in (223)) – instead of the subj attribute of the given conjunct.

The fact that constraints imposed by the verb are distributed to all conjuncts and resolved independently in each conjunct makes it possible to account for independent case assignment in gapping. Consider (226) with the corresponding f-structure in (227).

(226) Polish
[[Lisa lubiła Nelsona], a [Nelson Lisy nie]].
Lisa.nom.f liked.f Nelson.acc.m1 but Nelson.nom.m1 Lisa.gen.f neg
'Lisa liked Nelson, but Nelson didn't like Lisa.'
(Patejuk & Przepiórkowski 2017: (34))

(227)
$$\left[\begin{array}{l}\left\{\boxed{0}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{like}\langle\boxed{1},\boxed{2}\rangle\text{'}\\ \textsc{subj} & \boxed{1}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{Lisa}\text{'}\\ \textsc{case} & \textsc{nom}\\ \textsc{gend} & \textsc{f}\end{array}\right]\\ \textsc{obj} & \boxed{2}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{Nelson}\text{'}\\ \textsc{case} & \textsc{acc}\\ \textsc{gend} & \textsc{m1}\end{array}\right]\end{array}\right], \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{like}\langle\boxed{3},\boxed{4}\rangle\text{'}\\ \textsc{subj} & \boxed{3}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{Nelson}\text{'}\\ \textsc{case} & \textsc{nom}\\ \textsc{gend} & \textsc{m1}\end{array}\right]\\ \textsc{obj} & \boxed{4}\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{Lisa}\text{'}\\ \textsc{case} & \textsc{gen}\\ \textsc{gend} & \textsc{f}\end{array}\right]\\ \textsc{neg} & +\end{array}\right]\right\}\\ \textsc{conj}\quad \textsc{and}\\ \textsc{local}\quad \boxed{0}\end{array}\right]$$

(Patejuk & Przepiórkowski 2017: (35))

As mentioned earlier (see Section 3.5.1), simplifying, in Polish objects marked for structural case are required to bear accusative case in the absence of sentential negation, while genitive case is required if negation is present. In (226) the object of the first conjunct is accusative due to the lack of negation, while the object of the gapped conjunct is genitive because negation is present there. The relevant disjunctive case constraint is evaluated independently in each conjunct, leading to the f-structure representation in (227).

There is another interesting consequence of the fact that disjunctive constraints imposed by the verb are distributed across coordination under gapping. If a given verb allows for coordination of different categories – for instance, its object may correspond to an NP or a CP, as in (228) – then the object of the first conjunct may be an NP, while the object of the gapped conjunct may be a CP, as in (229), whose f-structure is given in (230).

(228) Polish
Lisa chciała [[książkę] i [żeby ktoś ją
Lisa.NOM wanted book.ACC and that somebody.NOM she.ACC
przytulił]].
hug
'Lisa wanted a book and that somebody hug her.'
(Patejuk & Przepiórkowski 2017: (38))

(229) Polish
[[Lisa chciała książkę], a [Maggie żeby ktoś
Lisa.NOM wanted book.ACC and Maggie.NOM that somebody.NOM
ją przytulił]].
she.ACC hug
'Lisa wanted a book and Maggie wanted that somebody hug her.'
(Patejuk & Przepiórkowski 2017: (39))

(230)

$$\left[\begin{array}{ll} \multicolumn{2}{l}{\left\{ \begin{array}{l} \boxed{0}\left[\begin{array}{ll} \text{PRED} & \text{‘WANT}\langle\boxed{1},\boxed{2}\rangle\text{’} \\ \text{SUBJ} & \boxed{1}\left[\begin{array}{ll}\text{PRED} & \text{‘LISA’}\\ \text{CASE} & \text{NOM}\end{array}\right] \\ \text{OBJ} & \boxed{2}\left[\begin{array}{ll}\text{PRED} & \text{‘BOOK’}\\ \text{CASE} & \text{ACC}\end{array}\right] \end{array}\right], \left[\begin{array}{ll} \text{PRED} & \text{‘WANT}\langle\boxed{3},\boxed{4}\rangle\text{’} \\ \text{SUBJ} & \boxed{3}\left[\begin{array}{ll}\text{PRED} & \text{‘MAGGIE’}\\ \text{CASE} & \text{NOM}\end{array}\right] \\ \text{OBJ} & \boxed{4}\left[\begin{array}{ll} \text{PRED} & \text{‘HUG}\langle\boxed{5},\boxed{6}\rangle\text{’} \\ \text{SUBJ} & \boxed{5}\left[\begin{array}{ll}\text{PRED} & \text{‘SB’}\\ \text{CASE} & \text{NOM}\end{array}\right] \\ \text{OBJ} & \boxed{6}\left[\begin{array}{ll}\text{PRED} & \text{‘SHE’}\\ \text{CASE} & \text{ACC}\end{array}\right] \\ \text{COMP-FORM} & \text{THAT} \end{array}\right] \end{array}\right] \end{array} \right\}} \\ \text{CONJ} & \text{AND} \\ \text{LOCAL} & \boxed{0} \end{array}\right]$$

(Patejuk & Przepiórkowski 2017: (41))

6 Conclusion

On the basis of various phenomena, this chapter discussed the possibilities created by the two key concepts related to coordination in LFG: the set-based representation (conjuncts are elements of a set) and distribution whose effects are important at two levels (attributes vs. properties). The distinction between distributive and non-distributive attributes is crucial not only for phenomena related to agreement (including feature resolution), it also makes it possible to share parts of f-structure (enabling dependent sharing). This chapter also discussed distribution at the level of properties (complex statements), showing that it is necessary to account for disjunctive subcategorisation constraints in coordination, which include not only category, but also features such as CASE, preposition/complementiser form, etc.

Apart from run-of-the-mill coordination, this chapter presented a range of more challenging coordination phenomena, including non-constituent coordination (NCC), coordination of unlike categories, coordination of different grammatical functions (showing the difference between monoclausal and multiclausal representation) and phenomena associated with ellipsis such as German SGF, sharing intertwined dependents and gapping. Selected interactions between these phenomena have also been discussed.

Despite its considerable size, this chapter could only discuss a selection of topics related to coordination. Feature resolution was only mentioned very briefly, on the assumption that it is more closely related to agreement than coordination. A key issue which has not been touched upon here is the semantics of coordination. Dalrymple et al. (2019: Chapter 16) is an excellent chapter devoted to coordination in LFG (with a different selection of phenomena, providing rich references) which extensively covers these two topics. It is remarkable in that it includes semantics as its key component, together with a formalisation in Glue.

Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

M1	human masculine (virile) gender
M3	inanimate masculine gender
PRT	particle
INH	inherent

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Chapter 9

Clause structure and configurationality

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LFG differs strongly from Mainstream Generative Grammar in basing its theory of clause structure on overt surface appearance, as would be input to a parser, rather than the outputs of a derivational process that might produce these structures. This leads to a number of differences, such as a much smaller number of functional projections, and more emphasis on a typology of overt structures, including the inclusion of special provisions for 'non-configurationality'. In this chapter, we examine LFG analyses resulting from this perspective from the beginning of LFG in Bresnan (1982b) through to the theory as presented in Bresnan et al. (2016).

1 Introduction

Because LFG is based on using phrase-structure rules (PS rules, with a substantial involvement of universal principles) to provide a direct description of overt structure, with more abstract levels such as f-structure determined by annotations on these rules, they carry a major burden in describing the organization of clause-structure. In particular, it is not possible to invoke 'movement' mechanisms to get things into their surface positions. Rather, with one plausible minor exception,[1] the PS rules have to put everything in the exact positions where they are found overtly, albeit with the possible help of filtering by other components of the grammar.

Partly for this reason, in LFG. the treatment of clause structure has been from the beginning closely involved with the concept of 'non-configurationality', a term coined by Hale (1981) to refer to situations where linear order does not determine grammatical relations in any clear way, and where, in addition, referring

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[1] "Second position" items, as discussed below.

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expressions and other clausal constituents are sometimes discontinuous. Transformational Grammar and its more direct descendants, sometimes called 'Mainstream Generative Grammar', avoided having a problem with this by proposing that underlying clause structures were transformed into overt ones by the application of 'scrambling' rules (in later work, sometimes relegated to the 'phonology'). But when phrase structure rules are to be used for providing a direct characterization of overt structures (with filtering by other components), this is not possible.

Another relevant issue is the position of subjects. If a language appears to have verb phrases that exclude an apparent 'subject' NP argument, then the PS rules have to provide a position for NP external to VP, while if a putative subject is freely intermixed with other arguments, then we probably do not want to have a full-sized VP containing the verb and other arguments, but rather have the verb and the arguments appear directly under S.[2] The theory should then plausibly provide two possibilities along the lines of (a) and (b) below, where (a) puts an NP in front of a VP, while (b) has no VP:[3]

(1) a. S ⟶ NP VP
    b. S ⟶ NP^* V NP^*

A comma could also be included in the first rule to allow the NP to precede or follow the VP, as in Makua (Stucky 1983).

A further general consequence of the archicture is that because many phenomena including agreement, case-marking and anaphora can be largely or entirely described in terms of the more abstract level of f-structure, the sources of evidence for phrase structure are more limited than they are in Mainstream Generative Grammar. We cannot, for example, easily use coreference phenomena to motivate phrase structures in which one object in a double object construction c-commands another, but would need a very extensive (and therefore fragile) argument to show that other levels such as f-structure are not sufficient.

In this chapter, I take a predominantly historical approach to clause structure in LFG, on the basis that a reader might want to engage in literature from any

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[2] As we shall see, languages sometimes have a smaller verbal phrase containing the verb and certain other material, but not, normally, the object; this is sometimes treated as a VP, and sometimes as a different kind of verbal phrase, often symbolized as $\overline{\text{V}}$.

[3] We don't use the 'ID/LP' notation of Gazdar (1982), first applied to LFG by Falk (1984), to allow the daughters of S to appear an any order in (1b) (S ⟶ NP^*, V) because of the plausibility of interpreting this as a possibly null string of NPs, either before or after one V. There are issues worth looking into further here, but not in this chapter.

time from the early 1980s to the present, and therefore find useful some discussion of what kinds of proposals were being made at different times. I will divide the history of clause structure in LFG into three periods so far, with the possibility of a new one starting now. In the first, from the beginnings of LFG in the early 1980s to the early 1990s, some version of the X-bar theory was assumed, but there was little explicit discussion about exactly what that version was. The 90s constitute a transitional period, in which both the 'extended projections' from Minimalism and ideas from Optimality Theory are taken on. The third period plausibly begins with Bresnan's (2001) theory of structure-function mappings, which can be seen as a consolidation of the work of the transitional period, based on a division between 'endocentric' and 'exocentric' structure, the former obeying the X-bar theory with functional structures, the latter not, along with some principles derived from Optimality Theory, such as Economy of Expression. This approach has persisted with little alteration through Bresnan et al. (2016) to the present. Since it is the result of multiple analyses of different languages by a number of people, I will call it the '2001 Synthesis'. More recently, a fourth period may have begun with Lowe & Lovestrand (2020) and Lovestrand (2022), a thorough revision of the underlying phrase-structure theory making greater use of architectural ideas of LFG rather than simply applying some version of mainstream X-bar theory. However there hasn't yet been substantial work on a variety of clause structures in this new approach.

In this chapter, I consider early LFG in the first section, the transitional period in the second, and the 2001 Synthesis in the third. Then, in the fourth section, I review some of the earlier and transitional systems in light of the 2001 Synthesis, and discuss the revisions that are thereby motivated, and conclude with a speculation about S derived from a modification in the new X-bar framework made in Lovestrand (2022).

2 Early LFG

In early LFG, it was assumed that some version of the X-bar theory was correct, but no attempt was made to seriously formalize or revise the proposals that were standard at the time. Bresnan (1982a: 354-356), which also appeared in the foundational LFG collection Bresnan (1982b), developed a fairly permissive theory of 'structure-function mappings', many provisions of which have persisted until now. This theory constrains how c-structure nodes can be annotated to produce f-structures, and shows the influence of Ken Hale's ideas about 'configurational' vs. 'non-configurational' languages. The other papers in the 1982b collection tended to conform to these ideas without discussing them explicitly.

In these papers, the languages treated as configurational (where grammatical relations are largely coded by phrase-structure position) were English, French, Russian and Icelandic, all of them analysed as SVO, while the one analysed as non-configurational was Malayalam, predominantly verb-final. Most of the SVO languages were analysed with distinct S and VP rules like these:

(2) a. $\begin{array}{llcc} \mathrm{S} & \longrightarrow & \mathrm{NP} & \mathrm{VP} \\ & & (\uparrow \textsc{subj})=\downarrow & \uparrow=\downarrow \end{array}$

b. $\begin{array}{llccc} \mathrm{VP} & \longrightarrow & \mathrm{V} & \mathrm{NP} & \ldots \\ & & \uparrow=\downarrow & (\uparrow \textsc{obj})=\downarrow & \end{array}$

But for Icelandic, Andrews used a flat S rule with subject first (consistent with Bresnan's 1982a: 354/296[4] schema, which he does not however cite or discuss).

From that time to the present, a major concern of LFG authors has been to marshal arguments that c-structure relationships were neither a necessary nor sufficient basis for assigning grammatical relations in the general manner suggested by Chomsky (1965) and persisting through to Chomsky (1981), which appeared in the early days of LFG, and beyond. So considerable attention was paid to arguing for the nonexistence of a VP node in languages that appeared not to have a VP constituent, and a contrastive sketch of configurational English versus non-configurational Warlpiri constitutes the first chapter of the high-level LFG textbook (Bresnan et al. 2016).

In the following two subsections, we consider first Malayalam, and then Warlpiri, the other non-configurational language to which considerable attention was paid in this period; discussion of Warlpiri was included in Bresnan (1982a) and several other chapters in the Bresnan (1982b) collection.[5]

2.1 Malayalam

Non-configurational Malayalam, an essentially verb-final language, was analysed by Mohanan (1982) using the clausal category S, introducing its arguments as an unstructured, possibly empty, string of NPs. It was proposed to have a verb-final S rule, with the NPs introduced by a rule whose first version was (Mohanan 1982: 507):

(3) $\mathrm{S} \longrightarrow \mathrm{NP}^{*} \quad \mathrm{V}$

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[4] The page before the '/' is for the journal version, the one after for the page in the 1982 volume.

[5] Warlpiri is discussed in Simpson & Bresnan (1983), but the focus of that article is grammatical relations rather than clause structure as such.

Annotations for this version of the rule were not specified. Later (Mohanan 1982: 542–643), a series of annotations are proposed associating specific grammatical functions with cases and other properties such as animacy, for example:

(4) (↑ obj)=↓
(↓ case)=acc
(↓ anim)=+

This is one of the alternative annotations to the NP in rule (3), allowing any NP in the series to have any grammatical function, subject to filtering by other constraints of LFG.

The flatness of the structure given by (3), with its absence of a VP dominating objects, is motivated by several arguments, one of which is the fact that the bearers of the grammatical relations can appear in any order. But the most important one, according to Mohanan (1982: 526-533), is the workings of a clefting phenomenon which allows all and only direct daughters of the S to be clefted, but not subconstituents of anything, such as possessors or objects of prepositions. The construction is effected by suffixing *-aanə* 'is' to the last word of the clefted constituent, and *-ṯə* 'is' to the verb. Some relevant examples are:

(5) Malayalam (Mohanan 1982: 528-529)

a. Kuṭṭi iṉṉale ammakkə anaayey-aaṇə koṭuṯṯa-ṯə.
child yesterday mother.dat elephant-is gave-it
'It was an elephant that the child gave to the mother yesterday.'

b. kuḷaṯṯil wecc-aaṇə jooṇinte kuṭṭi aanaye ṇuḷḷia-ṯə.
pond at-is John.gen child elephant pinched-it
'It was at the pond that John's child pinched the elephant.'

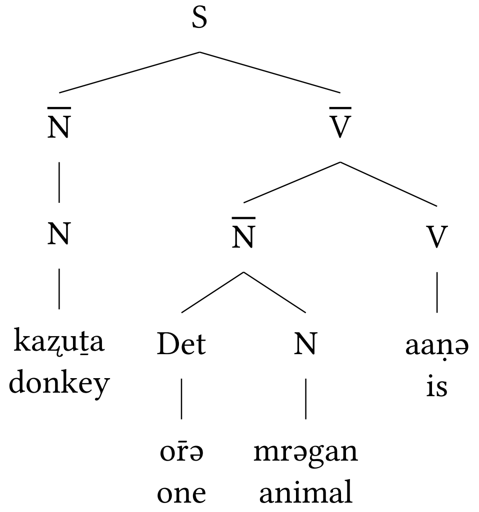
c. *kuḷaṯṯil aaṇə weccə jooṇinte kuṭṭi aanaye ṇuḷḷia-ṯə
pond is at John.gen child elephant pinched-it

In (a), the object is clefted, in (b) the PP, but when we try to cleft the object of the PP (or, not shown, the possessor of the object), the result is bad. The proposed generalization is that you can cleft a direct constituent of S, but not a subconstituent of S, which precludes the existence of a VP sitting on top of the verb and its object.

There are two further significant elaborations in Mohanan's analysis. First, it turns out that Malayalam is not actually strictly verb-final: in main clauses, the verb can be followed by additional NPs, but this normally requires putting a heavy nuclear pitch on the verb, wiping out the word melodies on the following NPs, and lengthening the vowel of the verb, evidently with some kind of contrastive meaning (Mohanan 1982: 511). This is furthermore not possible with certain kinds of subordinate clauses. Mohanan suggests an analysis involving a ‘scrambling rule’, which applies to the S rule, but this is not an option that is available in the LFG formalism, and these NPs need to be introduced in their surface positions, presumably with annotations connecting them to discourse functions (Zaenen 2023 [this volume]).

The second elaboration is that there is a kind of verb phrase, but it contains only the verb and certain additional elements, such as NPs and PPs used to form Copula Constructions and Complex Predicates (Mohanan 1982: 513-534). An example is:

(6)



‘The donkey is an animal.’ (Mohanan 1982: 513–534)

These are plausibly VPs (maximal projections of V, Malayalam having only one phrasal projection layer), which are however very restricted in what kinds of constituents and bearers of grammatical relations they can introduce. On the other hand, some superficially similar complex verbal constituents in other languages do not appear to contain any maximal projections, and so can be analysed as V^0 nodes with adjoined ‘non-projecting’ lexical nodes (Toivonen 2001), also discussed in Belyaev 2023 [this volume]. One example is Complex Predicate constructions in Japanese (Ishikawa 1985, Matsumoto 1996), discussed in Andrews 2023 [this volume], and another is Warlpiri preverbs, considered shortly below.

Another important characteristic of Malayalam and other non-configurational languages is that all or most arguments of verbs can be freely omitted, and understood as if they were represented by pronouns. Mohanan (1982: 544) discusses this briefly, and provides a few examples including:

(7) Malayalam (Mohanan 1982: 544)
Roṭṭi ewiṭe? Kuṭṭi ṯiṉṉu.
bread where? Child ate.
'Where is the bread? The child ate it.'

The LFG treatment of this kind of phenomenon uses lexical rules of 'anaphoric control', developed in Bresnan (1982a), which optionally add a pronominal f-structure specification to the lexical entries of verbs. In the above case, this would be (↑ OBJ PRED)='PRO'. In Malayalam, anaphoric control applies to the grammatical relations SUBJ, OBJ, and OBJ$_\theta$ ('indirect object'; OBJ2 in the original). Anaphoric control is not restricted to non-configurational languages, and is subject to numerous variations in different languages. In English, anaphoric control is predominantly used with subjects of nonfinite verbs, but also applies in some other, more limited, circumstances. For example, an inanimate subject can be omitted but understood as if it refers to something that the group of people being addressed are looking at:

(8) Looks bad! [said by one of a group of people staring at an engine with smoke coming out of it]

The typological range of such constructions and their semantics deserves further investigation in LFG.

2.2 Warlpiri

A more extreme form of non-configurationality was addressed in the comprehensive analysis of Warlpiri provided by Simpson (1983), later published with substantial revisions as Simpson (1991), and also discussed by Nordlinger 2023 [this volume]. Warlpiri differs from Malayalam (and Japanese) in a number of ways:

(9) a. In finite clauses, there is no constraint on NPs coming after the verb.
b. NPs can be discontinuous, with different components appearing separated by other constituents of the clause.
c. There is an 'auxiliary', obeying a complex 'second position' constraint.

All of these phenomena are illustrated in this example:

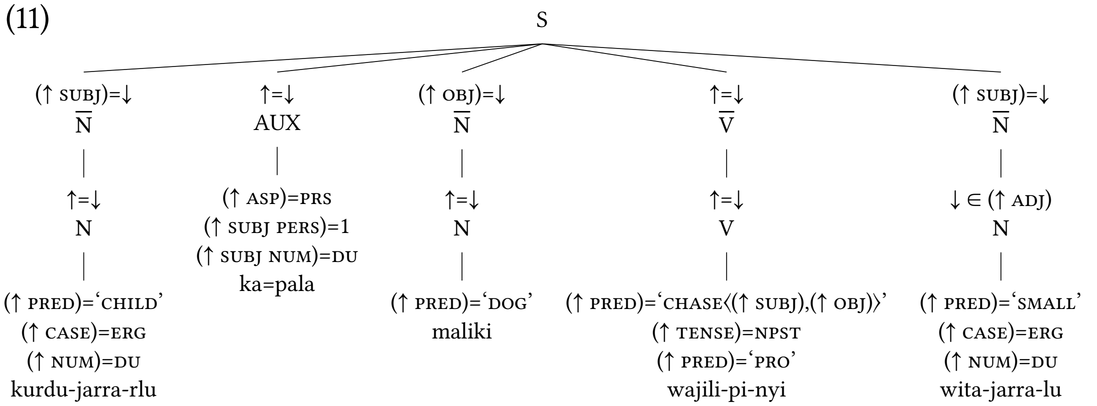
(10) Warlpiri
Kurdu-jarra-rlu ka-pala maliki wajilipi-nyi wita-jarra-rlu.
child-du-erg prs-du dog(abs) chase-npast small-du-erg
'(The) two small children are chasing the dog.'
'(The) two children are chasing the dog and they are small.'

The theoretically most interesting point is (9b).

Hale (1981) described the two nominals 'child' and 'small' in (10) as being interpretable in two ways, one being the 'merged' interpretation, shown in the upper gloss, where the two components are interpreted in the same way as a normal NP in English, and the other being the 'unmerged' interpretation, shown in the lower gloss, in which the second nominal is interpreted as a secondary predicate giving additional information.

To capture the merged interpretation, Simpson proposed that an NP (in her analysis, for Warlpiri, an $\overline{\text{N}}$, the language having no evidence for either a specifier level for lexical projections, or any kind of DP) could expand to an adjunct alone with no head (as well, as of course, to a single head), so that two independently introduced components of an f-structural NP-correspondent could merge, as reflected in the annotations on the tree for example (10):[6]

(11)



(Simpson 1991: 283)

The annotations on the first and last $\overline{\text{N}}$s allow them to unify into a single f-substructure, the value of subj:

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[6] Note that Simpson assumed a rule or convention that would copy agreement features from the f-structure correspondent of an NP down to those of its adj-members. There is furthermore a problem with the positioning of AUX that we will consider shortly.

(12)
$$\left[\begin{array}{ll}
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{child}\text{'} \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{small}\text{'}\\ \textsc{case} & \textsc{erg}\end{array}\right]\right\} \\ \textsc{case} & \textsc{erg}\end{array}\right] \\
\textsc{pred} & \text{`}\textsc{chase}\langle(\uparrow \textsc{subj}),(\uparrow \textsc{obj})\rangle\text{'} \\
\textsc{asp} & \textsc{prs} \\
\textsc{tense} & \textsc{npst} \\
\textsc{obj} & \left[\textsc{pred}\ \text{`}\textsc{dog}\text{'}\right]
\end{array}\right]$$

Similarly to Malayalam, Warlpiri also makes extensive use of anaphoric control, although many arguments not expressed as NPs will receive morphological registration in the AUX constituent, which we will discuss shortly.

There are two further characteristics of Simpson's analysis that interact with each other, and have been important in later developments. The first is that similarly to Malayalam, Simpson analyses Warlpiri as having an inner VP, symbolized as $\overline{\text{V}}$, containing the verb and certain other elements, especially 'preverbs', as discussed in Simpson (1991: 111). However none of these items can contain complex phrasal constituents, and it is therefore probably better to treat them as non-projecting words adjoined to V.

The second additional feature of Warlpiri, already seen in the Warlpiri tree structure (11), is the 'AUX' constituent. This was postulated for Warlpiri[7] in the classic article of Hale (1973: 310), as a constituent containing three kinds of constituents, all optional. First comes a 'complementizer', which has a variety of functions, later called the 'augment' by Laughren (2002). We will follow this usage. Next comes the 'base', which is one of the tense-aspect markers *-ka* 'present imperfective' or *-lpa* 'past imperfective'.[8] Finally come agreement markers, for subject and object. Hale (1973: 312) proposed that if the augment+base sequence was less than two syllables in length, then the auxiliary could not appear in initial position, but only after some other, evidently first, element of the clause.[9]

Simpson (1991: 83) proposes that the underlying position of the AUX is initial, as specified by this rule:

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[7] AUX as a node-type was widely proposed at that time for the analysis of many other languages, including English, as discussed extensively for example by Akmajian et al. (1979).

[8] Hale treated the future marker *kapi* as a base, but Legate (2008) shows that it is actually an augment.

[9] With the exception that certain items, such as topics set off with a pause, were seen as appearing outside the basic clause structure, allowing the AUX to appear in apparent third position if these items were included.

(13) S $\longrightarrow$ (AUX) α $(\alpha)^*$
$\alpha = \overline{\mathrm{V}}, \overline{\mathrm{N}}$, Particle
(↑ ASPECT) ↔ (↑ TENSE)
Assign (↑ G)=↓ freely
(where G stands for any grammatical function)

The second line tells us that α can be any of three kinds of constituents, while the third adds the information that ASPECT is specified if and only if TENSE is, a move that has the effect of requiring a verb to be present if an AUX is, by mechanisms we will not consider here. Finally, the last two lines allow constituents to be annotated freely as either heads (↑=↓) or arguments bearing any grammatical function, providing a high degree of non-configurationality, including generating multiple $\overline{\mathrm{N}}$ nodes with the (↑ SUBJ)=↓ annotation, allowing NP-splitting.

AUX is then put into second position in most examples by first allowing all AUXs to be classified as enclitics, but obligatorily so for the ones with monosyllabic bases (Simpson 1991: 69). Then the clitics are postposed to a position after the first phonological unit by a rule of sentence-phonology:

(14) Encliticization Rule:
]AUX $[\alpha]$ $[\alpha]^*$ → α+AUX $[\alpha]^*$
(the ']' in front of AUX represents that the AUX has enclitic status)

It is perhaps worth noting that for all examples where AUX appears in second position, the trees are also written with AUX in second position, including the effects of the Encliticization Rule in the diagram. In later work, various aspects of this proposal are questioned and revisions proposed, as we will see later, in Section 3.2 of this chapter.

A final observation I will make about Warlpiri concerns the treatment of discontinuous NPs. The LFG analysis permits an NP to be split into any number of separated components, all of which can contribute to a single f-structure with a nominal PRED-feature, subject to no constraints of any kind. There is considerable work showing that this appears to be false, including Schultze-Berndt & Simard (2012), Schultze-Berndt (2022) and Louagie & Verstraete (2016). Rather, discontinuous NPs appear to be associated with a range of specific discourse functions (and to furthermore be rather rare, probably not more than 1% of NPs), and examples where an NP is split into three or more components at the same level in f-structure (e.g. demonstrative, modifier(s) and head noun) do not appear to be attested in the literature so far. Unfortunately, none of this recent literature discusses Warlpiri, but I am aware of no triply split NPs in Simpson (1983, 1991), Nash (1986) or Laughren (1989),[10] nor in the discussion of discontinuous NPs in Latin and Classical Greek provided by Devine & Stephens (2000). Therefore, the proposition that discontinuous constituents are limited to two components is a proposition worth further investigation.

Similarly to Mohanan, Simpson provides some arguments for a flat structure and no VP, but they are more complex than Mohanan's cleft argument, one involving coreference, another involving nonfinite constructions. These will not be discussed here.

Concluding our discussion of the first period, we find a basic distinction between configurational and non-configurational encoding, the former associated with SVO languages, usually associated with a VP, the latter with verb-final or verb-anywhere languages, often with flat structure. It was usual to assume some kind of X-bar theory, without being very specific about the details. There were however some intimations of later developments, such as Falk's (1984) analysis of the English Auxiliary system, in which, influenced by Jackendoff (1977), he treats auxiliaries as a lexical category M, taking VP as a complement and the subject as a specifier. This can be seen as an early version of the idea of the functional projection IP, with its binary branching auxiliary structure as opposed to the flat ternary structure NP AUX VP proposed for S by Akmajian et al. (1979), which is taken up in the third period, the 2001 Synthesis (Section 4).

3 The transitional period

The characteristics of the transitional period are (a) the introduction of the concept of 'functional categories' from the GB and Minimalist frameworks, a feature which has remained; (b) considerable experimentation with ideas from Optimality Theory, which appears to have fallen off to some degree, although it is still being explored (Kuhn 2023 [this volume]). The dating of the period is difficult, since the use of functional categories could be said to have been anticipated by Falk (1984), while drafts of what I take to be the initiation of the third period, Bresnan (2001), were available to some workers as early as 1996 (Nordlinger 1998: 15). But I will here take it to begin with Kroeger (1993),[11] where the functional categories I and C are adopted from Government-Binding theory, and continue until the publication of Bresnan (2001). Many of the features of what I will in the next

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[10] Who also provides an example of discontinuous participial VPs, which Simpson (1991) argues are nominalized.

[11] The Stanford PhD thesis upon which the book is based is from 1991.

section call the '2001 Synthesis' are present in the analyses of the transitional period, to the point that some discussions could be put in either section. But here we take an essentially chronological view surveying phenomena that lead to the 2001 Synthesis, presenting the resulting system in Section 4, together with some new analyses as well as possible updates to older ones.

3.1 Kroeger (1993) on Tagalog

Tagalog is a verb-initial language with preverbal discourse positions, and, according to Kroeger, no evidence for a VP, and some evidence against (we will consider a different view below), but evidence for some other predicate phrases, namely, PP, AP and NP. Kroeger analyses these patterns by taking from Chung & McCloskey (1987) the idea of a special category 'S' that can constitute a predication ('small clause') without providing TAM information, and combining this with the notion of a 'functional projection' IP, where the S appears as the complement of I. He also departs from Chung & McCloskey to allow S to expand to a lexical predicate and multiple arguments, rather than only to a subject NP and a predicate phrase.

For clauses with an aspect-marked verb, this verb appears in the I head of the functional projection IP (INFL for Kroeger), while the arguments and adjuncts appear in free order under S, although there are some tendencies (p. 111):

(15)
   a. The 'Actor' (non-nominative Agent marked with *ng*, or *ni* if a proper name) tends to come first.
   b. The 'Nominative' (marked with *ang*, or *si* if a proper name) tends to come after the other arguments.
   c. "Heavier" NP's tend to follow "lighter" NPs.

Kroeger does not actually give a structure for a sentence with multiple NP arguments: the closest is one with a clitic Actor and a focussed adjunct in the specifier of IP. Clitics are however subject to very interesting positional restrictions which in this case put the clitic *ko* after the SPEC of IP, as indicated in this example (Kroeger 1993: 129), where the original tree has INFL rather than just I:[12]

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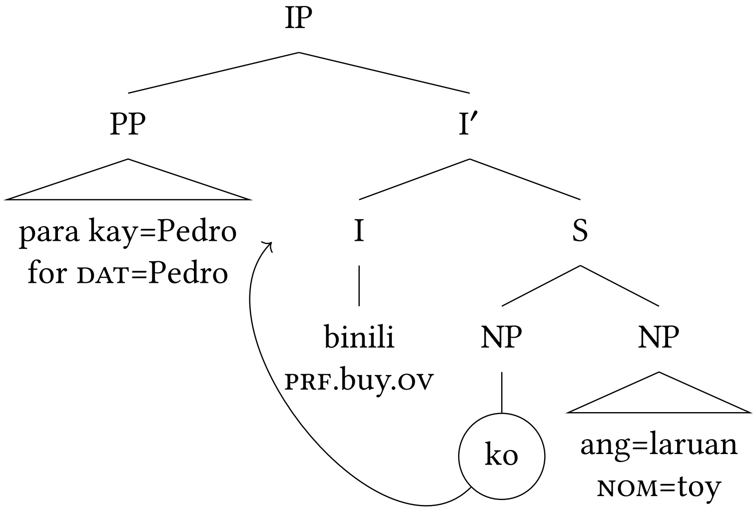
[12] The clitic rule, discussed in Kroeger (1993: 119-123), is: "Clitics appear immediately after the first daughter of the smallest maximal projection that contains them" (but there are some apparent exceptions). The 'object-focus' suffix glossed OV indicates that the Patient of the verb is the 'grammatical subject', traditionally called the 'focus' in Philippine linguistics, analysed by Kroeger as the SUBJ grammatical function in his LFG analysis.

(16) Tagalog

a. [Para kay=Pedro] ko binili ang=laruan.
for DAT=Pedro 1SG.GEN PRF.buy.OV NOM=toy
'For Pedro I bought the toy.'

b.

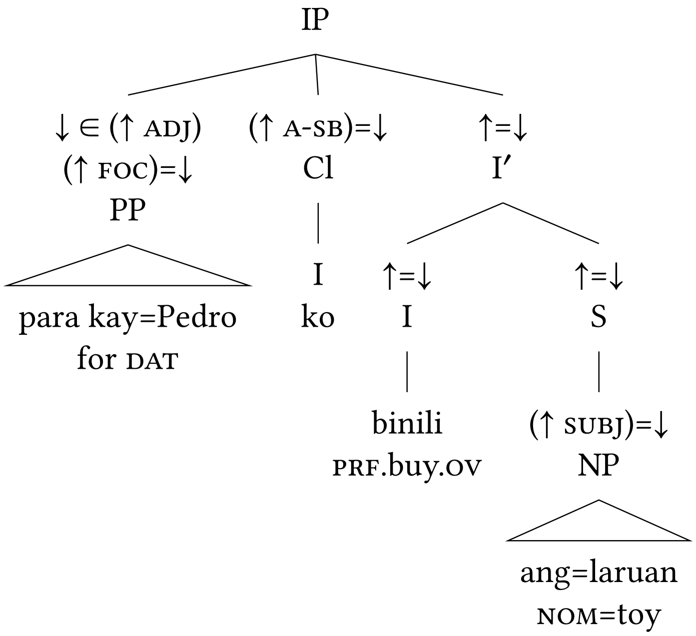


In this tree, the *ko* is ascribed to a position under S where a full NP argument could appear (initial in accord with the ordering tendencies noted above), with the arrow indicating some kind of clitic displacement to after the first constituent of IP. Another thing to note is the use of prime notation rather than bars, so I′ instead of $\bar{\text{I}}$. In this chapter, I will use whichever notation is employed by the original author.

Since functional projections have both the head and the complement annotated with ↑=↓, there is no problem with assembling the f-structure for a c-structure such as (16b). The initial PP is an instance of what Kroeger and much subsequent work has called 'Adjunct Fronting', which applies to the bearers of non-core GFs, that is, adjuncts, oblique arguments and adverbials (Kroeger 1993: 43). We can analyse this by allowing SPEC of IP to receive one of the non-term grammatical functions, together with some sort of focus-like discourse function. I can't find an explicit statement of this in the literature, but it appears to be an implication of the discussion in Kroeger and other sources such as Gerassimova & Sells (2008) that the construction is clause-bounded, since only subjects are said to be extractable from subordinate clauses, and only from ones that are themselves subjects (Kroeger 1993: 210, 215-221).

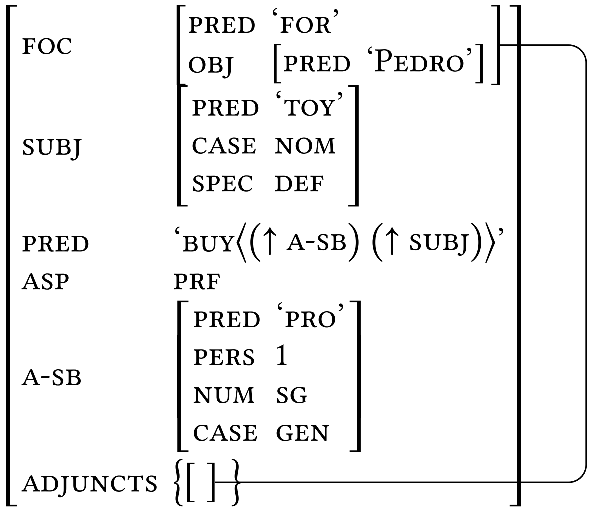
So we can propose an annotated structure like (17) below for the example, with the clitic *ko* placed overtly in its second position, without concern here for what constraints put it there, an issue discussed extensively by Kaufman (2010), but too complex to attempt to provide an updated account of here. We will notate it as ‘A-SB’, for the non-subject Agent in Philippine languages, following the choice of Manning (1996) for the Agent in syntactically ergative languages such as Inuit:

(17)



Given appropriate lexical entries, this will produce the following f-structure:[13]

(18)



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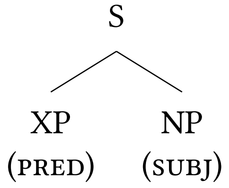
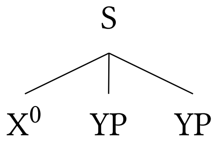
[13] This structure uses the older treatment of discourse functions such as FOCUS as grammatical functions in f-structure, along the lines of Bresnan (2001: 97-98) or Bresnan et al. (2016: 97). Kroeger (1993) does not provide any specific f-structures. For contemporary views, see Zaenen 2023 [this volume].

In addition to verbal clauses, there are clauses with adjectival, nominal and prepositional predicates. Kroeger argues that these show a different pattern, where some phenomena of clitic placement are said to show that the main predicate can either appear on its own as first daughter of S, or as head of a phrase that contains its complements, with the subject final under S in the former case, as indicated by these (somewhat abbreviated) structures (Kroeger 1993: 133):

(19) a.



b.



Unfortunately, Kaufman (2010: 259-260), working within the Minimalist framework, finds that the clitic facts cited by Kroeger[14] do not appear to be representative, in ways that undermine Kroeger's analysis. Since this is of some interest for the history of the subject, I think it is worth considering the examples, in the hope that it will be further investigated in LFG.

What Kroeger says is that with nominal, adjectival and propositional phrasal predicates, a personal pronoun clitic can appear either at the end, or after the predicate word, illustrated here for PP:

(20) Tagalog

a. Galing sa=Maynila siya.
from DAT=Manila 3SG.NOM
'He is from Manila.'

b. Galing siya sa=Maynila.
from 3SG.NOM DAT=Manila
'He is from Manila.'

But with a verbal main predicate, the sentence-final position is impossible:

---

[14] Originally from Schachter & Otanes (1972) and Sityar (1989).

(21) Tagalog

a. ??Hinangkan ng=nanay ako.
prf.kiss.dv gen=mother 1sg.nom
'I was kissed by mother.'

b. Hinangkan ako ng=nanay.
prf.kiss.dv 1sg.nom gen=mother
'I was kissed by mother.'

This is to be explained by:

(22) a. A principle to the effect that the clitics are placed after the first constituent in the domain they apply to, which is the IP.

b. The two constituent structures in (19) are available for nonverbal predicates, but only the flat one of (19b) for verbal predicates.

However, Kaufman finds that there is no significant difference between the clitic final position for verbal and nonverbal predicates: both are pretty bad. He also argues that Kroeger's generalization about where the clitic goes is insufficient, and proposes something different, well beyond the scope of this chapter. This leaves the flat rule (19b) motivated by the evidence, but not (19a), for Tagalog.

Nevertheless, there is motivation for structures of the general form of (22a) elsewhere in the Austronesian language family: Dalrymple and Randriamasimanana use it in their XLE grammar of Malagasy,[15] and Liu (2017) presents an LFG analysis of Squliq Atayal arguing on various grounds for this structure. Finally, Kaufman & Chen (2017) review a rather long tradition of argumentation in Austronesian historical syntax for the position that structures with a clause-initial predicate phrase and a following subject are the original form of the 'Philippine type' of which Tagalog is the most often discussed exemplar.

It is perhaps worth emphasizing that the 'subject' in Philippine languages is not the classic subject of western European languages with its strong association with semantic Agent properties, but rather the 'Pragmatic Peak' of Foley & Van Valin (1984), drawing heavily on earlier work by Paul Schachter and Edward Keenan (Keenan 1976, Schachter 1977), or the 'g-subject' of Manning (1996). These have an association with topic-like pragmatic functions, but not with agentivity. Indeed, the constructions with patient as subject tend to be more common than those with agent, and are closer in form to the proposed diachronic original, as discussed by Kaufman & Chen (2017).

---

[15] http://users.ox.ac.uk/~cpgl0015/pargram/; argumentation is however not provided.

A final point is that above IP, arguably the domain of clitic positioning, there are projections treated by Kroeger as CP, and irrelevant to clitic positioning (resulting in 'third position' phenomena), and this general approach is also adopted by Kaufman (2010).

3.2 Warlpiri: non-configurationality in Australian Languages

Austin & Bresnan (1996) update Simpson's (1983, 1991) analysis of Warlpiri to use the functional projection IP to house the material constituting the auxiliary, and also give an extended treatment of Jiwarli. Two important differences between Warlpiri and Tagalog with respect to I are:

(23) a. In Warlpiri, the verb does not appear in I.[16]
  b. I nodes in Warlpiri that meet a certain condition, to be discussed immediately below, cannot appear initially, at least in a phonologically independent clause.
  c. Most items, including the verb, can appear in front of the auxiliary material (contents of I). This analysis proposes two mechanisms for how this happens: NPs appearing in SPEC of IP, and a prosodic inversion operation for verbs and preverbs.

The nature of condition (b) calls for some discussion.

As mentioned above, earlier work from Hale (1981) to Simpson (1991) proposed that the AUX had to appear in second position if the augment+base was monosyllabic, but Laughren (2002) shows that the bisyllabicity condition is not correct, on the basis that the complementizer *yi-* 'for, since' followed by a null base can appear initially, as long as the entire auxiliary, including agreement markers, is bisyllabic (all the other augments are bisyllabic). This is also the case for the present imperfective base *-ka*, but apparently not for the past imperfective base *-lpa*.[17] So I suggest that the actual condition is a combination of phonology and morphology:

(24) In order for I to be overtly initial in Warlpiri, its contents must:
  a. be at least bisyllabic
  b. be phonologically well-formed as a word (initial *-lp* clusters are not allowed)

---

[16] Legate (2008) proposes in her Mimimalist analysis that the verb can be attracted to I, but in LFG, there is no advantage to be obtained by allowing it to appear there, as we will see below.

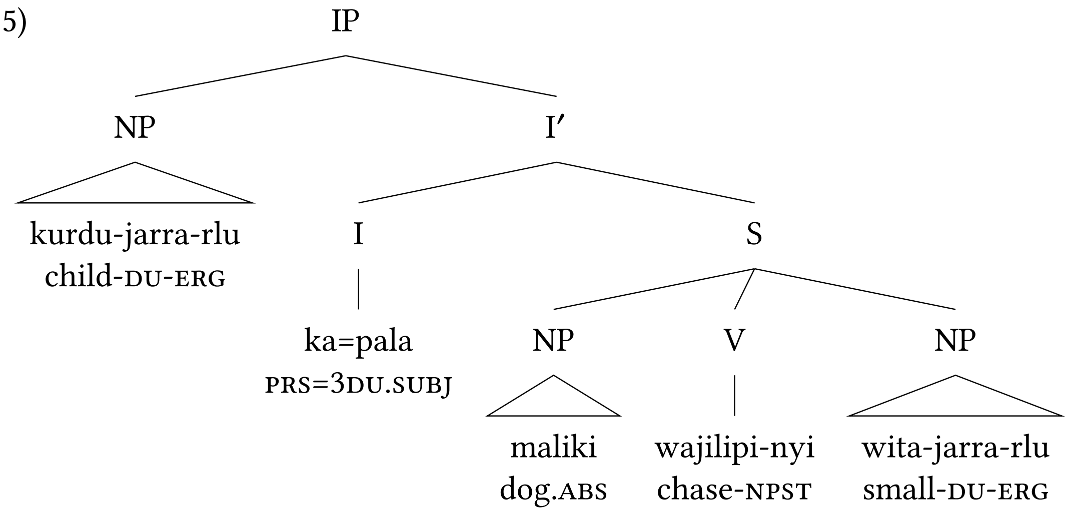
[17] But the existence of possible exceptions is discussed in Laughren (2002: 125, footnote 19).

c. have an overt augment+base (either augment or base is sufficient, as long as something appears).

I will call an auxiliary that meets these conditions ‘heavy’, and one that doesn’t, ‘light’. So our basic generalization is that only heavy auxiliaries can be initial in the sentence.

With this issue considered, we examine the basic sentence structure that Austin & Bresnan (1996) propose for Warlpiri, with an initial NP in the SPEC of IP position, and auxiliary material in the following I:

(25)



This illustrates the first mechanism whereby the auxiliary material can appear in second position, but is not plausible for cases when the verb is in first position, because a lexical category should not be able to occur in SPEC position in Warlpiri (Austin & Bresnan 1996: 226).

To deal with verb-initial sentences, Austin & Bresnan propose the rule of prosodic inversion from Halpern (1995), which moves the contents of I to a position after the verb, or, sometimes, after the initial part of a complex verb. This division of labor permits the inversion rule to apply to a considerably more restricted range of cases than Simpson’s Encliticization, removing the need for it to swap the auxiliary around multiword phrases.

Examples of multiword phrases are modifier+modified nominal constructions with case marking, on either only the last or both elements, and also coordinate NPs (auxiliaries in boldface to make the examples easier to follow):

(26) Warlpiri

a. Kurdu(-ngku) wita-ngku=**ka** maliki wajilipi-nyi
child(-ERG) small-ERG=PRS dog(ABS) chase-NPST
'The small child is chasing the dog.'
(Nash 1986: 159-160, citing Hale (1981))

b. Karnta-ngku manu ngarka-ngku=**pala** kurdu nya-ngu
woman-ERG and man-ERG=3.DU.SUBJ child.(ABS) see-PST
'The man and the woman saw the child.' (Nash 1986: 177)

Since these multi-word NPs can be generated in a position before I, we do not need to have any rule putting the auxiliary after them.

However, sentences with something other than an NP appearing before the auxiliary pose some tricky problems. If all and only the things found in this position were verbs, we could suggest that a V could optionally be adjoined to I, appearing in front of the auxiliary material. But this proposal faces two problems. One is that if the preverb appears in its normal position before the verb, then the auxiliary can appear between them, as long as it doesn't contain an augment (but polysyllabic auxiliaries with base *ka* are fine.):[18]

(27) Warlpiri (Austin & Bresnan 1996: 227)

a. Rambal-luwa-rnu=**rna=rla=jinta** marlu-ku
mistake-shoot-PST=1SG.SUBJ-1SG.DAT-DD kangaroo-DAT

b. Rambalpa=**rna=rla=jinta** luwa-rnu marlu-ku
mistake=1SG.SUBJ-3SG.DAT-DD shoot-PST kangaroo-DAT

'I shot at a kangaroo and failed.'

If the auxiliary intervenes, a preverb whose stem ends in a consonant must end in the stem-extender *-pa*, which it can do anyway. This indicates that one requirement for intervention is that the preverb must be construed as in some sense being an independent word.

Another is that for those 'productive' preverbs that can appear after or before the verb, the auxiliary material seems to almost obligatorily appear after just the verb rather than after the whole verb+preverb combination when the preverb comes second (Simpson 1991: 117):

---

[18] The suffix *-jinta* glossed DD indicates that this is a 'failed effect' construction discussed in Hale (1973: 336), in which the object is marked dative, indicating that the action indicated by the verb did not succeed.

(28) Warlpiri (Nash 1986: 52)
Yani=**rli** wurulypa
go-NPST=12 seclusion
‘Let’s go and hide.’

Nash observes that the ordering *yani-wurulypa=rli* occurs once in a text, but seems much less common than the other possibilities, while Simpson characterizes it as “hardly ever found, and it is usually rejected by speakers”. This is a problem for any analysis which puts V in front of I in c-structure, unless we assume a category other than V to dominate the V+Preverb order.[19]

So the conclusion is that an inversion rule along the lines of Simpson’s encliticization is needed, but applying in a narrower range of cases, more consistent with being a morphological or phonological operation. Austin & Bresnan (1996) assume that it is the ‘prosodic inversion’ of Halpern (1995), which only applies as a last resort. This is supposed to explain why the clitics can’t be inserted into phrasal units as in (27), but there is a problem here in that the structure in which the phrasal NP is sitting in SPEC of IP is different from one where it is initial in S right after I, so it is not clear that a ‘last resort’ restriction can apply in a well-defined manner.[20] A further problem is that it appears to be fine for a heavy auxiliary to appear after the verb (Laughren 2002: 97), so a last resort restriction won’t work.

What I suggest is an inversion rule which can be formulated like this:

(29) I V/Pvb
1 2 ⇒ 2+1
Subject to restrictions that need further investigation.

The category restriction is sufficient to prevent I from being inserted into an NP (a restriction documented at considerable length by Laughren), and another restriction, not formalized here, states that an auxiliary with an augment cannot be inserted into a verb.

A final problem discussed by Laughren (2002) and Legate (2008) concerns evidence that there is more than one functional projection dominating S, in spite of no evidence of two distinct head positions being occupied in the same clause. This is the interaction of topicalization and focus in questions. In (30) below, we see the auxiliary between the topic and a question word:

---

[19] On the other hand, Laughren (2002: 100) provides such an example without comment, but with a heavy auxiliary which could not be inserted into the verb.

[20] And it is furthermore clear that it is in general not impossible for second-position clitics to be inserted into otherwise intact NPs; this is for example rather common with *-que* ‘and’ in Latin.

(30) Warlpiri (Legate 2008: 34)
Kuturu-ju ka=npa=nyanu nyarrpara-wiyi marda-rni?
nullanulla-TOP PRS.IPFV=2SG.NOM=ANAPHOBJ where-first have-NPST
'Where do you have this nullanulla of yours?'

And in (31a-c) below, we see that a potentially interrogative word can be interpreted as either interrogative or indefinite if it appears right after an auxiliary, but only interrogative if before, while (31d) shows that if a potential question word appears further into the clause, after the auxiliary and the verb, it can only be interpreted as indefinite:

(31) Warlpiri
a. Kaji=ka=rna nyarrpara-kurra ya-ni.
NFACTC=PRS.IPFV=1SG where-ALL go-NPST
'I might go somewhere.'/'Where might I go?' (Legate 2008: 17)
b. Nyarrpara-kurra kaji=ka=rna ya-ni.
where-ALL NFACTC=PRS.IPFV=1SG go-NPST
*'I might go somewhere.'/'Where might I go?' (Legate 2008: 17)
c. Nyiya=rlangu kaji=ka=rlu nyina
what-for.example NFACTC=PRS.IPFV=3PL.OBJ be.NPST
wampana-piya-ju.
spectacled.hare.wallaby-like-TOP
'What ones for example might be like this spectacled hare wallaby?' (Legate 2008: 18)
d. Kaji=lpa=ngu wanti-yarla nyiya-rlangu
NFACTC=PST.IPFV=2SG.OBJ fall=IRR what-for.example
milpa-kurra.
eye-ALL
'If something fell into your eyes …'
*'What might have fallen into your eyes?' (Legate 2008: 18)

I tentatively suggest the following analysis. The auxiliary appears in a fixed position, which Austin & Bresnan call I, although C would also work. The interrogative/indefinite pronouns are interpreted as interrogative if they appear 'external to S', indefinite if 'internal'. 'Internal to S' means that they appear inside the lowest S in a stack of S's to which things have been adjoined (and are therefore not themselves adjoined), 'external to S' outside of the lowest in such a stack, so either adjoined to a S or in some higher projection. In Warlpiri, there are two ways in which this can happen: they can appear in Spec of CP, giving rise to

(31b-c) above, or adjoined to S, giving rise to the interrogative interpretation of (31a), where an internal position is also possible, giving rise to the indefinite interpretation. But in the case of (31d), the pronoun can only be internal to S, so only an indefinite interpretation is possible. However, for this to be the case we need a bit more, namely a restriction on adjunction to S, that it can only add a question-focus, which is easy to arrange with appropriate annotations.[21] Finally, in the case of (30), the Spec of CP position is occupied by the topic, so adjunction to S, and consequent position right after the auxiliary, is the only possibility for an interrogative reading (the only one that makes sense in the context).

The essential difference between the present LFG analysis and Legate's is that in the LFG analysis, the auxiliary appears in one position, and interrogatives in two, one on on either side of the auxiliary, while in Legate's, interrogatives appear in one position, while auxiliaries can appear overtly in two. I am aware of no clear theory-independent empirical evidence distinguishing between these possibilities; they are each motivated by what appears to work out best given the resources of the theory.

3.3 Russian

Although Russian has sometimes been presented as non-configurational, King (1995) argues that it is configurational, but with provisions that make the word order considerably more flexible than in English. She provides first a Government and Binding (GB) analysis, and then an LFG one, which leans heavily on the GB analysis for data and associated discussion.

She analyses Russian clauses as having CP, IP and VP layers, with two bar levels in each. The outer level of the VP introduces subjects, and there is one further layer over CP, which is available only in main clauses. This is for 'external topics', which have an initial XP, set off by a pause, with possibly an anaphoric pronoun later in the clause (King 1995: 202):

(32) Russian

a. Gleb, ja ego ne ljublju.
   Gleb, I him not like
   'Gleb, I don't like him.'

---

[21] I do not know what happens if there is more than interrogative word; typologically, there are various possibilities.

b.

Opera,	net	drugogo	vida	musykal’nogo	iskusstva,	kotoryj	privlekal
opera	not	other	type	musical	art	which	attract

by	k	sebe	takoe	vnimanie.
would	to	itself	such	attention.

‘Opera, there is no other kind of musical art which would attract such attention to itself.’

She analyses this with an ‘expression phrase’ rule (Banfield 1982, Rudin 1985) as follows, outside the X-bar system (similarly in her GB analysis):

(33) EP ⟶ XP CP
(↑ E-TOP)=↓ ↑=↓

King (1995: 105) suggests that these external topics do not fall under the X-bar system in Government-Binding theory, and does not attempt to assimilate them to X-bar theory in LFG either, but I suggest that perhaps the rule in (33) could be replaced by ‘Chomsky-adjunction’ to CP,[22] with some kind of further restriction, perhaps essentially semantic, preventing them from occurring in embedded positions (King 1995: 106):

(34) CP ⟶ XP CP
(↑ E-TOP)=↓ ↑=↓

Russian is not a full pro-drop language, so that an NP coreferential with an E-TOP is normally expressed.

In C we find the complementizer *što* and the question-marker *li*, most frequent in embedded questions, while in SPEC of CP we find question words: all question words in multiple wh-questions (King 1995: 215), unlike in English where only one appears. This is illustrated in the following example (King 1995: 216, ↑=↓ annotations omitted):[23]

(35) Russian

a.

kogda	kto	udaril	Boris-a
when	who(NOM)	hit	Boris-ACC

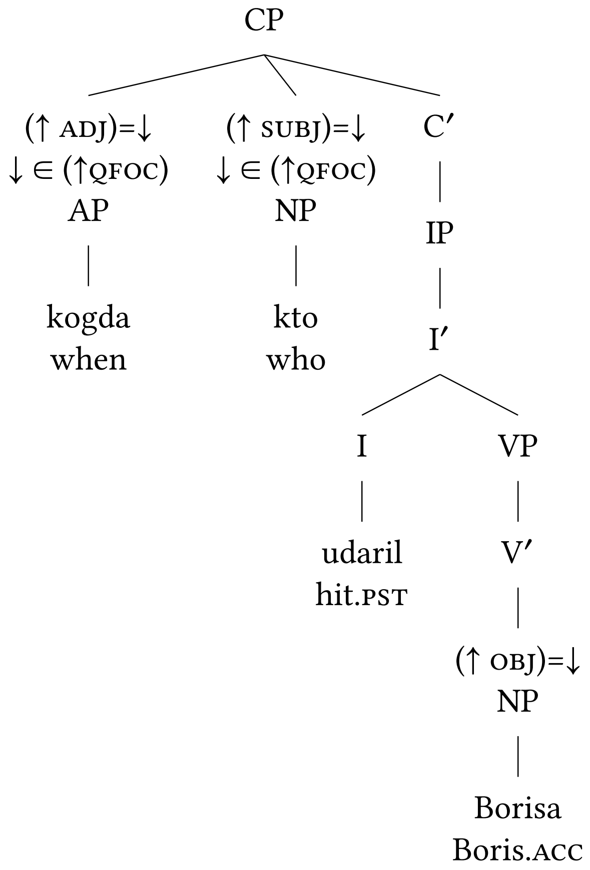
‘Who hit Boris when?’

---

[22] Meaning that it has one CP node as sister, another as mother, with identical feature-composition.

[23] In the tree, the annotation over the first constituent should be ↓ ∈ (↑ ADJUNCTS), but in the structure I give the original.

b.

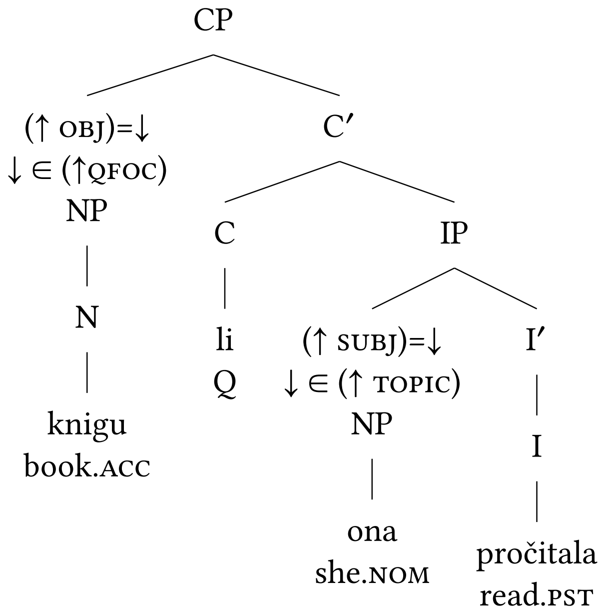


Yes-no questions can be marked either by intonation, or with the marker *li*, which appears in second position, after either an XP or the verb. An XP in front of *li* is interpreted as a focus, with the body of the question presupposed (King 1995: 236–237, King 1994), and items in SPEC of IP are Topics, as indicated by the annotation:

(36) Russian:

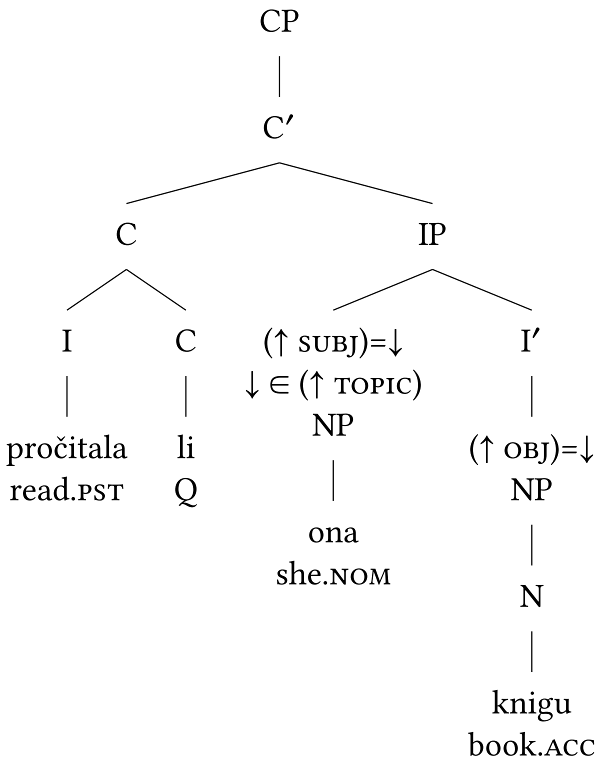
a. Knigu li ona pročitala?
book.ACC Q she.NOM read.PST
'Was it a book that she read?'

b.



If the yes-no question has no focus, then the verb appears before *li*, and King proposes that the verb is adjoined to C:

(37)



This solution avoids the issue of putting a nonmaximal projection in specifier position, and is independently motivated by the absence of the focus-presupposition articulation that appears when there is an XP in the specifier position. Formally, it could also be applied to Warlpiri, but without the additional motivation, insofar as is now known, and the problem of insertion of the auxiliary into combinations of verb and preverb would remain unsolved.

Moving down into IP, what we find here is 'internal topics' normally followed by contrastive foci, but with the possibility of some topics, especially pronouns, to come after the foci. Both contrastive foci and post-focus topics bear grammatical functions in their clause, and therefore do not cooccur with resumptive pronouns. The ordering phenomena are also connected to the issue of 'emotive' vs. 'non-emotive' sentences, an important topic in Russian syntax that does not get much discussion in King's LFG analysis (although more in the GB one). After considering various proposals, including recursive right-branching, King's final proposal is to use the ID/LP rule format (King 1995: 208), previously mentioned in footnote 3, where the '<' symbol in (b) means that the item in front of < must appear before the one after, if both occur in the structure:

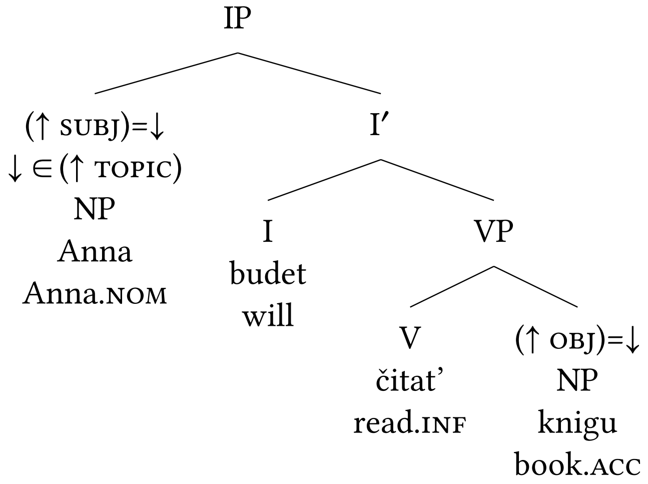
(38) a. $$\begin{array}{llcc} \text{IP} & \longrightarrow & \text{XP}^{*}, & \text{I}' \\ & & (\uparrow \text{GF})=\downarrow & \uparrow=\downarrow \\ & & \downarrow \in (\uparrow \text{DF}) & \end{array}$$

b. TOP < CFOC, XP < I′

A constraint putting the I′ after the XPs has been added, and 'DF' (discourse function) is assumed to comprise ordinary topics (TOP but not ETOP), and contrastive foci (CFOC). This formulation allows for considerable flexibility in word order, even though the language is fundamentally configurational. The big difference between King's IP rule for Russian and Bresnan's for English is that in Russian, any GF that is also topic or focus can appear in Spec of IP, while in English, only subjects can. King (1995: 133) notes that preverbal subjects tend to appear less markedly topicalized than other preverbal items, and discusses some possible reasons for this, including the tendency for arguments to be ordered consistently with the thematic hierarchy, which would put Agentive subjects, the most frequent kind, at the top, and therefore tending to be first.

In I itself appear finite verbs, either main verbs as in example (36), or the future auxiliary *budet* 'be', used to form imperfective futures, with the main verb appearing as head of VP:

(39)



This leads on to the structure of VP.

A somewhat unusual feature of King's analysis is that it introduces subjects not only as SPEC of IP, but also as SPEC of VP, along with other governed GFs that appear in V′ as usual, leading to this rule (King 1995: 209):[24]

(40) a.
$$\text{VP} \longrightarrow \underset{(\uparrow \textsc{subj})=\downarrow}{\text{(XP)}} \quad \underset{\uparrow=\downarrow}{\text{V}'}$$

b.
$$\text{V}' \longrightarrow \underset{\uparrow=\downarrow}{\text{V}} \quad \underset{(\uparrow \textsc{gf})=\downarrow}{\text{XP}^*}$$

The evidence for this comes from various kinds of sentences where the subject is not also a topic, discussed more in King's GB analysis than in the LFG version.

One kind of example is 'thetic sentences', which assert that something happened, with no NP or other constituent singled out as the topic. The order in such examples is VSX*, as illustrated in the example below, as answer to the question 'what happened yesterday' (King 1995: 101):

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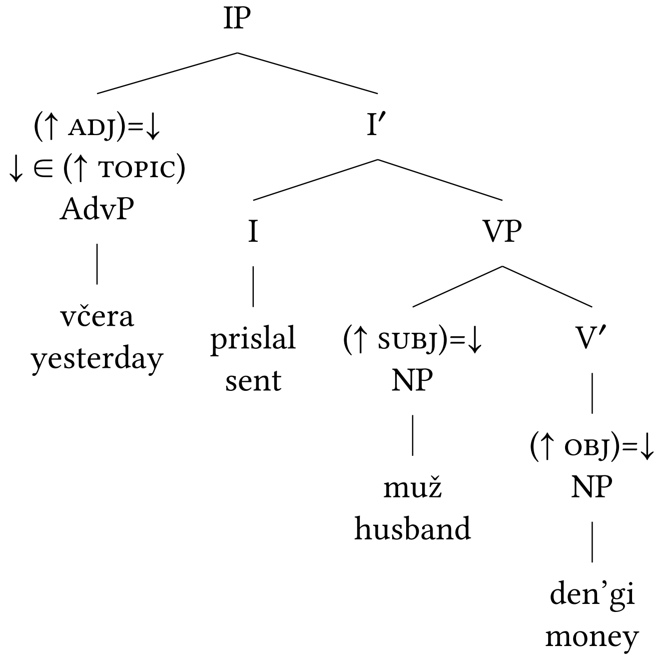
[24] King omits the Kleene star on the complements in (b), presumably as a typographical error.

(41)



‘Yesterday (my) husband(FOC) sent(FOC) (me) money(FOC).’

The placement of the subject in SPEC of VP rather than SPEC of IP causes it to be interpreted as Focus rather than Topic, leading to a thetic interpretation of the clausal material excluding *včera* ‘yesterday’. We will see later in Section 5.3 that this analysis can be assimilated to that of other languages within the 2001 Synthesis presented in that section, by having the complement of I be (configurational) S rather than VP with internal subject.

3.4 German

German as analysed by Choi (1999)[25] resembles Warlpiri in arguably having only one functional projection,[26] but differs in a number of respects:

(42) a. Verbs can appear in the functional projection (and, often, must), but otherwise appear finally in VP.

b. There is no NP-splitting.

c. There is some evidence for an S node, although this is challenged by the later work of Berman (2003).

---

[25] A revised version of her 1996 Stanford dissertation of the same title.

[26] A possibly confusing factor is that the German problem in Bresnan et al. (2016: 375-379) assumes that the auxiliary *haben* in final position is an occupant of I, but makes no argument for this analysis, which Choi explicitly rejects (Choi 1999: 33). Berman (2003: 31-32), citing Choi, also discusses the lack of evidence for I.

The functional projection in these works is labelled “C′”,[27] and houses complementizers in subordinate clauses, and the topmost (main) verb in matrix clauses. Otherwise, the verb appears clause-finally, and the so-called “auxiliaries” are treated as main verbs taking VP complements. Full clauses consist of an S with an NP VP structure. A sample main clause with the auxiliary *sollte* is:

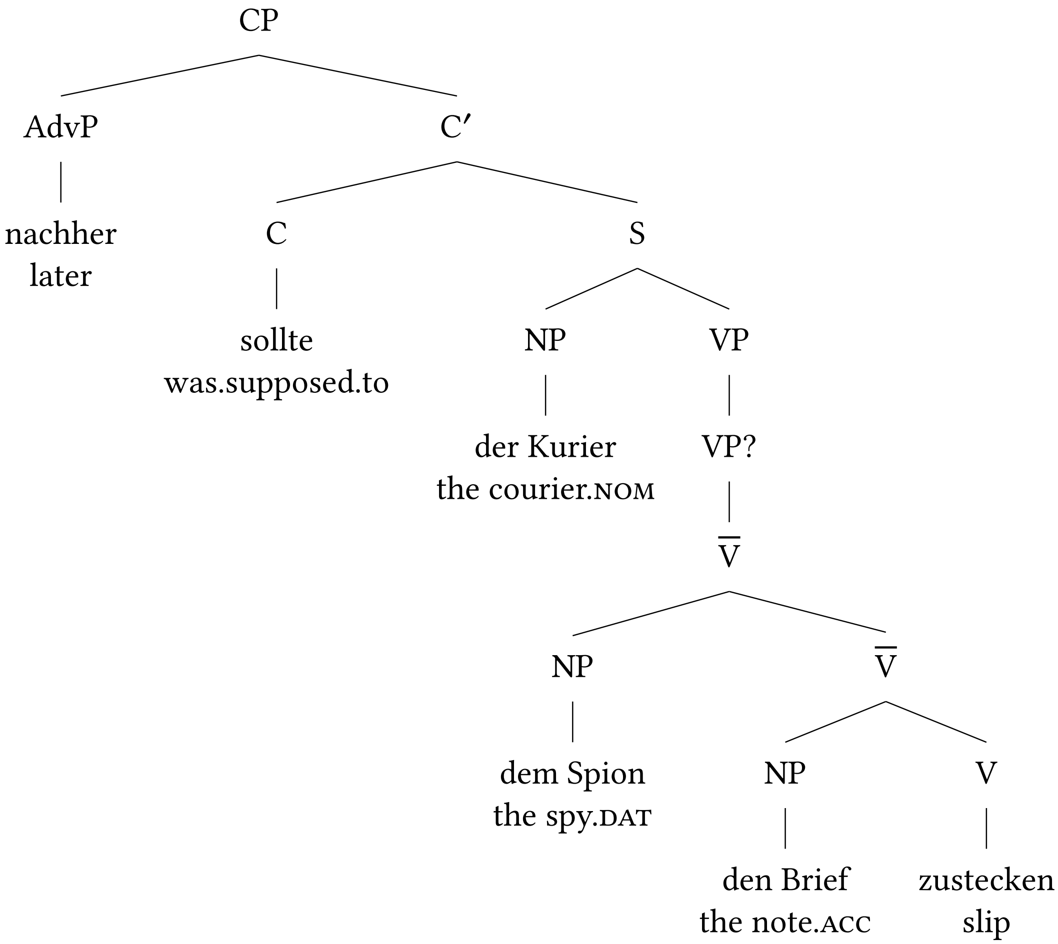
(43) German

a.

Nachher	sollte	der Kurier	dem Spion	den Brief	zustecken.
later	was.supposed.to	the courier.NOM	the spy.DAT	the note.ACC	slip

‘Later, the courier was supposed to slip the letter to the spy.’

b.



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[27] Presumably because it contains some traditional complementizers, such as *dass* ‘that’, although this choice is essentially arbitrary.

This structure is extrapolated from Choi (1999: 19, ex. 7a) on the basis of later examples such as Choi (1999: 27, ex. 20). The nested $\overline{\text{V}}$ nodes are postulated to introduce the complements of V, a feature of the 2001 Synthesis which appears to be arbitrary, as we will discuss in Section 4.

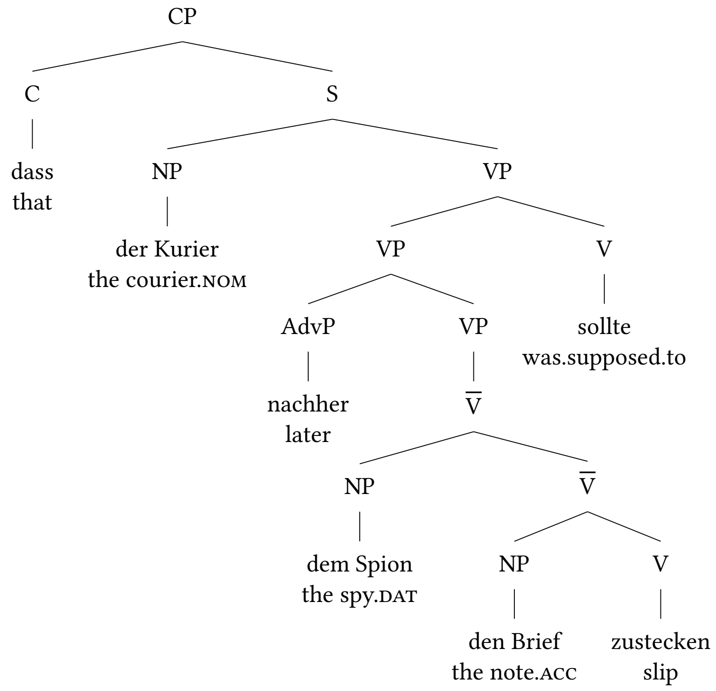
The question-marked VP solely dominated by another VP is motivated by the fact that the verbs traditionally called 'auxiliaries' in German (*sein* 'be', *haben* 'have', *werden* 'become', and the modals such as *sollen* 'should', which also has other meanings) appear syntactically to be plausibly taken to be the complement of the auxiliary *sollen* in C, whose VP appears immediately over the one with the question-marks. On the other hand, LFG for some time has been strongly oriented towards structure minimization principles, and the upper VP, which would be annotated '↑=↓', is not doing anything, and is therefore highly likely to be omitted, and indeed seems to be omitted by Choi in the somewhat later abbreviated structure (17) on p. 26.

A typical subordinate clause structure is:

(44) German (Choi 1999: 27, ex. 20)

a. dass der Kurier nachher dem Spion den Brief zustecken
that the courier.NOM later the spy.DAT the note.ACC slip
sollte
was.supposed.to
'that the courier was supposed to slip the note to the spy later'

b.



Here we see the complementizer occupying C, and the VP complement to the auxiliary *sollte*, at the end.

Although this analysis is in accord with the 2001 Synthesis, to be discussed in the next section, a later analysis by Berman (2003) rejects certain aspects of it, especially the arguments for putting the subject under S, as we will consider in Section 5.4 below.

3.5 Korean

The languages we have seen so far have one or two functional projections over S or equivalent, but Choi (1999) presents Korean as having none: S expands to NP followed by VP. She finds no evidence for I or C, since the functions of these projections are expressed by formatives on the verb, removing the need for any phrase structure positions to house them, and no other kinds of evidence for their existence.

She provides three arguments for VP (Choi 1999: 43–47), of which I will give two. One of them is that there is a contrastive focus-marking particle *nun* which can be attached to either an object NP or the verb to make either the attached-to constituent or the entire VP the focus, but not the entire clause including the subject. Illustrating the two readings for marking on the object, we have:

(45) Korean
Mary-ka chayk-un ilk-nun-ta
Mary-NOM book-TOP read-PRS-DCL
'Mary reads nothing but books.'
(Mary does nothing but read books)
(Choi 1999: 45, example 52; note that Choi glosses the marker as 'TOP' even though its function here is described as contrastive focus.)

Another argument is phonological: syllable-initial obstruents become voiced after a vowel in a phonological phrase, and this happens between an object and the following adverb *caypalli*, but not a subject; here, the segments voiced for this reason are italicized:[28]

(46) Korean
a. Cwuni-*g*a kong-ul *j*aypalli *j*a*b*-a.
Cwuni-NOM ball-ACC quickly catch-PRS
'Cwuni catches balls quickly.'

---

[28] Choi uses underlining to indicate the non-phonemic voicing, rather than different segmental phonetic symbols.

b. Kong-ul Cwuni-ga caypalli *jan*-a.
ball-ACC Cwuni-NOM quickly catch-PRS
'Balls Cwuni catches quickly.'

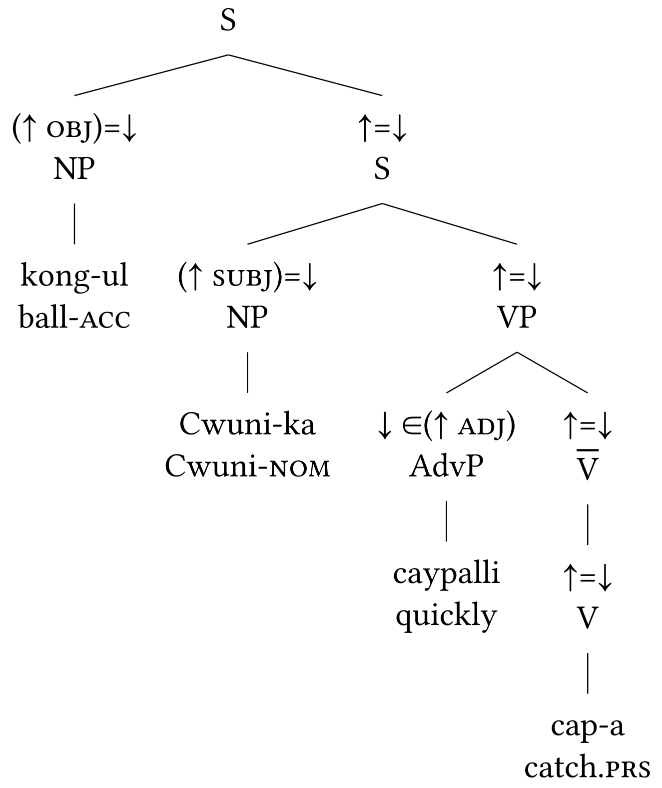
This treatment contrasts with that of Sells (1994), who proposes that Korean has an 'inner VP' (similar to the combinations of verb and preverb in Warlpiri) which can be plausibly analysed as a V^0 with adjoined non-projecting words, but no S vs. VP distinction. Instead, following Fukui (1986), all arguments are attached by phrase structure rules expanding VP to XP and VP, recursively. Sells's argument for the VP seems convincing, but not those for the binary branching structures for the arguments (Sells 1994: 353, fn. 2). Later, in Bresnan (2001), a branching VP like that of Sells was accepted, but with no serious attempt to show that it was superior to the more traditional flat VP assumed by Choi.

Another important characteristic of Choi's phrase structures is the absence of verbal functional projections. She considers an analysis in which tense and the declarative markers are treated as inhabitants of I and C, respectively, and morphologically fused with the verb, but rejects such analyses on the basis of violating the LFG principle that inflected words are inserted under single terminal nodes in the c-structure. One could propose that these projections do exist, but are fused with the verb via lexical sharing, but then there would be the problem of the nonexistence of any evidence for the syntactic autonomy of the two components, of the kind that the mechanism of lexical sharing was devised in order to explain.

As a consequence of the absence of C and I, we cannot use SPEC positions of these projections to house preposed items to provide a treatment of scrambling as found in (46b). Choi does not in fact present any c-structures for scrambled sentences in Korean, but states (Choi 1999: 9) that this is to be the structure for scrambling, and illustrates them for German (Choi 1999: 127, ex. 17a) with left-adjunction to S. This illustrates the principle that LFG does not propose a functional projection if there is no material that can occupy the head of that projection (in any structure; it is allowed for the head position to be unoccupied in some structures).

Furthermore, since there is no IP, we can't use SPEC of IP to house the subject, so Choi proposes S expanding to NP and VP. Therefore, the structure of (46b) is:

(47)



Caypalli is not one of the adverbs listed by Sells as restricted to immediately preverbal position, so we introduce it here as a daughter of VP rather than adjoined to V. The general question of VP versus $\overline{\text{V}}$ is a difficult one, which the new phrase structure theory of Lowe & Lovestrand (2020) might allow us to eliminate and thereby solve, but this is beyond the scope of this chapter.

4 The 2001 synthesis

And now we turn to the system presented in Bresnan (2001), foreshadowed at various points in the preceding discussion, and largely unchanged in its successor (Bresnan et al. 2016), which will be the source of our page reference citations. We have already introduced many elements of this proposal, so it is time to develop it more systematically. The basic ingredients, some of which are present in all of the intermediate stage analyses, are:

(48) a. the 3-level X-bar theory of Chomsky (1970), with one lexical and two phrasal levels, with the option for a language to have only two levels (one lexical and one phrasal), as in Warlpiri;

b. the modified system of category features (for nouns, verbs, etc.) from Jackendoff (1977) and Bresnan (1982a);

c. functional (extended) projections in the version of Grimshaw (2000), in which the extended projections share category features with their complements, which facilitates keeping the number of phrasal projections to 2. These are normally called I (as in Warlpiri), or C (as in German);
d. the existence of a category S, outside of the X-bar system, which can either be non-configurational, as proposed for Tagalog and Warlpiri, or configurational as will be proposed for Welsh and some minor constructions in English;
e. principles of structure-function mapping that limit what kinds of grammatical functions can be introduced in what positions;
f. the claim that phrases in the X-bar system are 'endocentric', while S is 'exocentric'.

A new feature of the 2016 version relative to the 2001 version is the 'non-projecting words' of Toivonen (2001), discussed in Belyaev 2023 [this volume], which have a category feature but are adjoined to another phrase without projecting anything themselves. Another feature of both versions that is not widespread in X-bar theory is the treatment of multiple complements. Bresnan et al. (2016: 127) observe that there are two possible treatments of complements, (49a) below with a nested structure, (49b) with a flat one:

(49) a. X′ ⟶ X′, YP
b. X′ ⟶ X, YP*

(49b) is what the older LFG literature assumed, (49a) what Bresnan (2001) and Bresnan et al. (2016) propose, on the basis of supporting a 'flexible definition of an endocentric complement' (Bresnan 2001: 118, Bresnan et al. 2016: 123).[29] Option (a) constitutes the choice that Choi makes for German in example (43), and works well when the complements can be ordered freely, but it is not clear to me how it is to account for the ordering restrictions in double object constructions, where the OBJ tends to precede an OBJ$_\theta$; the relevant restrictions can be easily stated, either with conventional phrase structure rules as in most early LFG, or with the ID/LP format (briefly mentioned in footnote 3). I suggest this is an issue best left for future investigation.

A further theme that interacts with the X-bar principles is a tendency to reduce the complexity of c-structure to a minimum. Two of the more important conditions are:

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[29] Bresnan et al. (2016), fn. 50 refers to footnote 41, but that appears to be be irrelevant; the relevant definition appears on the page following fn. 41.

(50) a. A c-structure position is not postulated unless there is a class of items that can fill it.
  b. In any specific structure, all nodes are optional.

(50a) prevents us from postulating a functional projection such as ‘T’ for topic, or ‘E’ for ‘evidential’, unless we can find a class of items that plausibly appear in their head positions, while (50b) allows us to leave out items in specific cases, as will be discussed below.

The optionality of c-structure positions is an aspect of an important more general principle, Economy of Expression (Bresnan et al. 2016: 90):

(51) **Economy of Expression**:
All syntactic phrase structure nodes are optional and are not used unless required by independent principles (completeness, coherence, semantic expressivity).

A consequence of this principle is that the traditional principle of ‘S as the “initial symbol” in a phrase-structure derivation of a sentence’ is abandoned: a ‘sentence’ can phrase-structurally be an S, an IP, or a CP, depending on the language and details of the particular sentence. I suggest that this involves a shift from a traditional ‘syntactic’ notion of sentence-hood to a more ‘semantic one’, since glue semantics (Asudeh 2023 [this volume]) can connect these multiple superficial syntactic structures to a single semantic type. Further reductions in the complexity of c-structure are achieved by the reworking of X-bar theory developed in Lovestrand & Lowe (2017), but these have not yet been applied to a substantial typological variety of clause structures so as to produce results with differently organized overall structure, and therefore will not be discussed here.

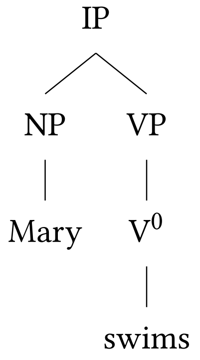
The c-structure principles interact with a set of structure-function mapping principles, which constrain the relationship between the c-structures and the f-structures. The principles (Bresnan et al. 2016: 105-109) assert that:

(52) a. C-structure heads are f-structure heads.
  b. Complements of functional categories are f-structure co-heads.
  c. Specifiers of functional categories are the grammaticalized discourse functions, such as SUBJ, FOC, TOP.
  d. Complements of grammatical categories are the non-discourse argument functions, such as OBJ, OBJ_θ (but not SUBJ).
  e. Constituents adjoined to phrasal constituents are optionally nonargument functions, either adjuncts or nonargument discourse functions.

This principle does not apply to S, whose daughters can bear any grammatical function.

Some simple effects of these principles apply in the structure for ‘Mary swims’:[30]

(53)



(Bresnan et al. 2016: 120)

The NP ‘Mary’ can be a subject because it is external to the VP in SPEC of IP position, while the other nodes will bear the ↑ = ↓ equation and so will correspond to the single f-structure that the NP’s f-structure correspondent is SUBJ of. Turning to Economy, unfilled heads and intermediate level nodes that dominate nothing but their head are eliminated, and the IP, VP, and V nodes will all correspond to the same f-structure.

The CP level appears in complement clauses, where the complementizer is head of C, and in certain other structures such as questions, where we get a CP level with an auxiliary verb filling C, a kind of analysis that is strengthened by the fact that an auxiliary can replace the complementizer *if* in a somewhat archaic/solemn variant of conditional clauses:

(54) Has he called?

(55) a. If he had called, I would have answered.
b. Had he called, I would have answered.

For (54), given the preceeding, the plausible structure is:

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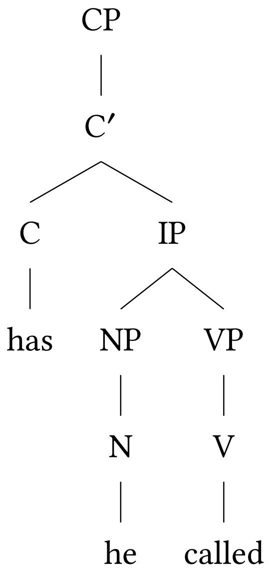
[30] The Bresnan (2001) version has S instead of IP, but this is rejected due to the lack of independent evidence for S in English main (indeed, finite and most nonfinite) clauses in English.

(56)



The IP provides the location of the subject, which has no alternative locations in English finite clauses.[31] The conditional clause in (55b) has the same structure, with the preposed auxiliary replacing the overt complementizer that appears in (55a).

In the systematization of Bresnan et al. (2016: 103), the functional projections are distinguished from the lexical ones by having values 1 or 2 for a feature F, whose value is unspecified for lexical projections. This implies that the choice of C or I in the 1 level languages such as Warlpiri and German is arbitrary, with a further consequence that any tendency in two-level languages to express some things in C and others in I is probably functional in origin. It is of course also possible for there to be no verbal functional projections at all, as argued by Choi for Korean, and is plausibly also the case for Malayalam and Japanese.

5 Applications to languages

In this section we consider the application of the 2001 synthesis to various languages, starting with Welsh, and then reviewing some of the previous ones which call for comment. Malayalam and Korean fit without further discussion, and so are omitted here.

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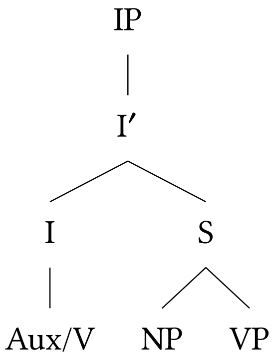
[31] But, as we will see shortly, certain nonfinite ‘small clauses’ arguably use S rather than IP. The exact nature of the connection between ‘finiteness’ and IP deserves further investigation.

5.1 Welsh

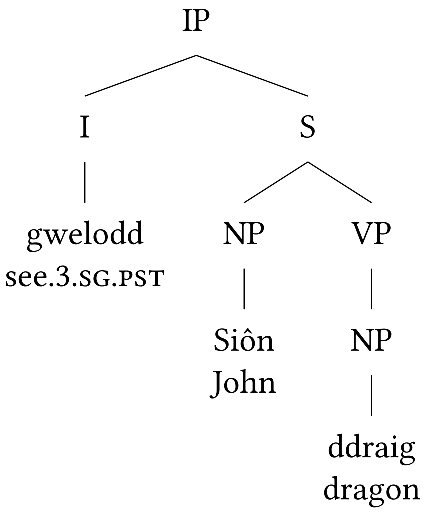
The basic structure for a main clause is:

(57)



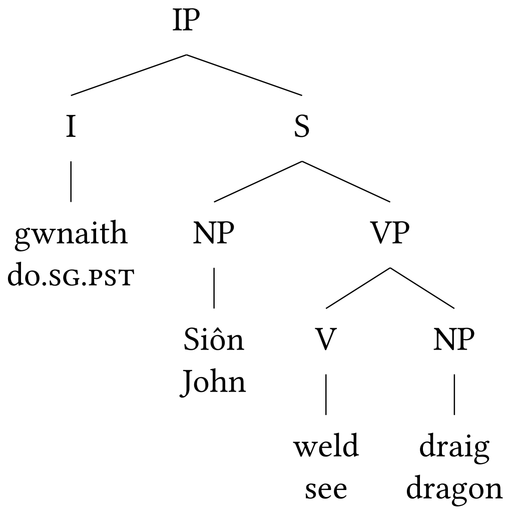
If there is no auxiliary, the finite verb appears at the front of the sentence, in the I position, as shown in (58a) below, very similarly to King's (1995) analysis of Russian. But if there is an auxiliary, the auxiliary appears in I, the verb initially in V of VP, again similarly to Russian, as shown in (58b), but with the VP under S dominating the subject, rather than a two-level VP (Bresnan et al. 2016: 131-133):

(58) a.



'John saw a dragon.'

b.



'John saw a dragon.'

One issue here is how a VP can appear sitting over only an NP in (58a). This goes against the idea that an endocentric category needs to have a head, while the presence of a VP is motivated by the range of things that can appear in the position after the subject, where overt VPs sometimes appear over the same material.

This problem is averted by the 'Extended Head Principle' (Bresnan et al. 2016: 135-137), which in effect says that a phrase can have a 'displaced head', as long as that head appears within a higher phrase having the same f-structure correspondent. The definition of 'extended head' is:

(59) Given a c-structure containing nodes $\mathcal{N}$ and $\mathcal{C}$ and a c- to f-structure correspondence ϕ, $\mathcal{N}$ is an extended head of $\mathcal{C}$ if and only if $\mathcal{N}$ is the minimal node in $\phi^{-1}(\phi(\mathcal{C}))$ that c-commands $\mathcal{C}$ without dominating $\mathcal{C}$. (Bresnan et al. 2016: 136)

and the principle is:

(60) Every (phrasal)[32] lexical category has an extended head

Although we have discussed only I, Welsh also has a functional projection C, containing complementizers as discussed by for example Roberts (2005). Therefore it is a 2-level language like English, but differs from English in that the complement of I is S rather than VP. This is required because in Welsh, the position of the subject is after the auxiliary rather than before it. 'I+S' languages, such as

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[32] This qualification is absent from the original, but seems to me to make the principle work properly.

for example Tagalog, also often have the property that S can have PP, AP, and NP as well as VP as the predicate phrase, but this does not appear to be the case for Welsh, since it uses a copula in sentences where these play the semantic role of predicate.[33] Welsh also differs from English (and is similar to most other Germanic languages) in that all verbs can appear in I, rather than only a restricted class of 'auxiliaries'.

5.2 More English

As observed above, the fact that English puts the subject in front of I rather than after it indicates that it has VP rather than S as complement of I, an analysis corroborated by the fact that a verb is obligatory in finite clauses (recalling that IP shares category features with its complement, so excludes a non-verbal complement). But nevertheless, as observed by Chung & McCloskey (1987), English does arguably have nonfinite clauses where S expands to NP subject and a predicate phrase, which can be NP, AP, VP or PP. These so-called 'small clauses' are used in English to express a combination of incredulity and often dismay (Akmajian 1984):

(61) a. What?? Him an alcoholic??
b. What?? Her sick with the flu??
c. What?? Him run(ning) a company??
d. What?? That guy in the White House??

Along with nonfiniteness comes accusative case on the subject and no agreement with any verbal element. This is evidence that in English, nominative case on NPs is a marker of finiteness on the clause, somewhat in the manner of the proposals of Pesetsky & Torrego (2007) within the Minimalist program, although an LFG analysis would have quite a different implementation, similar to the treatment of 'modal case' in Tangkic languages, as presented in somewhat different forms by Andrews (1996) and Nordlinger (1998). In these languages, nominative forms would have an equation specifying an appropriate tense feature value for whatever they were subject of.

Another plausible case for S would be gerundive nominalizations with accusative (rather than genitive) subjects, as analysed by Schachter (1976):

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[33] Bresnan et al. (2016: 130) suggest that Welsh has these as possible predicates under S, but no examples are provided, and Welsh appears in fact to use a copula. See Borsley (2019) for a recent discussion of Welsh copular clauses in the framework of HPSG.

(62) John giving/*give an invited talk might be a good idea

A potential issue with having NP expanding to S here is that the predicate phrase of the S is restricted to being a VP whose verb is marked with *-ing*. But this can be accommodated by including an appropriate constraining equation in the c-structure rule:

(63)
$$\text{NP} \quad \longrightarrow \quad \begin{array}{c} \text{S} \\ \uparrow=\downarrow \\ (\downarrow \textsc{vform}) =_c \textsc{ing} \end{array}$$

The constraining equation will require the predicate of the S to be a verb, as well as a verb marked with *-ing*. Taking this analysis further would require entering the realm of 'mixed category constructions', beyond the scope of this chapter. But there is clearly a question of what causes S to have a rather limited distribution in English, as opposed to other languages such as Welsh or Tagalog.

5.3 Russian revised

Moving on to Russian, King's analysis, discussed in Section 3.3, diverges from the previous analyses we have discussed in this section in using a two-level VP, with the top level introducing a subject. This difference can be easily eliminated by replacing the upper level VP with S, but is there any serious motivation for doing that?

The structure-function mapping principles listed in (52) are not entirely clear on this: (52c) says that specifiers of functional categories are the grammaticalized discourse functions, which suggests no, but grammaticalized discourse functions can also be adjoined (52e), which suggests possibly yes. A general point that suggests that the S analysis is correct is that the question of what should appear in the specifier of VP in many languages, such as English, has always been rather controversial. Fukui (1986) proposes that only functional, not lexical, categories, have specifiers, and this appears to be consistent with what we have seen here. On the other hand, specifier is at least a somewhat plausible place to locate quantity and degree modifiers of nouns and adjectives, but there could be a weaker position that specifiers of lexical categories do not supply arguments to those categories, but serve different functions when they exist at all.

If we accept this reanalysis, a natural concomitant is to place postposed focussed subjects and certain other NPs under S, following the VP:

(64)
$$\text{S} \quad \longrightarrow \quad \begin{array}{c} (\text{XP}) \\ (\uparrow \textsc{subj})=\downarrow \\ \end{array} \quad \begin{array}{c} \text{VP} \\ \uparrow=\downarrow \\ \end{array} \quad \begin{array}{c} \text{XP}^{*} \\ (\uparrow \textsc{gf})=\downarrow \\ (\uparrow \textsc{foc})=\downarrow \end{array}$$

King (1995: 210) put these under V′ in order to treat examples such as:

(65) Russian (King 1995: 209)
Kupila plat'e Inna.
bought dress Inna
'Inna.FOC bought a dress.'

But this actually does run against the structure-function mapping principle (52d). Using S in this way gives us a version of King's analysis that is clearly within the framework of the 2001 Synthesis.

5.4 German again

German, however, presents a problem. Choi's treatment was within the Synthesis, in spite of originating in 1996, but Berman (2003) eroded an important aspect of it, that subjects appear under S. In particular, following Haider (1990, 1995), she concluded that various kinds of presumed subjects were included in VP-preposing, including the rather hard to dismiss unergatives, which cannot be construed as nominative objects, as is possible for some of the other examples:

(66) German (Berman 2003: 36)
Kinder gespielt haben hier noch nie.
children played have here still never
'Children have never played here.'

Her solution was to introduce all arguments, including subjects, under VP in nested VPs, her VP not being clearly distinct from Choi's $\overline{\mathrm{V}}$, with a complex verb at the bottom, as discussed in a considerable amount of literature in different frameworks.[34]

Unfortunately, she did not provide an actual tree for this example ((28b) in the text, nor for the similar (28a)), but I suggest:

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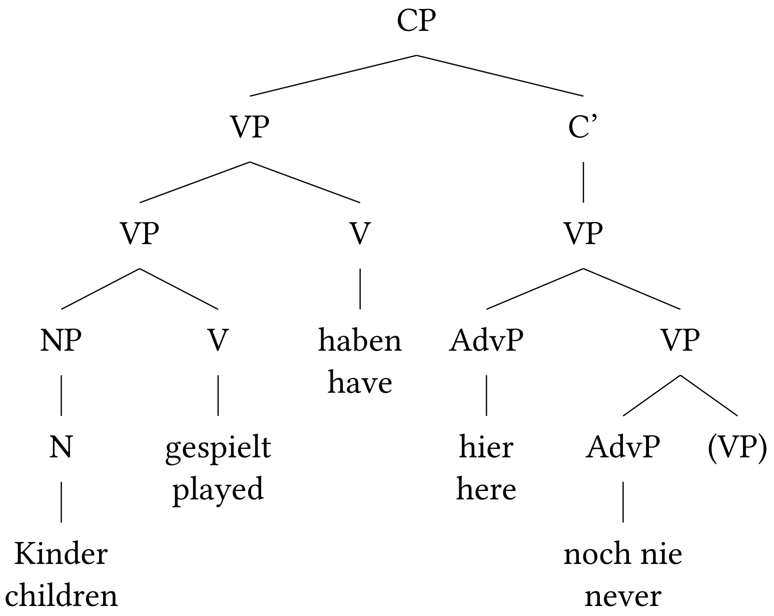
[34] For example Wurmbrand (2017) in Minimalism, Zaenen & Kaplan (1995) in LFG.

(67) German



Where the parenthesized (VP) is an informal notation for the fact that the head of the unparenthesized VP above it is supplied by the Extended Head Principle from the Spec of CP position.

This would seem to call for revision of Choi's structures for German such as (44a), but, on the other hand, the VP-internal subjects appear to be restricted; for example, they must be indefinite. So it is not excluded that there is both an S where most subjects reside, as proposed by Choi, and subjects appearing in the VP, as proposed by Haider. Alternate word orders are also produced by 'scrambling', with strong effects on information structure, as extensively discussed by Choi.

5.5 Final remarks

We can sum up the discussion in the previous subsections into a set of rules for when to posit S as opposed to VP as complement of I and in some other environments.

(68) a. If SPEC of IP has a subject position, and subjects appear there, rather than in the complement of I, then the complement of I is VP or possibly other maximal lexical projections.

b. If subjects appear in the complement rather than in the SPEC of IP, then the complement of I is S.

c. This can happen in two ways: either S is non-configurational, introducing predicates and arguments in variable order (with the possibility of the predicates being ordered at the end or beginning of S), or S is configurational, dominating NP and a predicate phrase (maximal projection).

In this context, we interpret ‘subject’ as the core grammatical function (Bresnan et al. 2016: 97) that is also a discourse (topic) grammatical function (Bresnan et al. 2016: 100). We also of course assume S when there is no evidence for I, as in Korean.

The organization of functional projections, on the other hand, is to be ascertained by the arrangements of elements marked by verbal features with respect to other members of the clause, with a general tendency for there to be more intervening items when the projections precede the main verb position than when they follow, leading to a tendency for verb-final languages to appear to lack verbal functional projections.

It is clear that many of the languages we have considered are due for careful reanalysis, due to unresolved issues and discrepancies between earlier and later versions of LFG, and also taking into account the new phrase structure theory of Lowe & Lovestrand (2020). Of particular interest would be the nature of clitic placement in Tagalog, and the issue of flat versus nested structure in non-configurational languages such as Tagalog and German, where the order of arguments is free, but the predicate is fixed at one end or the other.

A major study of clause structure that we have not tried to work through is Sells (2001) on Swedish, for the reason that this makes heavy use of Optimality Theory in ways that have not become mainstream in LFG. However, word order and clause structure in Scandinavian languages is an extremely complex and interesting area that deserves further investigation.

I will conclude with a speculation about the nature of nonconfigurationality. This is that nonconfigurational S is what ensues diachronically when a language makes such extensive use of discourse-conditioned preposing that the learner gives up trying to analyse it, but instead returns as c-structure something that is essentially a list of fragments, similar to what the XLE system (Forst & King 2023 [this volume]) does when it can’t find a parse. But the syntax does find an f-structure for the c-structure fragment list appearing under S. The idea of non-configurational S as a kind of partial failure of c-structure parsing would be consistent with the revision of the theory of Lowe & Lovestrand (2020) proposed in Lovestrand (2022), whereby non-configurational S has no category feature value.

Acknowledgements

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Chapter 10

Unbounded dependencies

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The basic grammatical representations and formal operations of Lexical Functional Grammar are designed to take advantage of the fact that most syntactic dependencies apply to nearby elements of the string, constituent structure, or functional structure. As is well known, languages also exhibit phenomena with syntactic relations that hold over wider and potentially unbounded domains. The earliest LFG approaches to such unbounded dependencies were modeled after the phrase structure solutions of other frameworks. But it is now generally recognized that the functional configurations enshrined in f-structure support the simplest descriptions and explanations of the ways that such dependencies interact with the local organization of clauses and sentences. This chapter surveys many of the theoretical, empirical, and technical issues that have been discussed in the LFG literature and in the linguistic literature more broadly. Modern LFG accounts of unbounded dependencies make use of functional uncertainty with off-path annotations, carefully defined technical devices that integrate well with other aspects of the LFG formalism.

1 Introduction

Grammatical representations and the operations defined on them are designed to take advantage of the fact that most syntactic dependencies (such as agreement, government, and control) are local. Typically, they can be defined on string-adjacent elements or on elements that can be made tree-adjacent with hierarchical structures of modest and definite depth. It is also well known, however, that languages exhibit some phenomena that require the capability to describe syntactic relations that hold over wider domains. With such unbounded dependencies, a grammatical function assigned within an embedded clause is correlated with

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a configuration of items that appear elsewhere in the sentence and perhaps far away from the other words and phrases that make up that clause. Constructions with different patterns of unbounded dependencies have posed descriptive and explanatory challenges to most grammatical theories. This is because the correlations can be sensitive in intricate ways not only to internal properties of the clause and properties of the external configuration, but also to syntactic properties of the intervening material.

There is a substantial literature that aims to identify principles that apply broadly, if not universally, to condition the appearance of unbounded dependencies and also to identify the dimensions of variability across constructions and languages. This chapter surveys just some of the major descriptive and theoretical challenges that these dependencies have presented and sketches how they have been, or in some cases might be, addressed with the tools and techniques of Lexical Functional Grammar. Section 2 sets the stage for this discussion with some simple examples of the topicalization construction. These show that a phrase at the front of a sentence is interpreted as an argument of a distant predicate and its syntactic features are governed by that predicate. Kaplan & Bresnan (1982) proposed an LFG account of unbounded dependencies based on the categories and dominance relations of c-structure. Section 3 outlines that original proposal but then summarizes the considerations that led Kaplan & Zaenen (1989) to conclude that these dependencies are better described in functional terms, as instances of "functional uncertainty". Functional uncertainty is a straightforward extension to the notation of functional descriptions and has now become the standard mechanism for characterizing unbounded dependencies in LFG grammars.

English constituent questions (Section 4) are slightly more complicated than topicalizations because of the additional requirement that an interrogative pronoun exists at an uncertain position inside the initial question phrase. In traditional treatments the topicalized and question phrases correspond to the values of distinguished f-structure attributes, TOPIC and FOCUS respectively, that serve as signals for the discourse entailments of these constructions. It has been argued that those entailments properly belong to a separate component of grammar, Information Structure (Zaenen 2023 [this volume]), and this suggests (Section 5) removing such grammaticized discourse functions from f-structure in favor of explicit mappings to i-structure made possible by LFG's Correspondence Architecture.

The English *tough* construction (Section 6) is of interest because its unbounded dependency is introduced by an annotation in a lexical entry rather than a c-structure rule, and also because the shared f-structure element is governed by predicates in two different clauses. This may lead to a connectivity problem wherein a sentence is grammatical even though the two clauses assign incompatible values to some features, CASE in particular. This section outlines several solutions to that problem. Connectivity is also a potential issue for relative clauses, since as in *tough* constructions the relativized NP appears to play a role in two clauses. Relative clauses have the additional complexity, like constituent questions, that an initial topic phrase must contain a relative pronoun at some uncertain position. Relative clauses are discussed in Section 7.

Section 8 covers a collection of constraints that may be layered on top of the basic constructions previously described. For some constructions in some languages the form of a clause may change if a dependency passes through it. Some clauses and some configurations are impervious to unbounded dependencies, forming what are traditionally known as islands. And there are also linear order constraints that seem to tie the functionally-specified unbounded dependencies more closely to the sequence of words in the sentence. The last section discusses possible LFG accounts for parasitic gaps and other multiple gap constructions, a dependency pattern that is unexpected and problematic for almost every grammatical theory.

2 Topicalization: A simple unbounded dependency

Typical examples of unbounded dependencies are topicalization, constituent questions, and relative clauses in English and other languages. What is important in these constructions is that an element in a matrix clause bears a grammatical function governed by the verb in a clause that may be arbitrarily far away in the sentence. This is exemplified by the topicalization in (1).

(1) Mary, John claimed that Bill said that Henry called.

In (1), *Mary* is understood as the object of *called* but it occurs outside the embedded clause that contains that verbal predicate. Hence local functional equations are not able to describe the dependency nor can it be inferred from the local c-structure hierarchy. Without further specification the embedded f-structure will be incomplete. Of course the grammar can include a local functional dependency with a long sequence of attributes to share information between the higher and lower clauses in this particular sentence. But the hallmark of dependencies of this type is that they tend to be unbounded in the sense that the embedding structure can be arbitrarily deep, as the following variant of (1) suggests:

(2) Mary, John claimed that Bill said that Henry expected to call.

There is little morphological marking on the elements of English topicalization. But in other languages it is very clear that the external item must have the markings that go along with the clause-internal grammatical function to which it is assigned. The following German example is an illustration of such a correlation:

(3) German (Berman 2003)
Den Peter glaube ich hat die Maria eingeladen
the.ACC Peter believe I has the Maria invited
'Peter, I think that Maria has invited.'

Here *den Peter* is in the accusative because *einladen* 'invite' takes an accusative object. Case marking is not the only connectivity effect. Reflexivization constraints also register the external element as fulfilling a function in the embedded f-structure, as shown in the following Icelandic example:

(4) Icelandic
Sjálfum sér held ég ekki að Jón geðjist.
Himself think I not that John likes.
'I don't think that John likes himself.'

In Icelandic, elements that are coreferent with the subject of their clause need to take a reflexive form (*sjálfum* in this example) that is distinct from a nonreflexive pronoun (*hann*). This requirement must be satisfied even when the subject is realized outside of the clause.

As a first approximation, the obvious way to handle such interactions is through the kind of structure sharing that is used in LFG descriptions of raising constructions (Vincent 2023 [this volume]). There it is also the case that an f-structure element plays two roles, e.g. subject of a lower clause and object of a higher one. What is different in the case of unbounded dependencies is the fact that the inventory of possible f-structure paths between higher and lower elements cannot in principle be characterized by finite sequences of intermediate functions.

3 LFG formalizations

LFG has two types of syntactic representations and it is not clear *a priori* whether unbounded dependencies should be modeled in the c-structure or in the f-structure.

3.1 Early approach based on c-structure

In Kaplan & Bresnan (1982) unbounded dependencies were modeled via the c-structure spine as in many other frameworks of that period. The representation for sentence (1) is shown in Figure 1.[1]

In this formulation the linkage between the clause-external item and its clause-internal function is specified by the c-structure rules in (5). This analysis depends on the fact that the obj function is assigned to an NP under VP (5c) and that any NP can expand to an empty "trace" node, indicated by e in (5b).

(5) a. $\text{CP} \longrightarrow \underset{\substack{(\uparrow \textsc{topic})=\downarrow \\ \downarrow=\Downarrow}}{\text{NP}} \quad \underset{\uparrow=\downarrow}{\text{C}'}$

b. $\text{NP} \longrightarrow \underset{\uparrow=\Uparrow}{\text{e}}$

c. $\text{VP} \longrightarrow \underset{\uparrow=\downarrow}{\text{V}} \quad \underset{(\uparrow \textsc{obj})=\downarrow}{\text{NP}}$

The double arrows ⇑ and ⇓ are metavariables, like ↑ and ↓, that denote the f-structures corresponding to c-structure nodes in particular configurations. In the annotations on a daughter category in a given rule, ↑ refers to the f-structure corresponding to the mother node, and ↓ refers to the f-structure corresponding to the daughter. In contrast, the double arrows (called "bounded-domination metavariables") match nodes that are separated in the c-structure but are related through a longer dominance path. Thus the NP in front is a sister of a clause that contains the trace node, and the dominance path between the nodes is allowed because it does not contain other nodes that encode so-called island constraints (see Section 8.2). The dotted line in Figure 1 connects the two c-structure nodes with matching double arrows. The c-structure-to-f-structure correspondence then induces the sharing relationship depicted in the f-structure. The topic function

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[1] The nodes in this c-structure are labeled with modern X′ categories instead of the traditional categories found in earlier LFG papers (e.g. Kaplan & Bresnan 1982, Kaplan & Zaenen 1989). But I depart from common X′ assumptions in showing c-structures that are not cluttered with nodes that are nonbranching, nonmajor, nonlexical, and functionally transparent (annotated with ↑=↓). Other categories (like C′ and VP′) can appear as macro arguments, phantom categories, or metacategories in c-structure grammar specifications (Kaplan & Maxwell 1996, Crouch et al. 2011) and thus can still be used to express generalizations over the context-free rules that describe well-formed c-structures. In that regard they have the same explanatory value as the names and arguments of the f-structure templates discussed by Dalrymple et al. (2004). These reduced c-structures are compatible with Bresnan's (2001) notion of economy and with Lovestrand & Lowe's (2017) theory of minimal phrase structure.

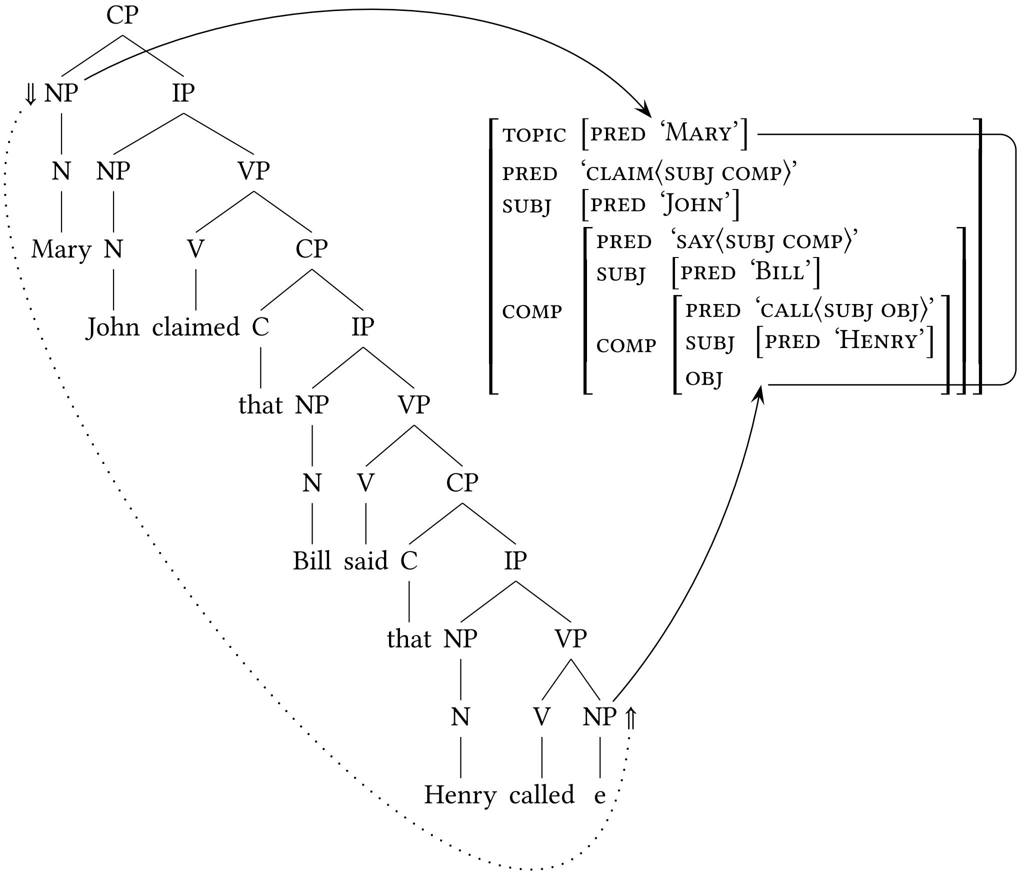

Figure 1: Long-distance relation in c-structure induces f-structure sharing for sentence (1), following Kaplan & Bresnan (1982).

records the special significance of the external constituent as a placeholder for subsequent interpretation by other components of grammar, but it is not here involved in establishing the syntactic connection; Section 5 revisits the grammatical status of the discourse attributes TOPIC and FOCUS.

In this example the nodes that are linked by the double-arrows are both labeled by the same c-structure category NP, but this is not a necessary property of the topicalization construction. Indeed, Kaplan & Bresnan (1982) noted that in some cases instead the nodes are required to have categories that mismatch, as illustrated in (6). Examples (6a-b) show that a CP complement can appear within a clause immediately after *think* but not after *think of*. In contrast, a CP complement in topicalized position is acceptable only when it is linked to the canonical NP position after *of* (6c-d).

(6) a. He didn't think that he might be wrong.

b. * He didn't think of that he might be wrong.

c. * That he might be wrong he didn't think.

d. That he might be wrong he didn't think of.

In the face of examples such as these, Kaplan & Bresnan (1982) embellished their node-linking notation to enable a more intricate relationships of nodes and categories.

It became apparent through subsequent research, however, that constraints on unbounded dependencies are generally more sensitive to functional rather than to c-structure properties. Kaplan & Zaenen (1989) point out that in Icelandic, for example, binding into comps is possible but binding into adjunct clauses is restricted, even when these two types of embeddings have similar c-structures. They consider the following sentences:

(7) Icelandic

a. Jón var að þvo gólfið eftir að María hafði skrifað bréfið.
John was at wash floor.the after that Maria had written letter.the
'John was washing the floor after Maria had written the letter.'

b. þu vonaðist til að hann fengi bíl.
You hoped for that he will.get car
'You hoped that he would get a car.'

They argue that both embedded clauses are introduced with a PP that is the c-structure sister of the main verb, but the f-structures for these sentences are different. In the first example the embedded clause is not an argument of the main verb whereas in the second one it is. This difference correlates with the binding contrast illustrated in (8).

(8) Icelandic

a. *Þessi bréf var Jón að þvo gólfið eftir að María hafði skrifað.
this letter was John at wash floor.the after that Maria had written
'This letter, John was washing the floor after Maria had written.'

b. Hvaða bíl vonaðist þú til að hann fengi.
Which car hoped you for that he will.get
'Which car did you hope that he would get?'

These Icelandic contrasts and the English examples (6) together suggest that the constraints on unbounded dependencies cannot easily be stated in terms of c-structure categories and configurations. In both cases a more natural account can be formulated in terms of functional properties, the difference between arguments and adjuncts, in the Icelandic case, and the restriction against the COMP function with the predicate *think* in the English case.

In general, unbounded dependencies are acceptable only if they assign clause internal functions that satisfy the subcategorization requirements of the embedded predicates. The topicalization example (1) is grammatical because the predicate *call* subcategorizes for the function OBJ; the putative topicalization (9c) is ungrammatical because *arrive* is intransitive.

(9) a. I think Henry will call Mary.
b. * I think Henry will arrive Mary.
c. * Mary I think Henry will arrive.

The fact that subcategorization in LFG is defined at the level of f-structure via the Completeness and Coherence Conditions provided strong motivation for investigating a functional approach to unbounded dependencies.

Additional motivation comes from the fact that unbounded dependencies resemble more local dependencies in the way that they interact with coordinate structures. Sentence (10a) is grammatical because *dedicate* subcategorizes for both an OBJ and an oblique function OBL_θ while (10b) is unacceptable because *bake* does not subcategorize for OBL_θ. Grammatical functions in LFG distribute to all of the conjuncts of a coordination set (Bresnan et al. 1985, Kaplan & Maxwell 1988b, Dalrymple & Kaplan 2000, Patejuk 2023 [this volume]), and thus the coordination (10c) fails Coherence just as in the uncoordinated case. The topicalization (10d) is also ungrammatical, and the simplest explanation is that the within-clause function of the external phrase is distributed in the ordinary way across both predicates.

(10) a. John dedicated a pie to Bill.
b. * John baked a pie to Bill.
c. * John dedicated and baked a pie to Bill.
d. * To Bill, John dedicated and baked a pie.

3.2 Uncertainty of function assignments

Based on these considerations, Kaplan & Zaenen (1989) developed an approach that refers mainly to f-structure notions to characterize the nature of unbounded dependencies. The f-structure sharing induced by the domination metavariables

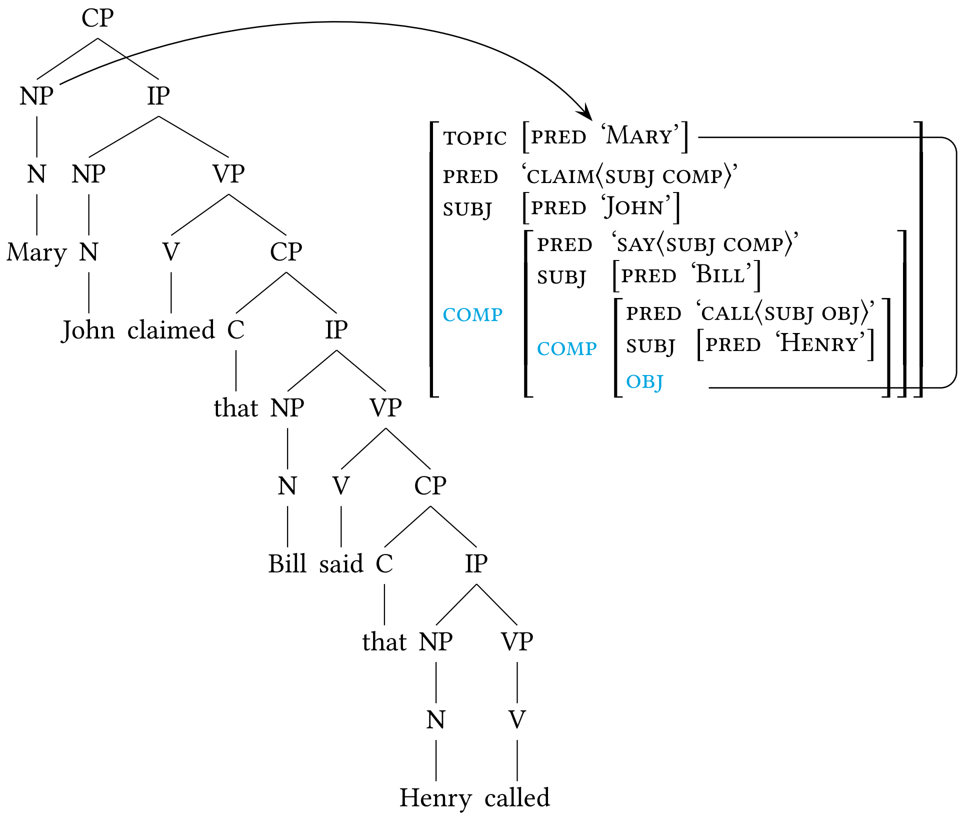

Figure 2: Unbounded relation for sentence (1) defined directly in f-structure via the path of blue attributes (after Kaplan & Zaenen 1989).

for the particular example in Figure 1 can be specified directly by the f-description annotation in the alternative rule (11a). This is true even if a c-structure rule such as (5b) is not used to provide a trace NP. Instead, a traceless c-structure configuration is licensed by the alternative VP rule (11b), independently needed for the analysis of clauses with intransitive verbs.

(11) a. $$\text{CP} \longrightarrow \begin{array}{cc} \text{NP} & \text{C}' \\ (\uparrow \text{TOPIC}) = \downarrow & \uparrow=\downarrow \\ (\uparrow \text{COMP COMP OBJ}) = \downarrow & \end{array}$$

b. $$\text{VP} \longrightarrow \begin{array}{c} \text{V} \\ \uparrow=\downarrow \end{array}$$

The grammatical functions on the longer path in (11a) match the blue attributes in the f-structure in Figure 2 and thus establish the intended link for sentence (1).

For the dependency in sentence (2), however, a longer equation with an additional XCOMP is required, and it is not clear at the position of the topic NP which of the two equations should be chosen to fit the f-structure embeddings of the following clause. In fact, since there is no bound in principle on the depth of an unbounded dependency, there would be infinitely many equations to choose from to account for all possible linkages to the within-clause function of the external NP.

Kaplan & Zaenen (1989) addressed the unbounded uncertainty of the within-clause function assignment by extending the notation and interpretation of LFG's functional descriptions. Kaplan & Bresnan (1982) introduced the basic format and satisfaction condition for function-application expressions of single attributes in (12a) and for notational convenience provided the left-associative extension to a path of attributes in (12b), with (12c) defining the base case of an empty string. Condition (12d) is satisfied by members of a set of f-structure elements, and the later addition (12e) is the foundation for LFG's distributive theory of coordination, as illustrated in (10) above.

(12) Satisfaction conditions for attributes

a. $(f\ a) = v$ iff f is an f-structure, a is an attribute and $\langle a, v\rangle \in f$.

b. $(f\ a\sigma) = v$ iff $a\sigma$ is a string of attributes and $((f\ a)\ \sigma) = v$.

c. $(f\ e) = v$ iff $f = v$ (e denotes the empty string).

Satisfaction conditions for sets

d. $v \in f$ iff f is a set and v belongs to f.

e. $(f\ a) = v$ iff f is a set and
$(g\ a) = v$ for all $g \in f$ if a is a distributive attribute
$\langle a, v\rangle \in f$ if a is a nondistributive attribute.

Kaplan & Zaenen (1989) first generalized from the single-string specification (12b) to sets of attribute strings as in (13a).

(13) Functional uncertainty

a. If Paths is a set of attribute strings,
$(f\ \textsc{Paths}) = v$ iff $((f\ a)\ \mathit{Suff}(a, \textsc{Paths})) = v$, where
$\mathit{Suff}(a, \textsc{Paths}) = \{\sigma \mid a\sigma \in \textsc{Paths}\}$.
(the suffixes of strings in Paths that begin with attribute a)

b. $(f\ \in) = v$ iff $v \in f$ for the special "attribute" $\in$.

The uncertainty about which paths might result in complete and coherent within-clause function assignments is represented under this formulation by the choice between alternative strings in such a path language. A language containing at least the strings comp comp obj and comp comp xcomp obj, for example, would account for both topicalization sentences (1–2). According to (13b), if the special attribute ∈ on a path coincides with a set of f-structures, the path can continue through any one of the set's freely chosen elements.

A finite enumeration of path-strings is in essence only a succinct way of specifying a finite disjunction; it would not yet express the unbounded nature of these dependencies. But Kaplan & Zaenen (1989) went further and allowed path-sets to be regular languages containing possibly an infinite number of strings. Such languages can be specified as regular expressions that appear in the annotations in rules and lexical entries. Rule (14) extends the particular annotation in rule (11) to account not only for examples (1–2) but also for topicalizations with comp embeddings of arbitrary depth.

(14)
$$\text{CP} \longrightarrow \begin{array}{cc} \text{NP} & \text{C}' \\ (\uparrow \textsc{topic}) = \downarrow & \uparrow=\downarrow \\ (\uparrow \textsc{comp}^{*}\ \textsc{obj}) = \downarrow & \end{array}$$

Each of the infinitely many paths in this uncertainty language begins with some number of comps, what Kaplan and Zaenen called the "body", and finally ends in obj (the "bottom"). Rule (15) covers a larger set of English topicalization patterns by relaxing the category of the external phrase and enlarging the set of paths in the uncertainty language.[2]

(15)
$$\text{CP} \longrightarrow \begin{array}{cc} \text{XP} & \text{C}' \\ (\uparrow \textsc{topic}) = \downarrow & \uparrow=\downarrow \\ (\uparrow \textsc{TopicPaths}) = \downarrow & \end{array}$$
$$\text{where } \textsc{TopicPaths} \text{ is } \{\textsc{comp}, \textsc{xcomp}, \textsc{adj}\ (\in)\}^{*}\ [\textsc{gf}-\textsc{comp}]$$

As discussed by Kaplan and Zaenen, CP is a possible realization for the generic XP category in this rule and thus provides the c-structures for the topicalized complements of *think* in (6c–6d). The relative-difference [gf−comp] at the bottom of every uncertainty path disallows comp but includes obj, subj, $\textsc{obl}_{\theta}$, adj, and every other function. The short, bottom-only path-string comp is thus not

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[2] In movement-based frameworks the clause-external c-structure phrase in topicalization and other constructions is often referred to as the "filler" of the dependency and the string position of a putative trace node is known as the "gap". That conventional terminology translates to the LFG functional account with the proviso that the filler refers not to the external phrase but to its corresponding f-structure, and the gap is the within-clause function assignment of that f-structure. The canonical string position for the gap function (or the position of the empty node in a trace-based analysis) is often marked by an underscore, just as a reader's guide to the intended interpretation.

available for the inadmissible example (6c). Adding XCOMP to the body of this expression allows for the bottom function to be embedded under a mixture of tensed and infinitival complements. Given (13b), the ADJ and ∈ options provide an analysis for the English sentences (16) (examples from Dalrymple 2001); presumably ADJ would not appear in the language of Icelandic paths.

(16) a. Julius teaches his class in this room.
b. This room Julius teaches his class in.
c. In this room Julius teaches his class.

Further extensions and restrictions on the TopicPaths and other path language are discussed in later sections.

Functional uncertainty has become the primary technical device for describing unbounded dependencies in LFG. Uncertainty languages can be defined by the primitive regular-expression operators of concatenation, union (curly braces), optionality (parentheses), and Kleene-star and Kleene-plus repetition. Indeed, since the regular languages are closed under intersection and complementation, a collection of attribute paths can be specified by any Boolean combination of the same regular predicates that are allowed in the right sides of LFG c-structure rules (see Kaplan & Maxwell 1996, Crouch et al. 2011). This includes the relative difference operator [GF−COMP] above and its equivalent but more succinct term-complement predicate \COMP. Path languages that describe a wide range of constructions in different languages can thus be expressed as the composition of separate, simpler formulas that encode independent linguistic generalizations, as illustrated in later sections. Also of importance, it has been shown that the satisfiability of functional descriptions remains decidable when the LFG formalism is extended with regular path languages (e.g. Kaplan & Maxwell 1988a, Backofen 1993).

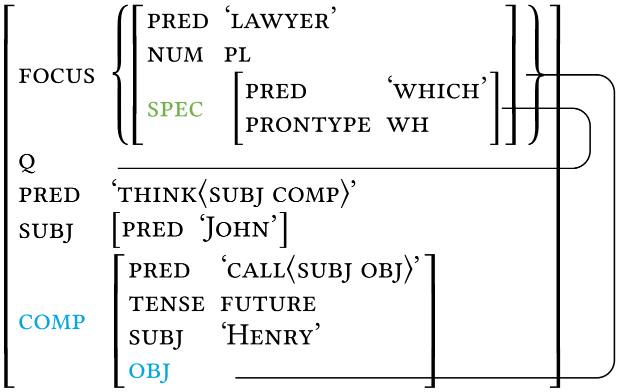
4 Constituent questions

Constituent questions in English resemble topicalization in that the f-structure of a clause-external phrase is assigned a grammatical function at some level inside its sister clause. The possibilities for the dependency path between the filler and its within-clause function are similar, but there is an additional requirement that the filler either must be an interrogative (*wh*) pronoun or must contain one. The examples of indirect questions in (17) illustrate some of the possibilities.

(17) I wonder …
   a. who John thinks Henry will call.
   b. which lawyer John thinks Henry will call.
   c. whose friend John thinks Henry will call.
   d. whose lawyer's friend John thinks Henry will call.
   e. from whom John thinks Mary will get a call.
   f. when John will call Mary.
   g. * this lawyer John thinks Henry will call.
   h. * he John thinks Henry will call.

Kaplan & Bresnan (1982) proposed the attribute FOCUS (distinct from the topicalization attribute TOPIC) as a placeholder for the communicative entailments of the question construction, and a separate attribute Q to place the interrogative pronoun in a canonical position for later interpretation. An f-structure configuration with these attributes for the embedded question in (17b) is shown in (18).

(18)



FOCUS is represented here as taking a set of f-structures as its value. It can thus hold the contributions of additional English question words that might appear in situ (19a) or the multiple question words in initial position that other languages might allow (19b).

(19) a. I wonder who John thinks would like to get what.
   b. Hungarian (from Mycock 2007)

Ki	ki-t	ki-nek	mutat-ott	be?
who-NOM	who-ACC	who-DAT	introduce-PAST-DEF.3SG	VM

'Who introduced who to who?'

The f-structure (18) for the embedded question (17b) is assigned by rule (20). The FocusPaths uncertainty resolves to the blue attribute sequence that relates the entire filler f-structure to its within-clause (non-comp) function, as for topicalization. The green path, taken from WhPaths, establishes q as an element inside the filler. The intersection with WhPro further ensures that q is an interrogative pronoun: given the off-path $=_c$ constraint, the f-structure at the end of any WhPaths string is acceptable only if it also includes the feature [prontype wh]. Off-path annotations are discussed in Section 8.1 and defined there in (55).

(20)
$$\text{CP} \longrightarrow \begin{array}{c} \text{XP} \\ \downarrow \in (\uparrow \text{FOCUS}) \\ (\uparrow \text{FocusPaths}) = \downarrow \\ (\uparrow \text{Q}) = (\downarrow \text{WhPaths} \ \& \ \text{WhPro}) \end{array} \qquad \begin{array}{c} \text{IP} \\ \uparrow = \downarrow \\ \\ \\ \end{array}$$

where FocusPaths is $\{\text{COMP}, \text{XCOMP}, \text{ADJ}\ (\in)\}^{*} \setminus \text{COMP}$
WhPaths is $\{\text{SPEC}^{*}, \text{OBJ}\}$
WhPro is $\text{GF}^{*} \underset{(\rightarrow\ \text{PRONTYPE}) =_c \text{WH}}{\text{GF}}$

In fuller treatments, of course, the uncertainty languages FocusPaths and WhPaths are supplemented with appropriate configurations of obliques, adjuncts, and other grammatical functions.

The initial phrase of the English c-structure configuration is the probable cause, the trigger, for introducing the FocusPaths uncertainty expression, and this must then resolve to the proper within-clause grammatical function for that focus phrase. In Mandarin interrogative pronouns appear in situ, at the position in the embedded clause where the proper function is assigned by normal clause-level rules. Huang (1993) discusses the following example.

(21) Mandarin
Zhangsan xiwang Lisi gen shei xue yuyanxue?
Zhangsan hope Lisi gen(with) who learn linguistics
'With whom does Zhangsan hope that Lisi will learn linguistics?'

An unbounded uncertainty is not needed here to establish the within-clause function, and indeed there is no natural place in the c-structure to specify a FocusPaths connection as in (20). But Huang notes that the pronoun must still be linked to some enclosing f-structure in order to establish the necessary scope for semantic and discourse interpretation. He proposes to include in the lexical entry of an interrogative pronoun an uncertain path language that resolves to a higher-level f-structure. Along the lines of that proposal, the lexical entry (22) places the interrogative pronoun in the focus set of a clause from which it is accessible through a path in the collection of (Mandarin-specific) FocusPaths.

(22) *shei*: ↑ ∈ ((FocusPaths ↑) focus)

This makes use of the formal device of *inside-out function application* (23a), originally introduced by Kaplan (1988) and subsequently extended by Halvorsen & Kaplan (1988) to uncertain path languages (23b).

(23) Inside-out function application

a. $(\sigma\, f) = g$ iff σ is an attribute string and $(g\, \sigma) = f$.

b. (Paths f) $= g$ iff Paths is a set of attribute strings and (g Paths) = f.

In this case also there is an explicit probable cause for the uncertainty, the interrogative lexical entry. In contrast, there is typically no local evidence to trigger the inside-out uncertainties that are attached to empty nodes in trace-based theories of unbounded dependencies (e.g. Bresnan 2001, Bresnan et al. 2016).

5 Grammaticized discourse functions?

Kaplan & Bresnan (1982) introduced the attributes topic and focus to distinguish the fillers of the different unbounded dependency constructions as separate from the establishment of their within-clause grammatical functions. These f-structure attributes were presumed to represent the syntactic features needed for subsequent interpretation by semantic and discourse components of grammar, and they were maintained as "grammaticized discourse functions" in some later work (e.g. Bresnan & Mchombo 1987). Other chapters describe the subsequent development of explicit theories of semantic representation (Asudeh 2023 [this volume]) and information structure (Zaenen 2023 [this volume]) and how LFG's Correspondence Architecture (Kaplan 1987, 1995) provides a uniform framework for integrating such independent modules with the core components of syntax. The literature surveyed in those chapters and also Dalrymple et al. (2019) suggest that the entailments of discourse functions like topic and focus can be spelled out in information structure (i-structure) features such as ±new and ±prom(inent) and by other potential i-structure concepts that help in managing how semantic content is transmitted from speaker to hearer.

With respect to the external phrases of topicalization and question formation, if their different discourse entailments can be carried over to i-structure, there may no longer be motivation to mark those with the distinguished topic and focus attributes in f-structure. Thus, to record the external element in either construction, Asudeh (2004, 2012) proposed just one "overlay function" udf (for "Unbounded Dependency Function"), Alsina (2008) suggested the attribute op (for "operator"), and Dalrymple et al. (2019) used the attribute DIS (for "dislocated"). Snijders (2015) goes even further, questioning whether the filler f-structure of either construction is needed other than at its within-clause position. This issue was foreshadowed in King's (1997) earlier and more general argument that discourse focus should be represented in the independent information-structure module. If the discourse functions do not interact with other syntactic features and if the i-structure discourse status of the within-clause function can be signaled without them, then the f-structure clutter of these grammaticized functions can be eliminated entirely. In the following, I explore this possibility.

The Correspondence Architecture is designed to encourage theoretical modularity, allowing different components of linguistic description to be organized in their own most natural ways and avoiding the complexity and confusion that comes from mixing conceptually unrelated primitives in a single representation. Dalrymple & Nikolaeva (2011) propose to relate f-structure to i-structure with the correspondence functions diagrammed in (24) (see also Dalrymple et al. 2019). The projection σ maps from units of f-structure to meaning constructors in semantic structure, and the projection ι maps meaning constructors into correlated properties in information structure.

(24) I-structure correspondences (from Dalrymple & Nikolaeva 2011)

$$\begin{tikzcd}\text{c-structure} \arrow[r, "\phi"] & \text{f-structure} \arrow[r, "\sigma"] & \text{s-structure} \arrow[r, "\iota"] & \text{i-structure}\end{tikzcd}$$

Given this arrangement and without involving any special features in f-structure, the composition of projections $\iota \circ \sigma \circ \phi$ can be used to express the fact that the filler in the topicalization construction is interpreted as an i-structure topic.

The abstract interface between the syntactic and information modules, according to this organization, is made explicit in the revision of the topicalization rule (15) shown in (25a). The TOPIC function assignment has been replaced by the invocation of the TOPIC template defined in (25b) (for more on the explanatory value of templates, see the discussion in Dalrymple et al. 2004).

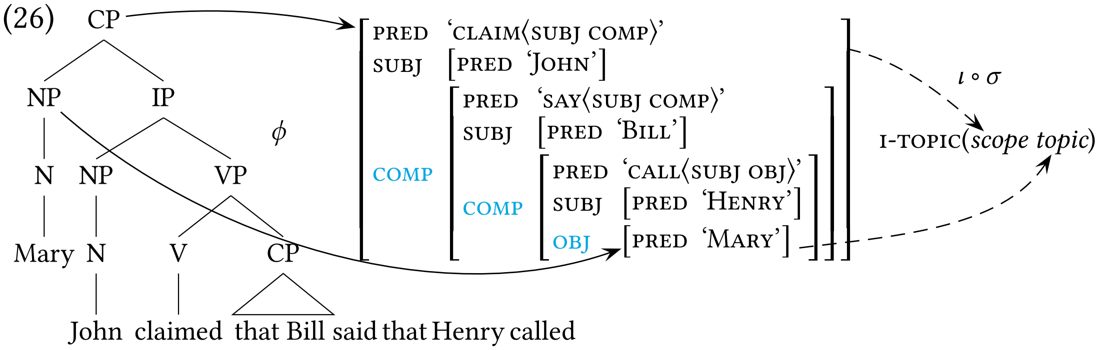
(25) a.

$$\text{CP} \longrightarrow \begin{array}{cc} \text{XP} & \text{C}' \\ @(\textsc{topic}\uparrow\ \downarrow) & \uparrow=\downarrow \\ (\uparrow \textsc{TopicPaths})=\downarrow & \end{array}$$

b. $\textsc{topic}(\textit{scope topic}) \equiv @(\textsc{i-topic}\ \textit{scope}_{\sigma\iota}\ \textit{topic}_{\sigma\iota})$

The template I-TOPIC is a placeholder for a separate i-structure theory of topic whose details are hidden from the syntactic modules, but substituting the f-structure designators ↑ and ↓ for the template parameters *scope* and *topic* makes clear that the information needed to interpret the topic is carried by the external phrase.[3] The subscript $\sigma\iota$ is the conventional way of notating the composition of projections in LFG annotations. In comparison to the structures shown in Figure 2 for sentence (1), this gives rise to the three-module relationships in (26).

(26)



Note that there is no TOPIC and no structure sharing in this f-structure. The filler f-structure appears only at the position of its within-clause function, with the projection lines indicating how the c-structure phrases relate indirectly through the f-structure to the topic in i-structure.

Rule (27a) is a similar revision of the constituent question rule (20). The three-place template FocusQ defined in (27b) makes properties of the interrogative pronoun available for i-structure interpretation in addition to information about the focus constituent and its scope.

(27) a. $$\text{CP} \longrightarrow \begin{array}{cc} \text{XP} & \text{IP} \\ @(\text{FocusQ}\ \uparrow\ \downarrow\ (\downarrow\ \text{WhPaths}\ \&\ \text{WhPro})) & \uparrow=\downarrow \\ (\uparrow\ \text{FocusPaths}) = \downarrow & \end{array}$$

b. $\text{FocusQ}(\mathit{scope}\ \mathit{focus}\ q) \equiv @(\text{i-FocusQ}\ \mathit{scope}_{\sigma\iota}\ \mathit{focus}_{\sigma\iota}\ q_{\sigma\iota})$

This results in the relationships shown in (28) for the indirect question (17a).

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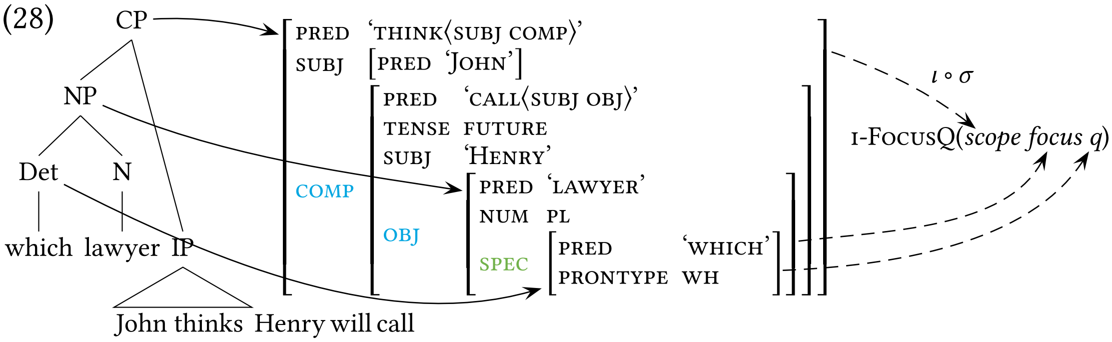
[3] Of course the original f-structure TOPIC attribute, should that be useful, can be easily resurrected by the alternative definition (i).

(i) $\text{TOPIC}(\mathit{scope}\ \mathit{topic}) \equiv (\mathit{scope}\ \text{TOPIC}) = \mathit{topic}$

(ii) $\text{TOPIC}(\mathit{scope}\ \mathit{topic/focus}) \equiv \mathit{topic} \in (\mathit{scope}\ \text{DIS})$

Definition (ii) produces the common DIS representation that Dalrymple et al. (2019) specify for both topic and focus. The set value suggests that syntactically the topic is not easily accessible.

(28)



There is no set-valued FOCUS attribute and again no structure sharing in this simplified f-structure: the discourse entailments of this construction are off-loaded to the separate i-structure module. This is attractive because it exploits the Correspondence Architecture to simplify syntactic representations, but the full consequences of this arrangement remain to be investigated.

6 The *tough* construction

The English *tough* adjectives (*easy*, *hard*, *difficult*, *impossible*...) induce unbounded dependencies with only one uncertainty, as for topicalization, but they differ from both topicalization and constituent questions in that a single phrase contributes information to grammatical functions that are governed by predicates in two clauses. These adjectives subcategorize for a subject and an open *to*-complement. If the complement has a simple transitive predicate, the adjective's subject is understood as the complement's object and its object must otherwise not be realized. The basic pattern is displayed in (29).

(29) a. Moths seem tough to kill.
(cf. It seems tough to kill moths.)
b. Moths are tough (for someone) to kill.
c. * Moths are tough to kill moths.
d. * Moths are tough to arrive.

It is also generally accepted that the adjective's SUBJ can serve as an OBJ in a clause embedded at an uncertain depth within the immediate complement, as illustrated by the examples in (30).

(30) a. Moths are tough to plan to kill.
b. This book is hard to get her to avoid reading. (Dalrymple & King 2000)

c. Kim would be difficult for me to persuade Robin to attempt to deal with. (Hukari & Levine 1991)
d. Mary is tough for me to believe that John would ever marry. (Kaplan & Bresnan 1982)
e. Kim is difficult to sit next to. (Grover 1995)

This unbounded dependency also differs from topicalization in that the uncertainty is keyed by the lexical entries of adjectives in this particular class rather than by a rule that describes a generic configuration of c-structure phrases. The uncertainty language itself is also quite different. The paths begin with sequences of xcomps that do not alternate with comps (31a-b), and they end only with obj, not just any non-comp grammatical function (31c-d). The bottom obj can be preceded by an oblique (30c), a comp (30d), or a member of a set of adjuncts (30e).

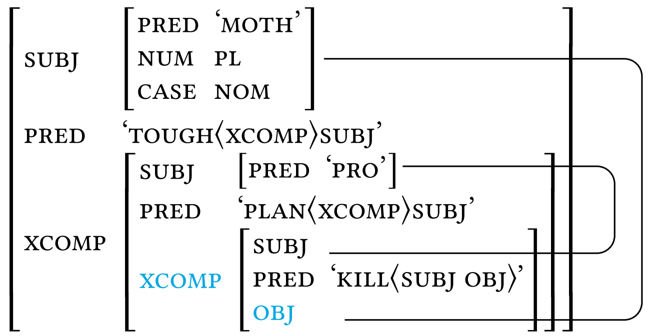
(31) a. * Mary is tough that John would ever marry.
b. * Mary is difficult for me to believe that John wanted to plan to marry.
c. * Tuesday would be difficult to take the exam. (Dalrymple & King 2000)
d. * Mary is tough for me to believe would ever marry John.

These possibiliites are expressed in the lexical uncertainty shown in (32).

(32) *tough* A (↑ pred) = ‘tough⟨xcomp⟩subj’
(↑ subj) = (↑ xcomp ToughPaths)
where ToughPaths = xcomp* {obl$_\theta$, comp, adj ∈} obj

This gives rise to the outer connection shown in (33), the f-structure corresponding to sentence (30a) (the inner line indicates the local functional control relation for *plan*).

(33)



The *tough* uncertainty establishes an identity between the SUBJ of the adjective and an OBJ somewhere within its complement. The effect is that the predicate and all other f-structure properties of the matrix SUBJ appear also in the embedded OBJ. The examples in (34) suggest that this might lead to inconsistent values for a shared CASE feature.

(34) They/*Them are tough to kill.
It is tough to kill *they/them.

This connectivity problem has received some attention in the literature (e.g. Hukari & Levine 1991, Dalrymple & King 2000). Dalrymple & King 2000 proposed to avoid this problem by removing the functional identity of the two f-structure values. Rather than linking the *tough* SUBJ directly to an embedded OBJ, they depend on an obligatory anaphoric relation between the SUBJ and a grammaticized pronominal TOPIC in *tough*'s immediate complement. It is then the TOPIC f-structure that the uncertainty identifies with an embedded OBJ, as spelled out in (35a).[4] This two-step connection preserves the intended semantic entailments while the appeal to the referential component of grammar suppresses the propagation not only of CASE but also of all other syntactic features. The entry in (35b) achieves the same effect without relying on anaphora or an explicitly grammaticized TOPIC simply by asserting that the SUBJ and the embedded OBJ share only the same uniquely instantiated PRED.[5]

(35) a. *tough* A (↑ PRED) = 'TOUGH⟨XCOMP⟩SUBJ'
(↑ XCOMP TOPIC PRED) = 'PRO'
(↑ XCOMP TOPIC) = (↑ XCOMP ToughPaths)
b. *tough* A (↑ PRED) = 'TOUGH⟨XCOMP⟩SUBJ'
(↑ SUBJ PRED) = (↑ XCOMP ToughPaths PRED)
@(TOPIC (↑ XCOMP) (↑ SUBJ))

The lexical entry (35a) would assign the f-structure (36a) to sentence (29b), with the dashed lines representing an anaphoric relationship. Entry (35b) would assign the f-structure (36b).

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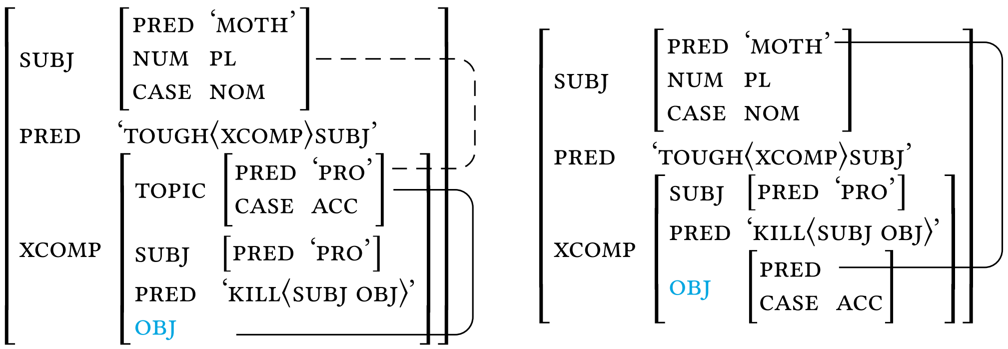
[4] Dalrymple & King (2000) assign the function COMP instead of XCOMP to the immediate complement, for reasons that are not relevant to the current discussion. They also argue that the *tough* SUBJ is thematic, but here I follow the raising/non-thematic representation suggested by Kaplan & Bresnan (1982). With respect to the issues of unbounded dependencies, this is also a difference of no consequence.

[5] Since SUBJ is generally assumed to map to a position of i-structure prominence, invoking the TOPIC template in (35b) may not be necessary for proper interpretation.

(36)



a. Anaphoric binding to SUBJ

b. PRED sharing of SUBJ and OBJ

Each of these solutions supports the intended semantic interpretation while avoiding the CASE conflict. But each allows for free variation of all other syntactic features, even inherent features like gender or person that may enter into patterns of agreement that CASE does not participate in.

A more precise alternative is based on the restriction operator defined in (37). This permits relaxing the compatibility requirement for specific features (like CASE) while still enforcing consistency of all otherwise unmentioned features.

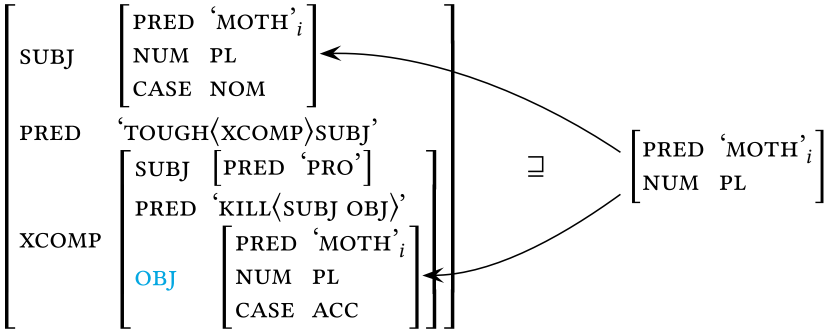
(37) Definition of restriction: (Kaplan & Wedekind 1993)
If f is an f-structure and a is an attribute, then the restriction of f by a is the f-structure $f\backslash_{a} = \{\langle s, v\rangle \in f \mid s \neq a\}$.

An f-structure f restricted by an attribute a contains all the attribute-value pairs of f except for the attribute a and its value. This formal device was used by Zaenen & Kaplan (2002) to suppress unwanted CASE conflicts in German functional control. It is applied in (38) to exclude CASE from the unbounded lexical uncertainty that holds between the *tough* SUBJ and the embedded OBJ. That particular incompatibility is thereby eliminated while all other features are shared (and may conflict).

(38) *tough* A (↑ PRED) = 'TOUGH⟨XCOMP⟩SUBJ'
$(\uparrow \text{SUBJ})\backslash_{\text{CASE}} = (\uparrow \text{XCOMP ToughPaths})\backslash_{\text{CASE}}$
@(TOPIC (↑ XCOMP) (↑ SUBJ))

The logical f-structure relationships that the CASE restriction induces are shown explicitly in (39):

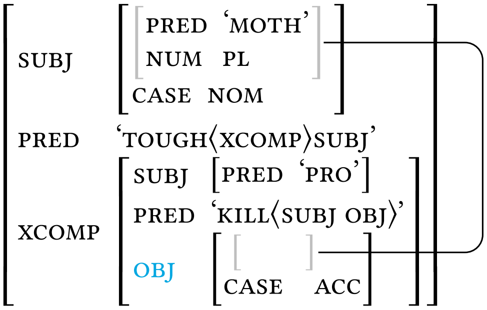
(39) Functional binding of case-restricted subj



On the right is the case-restricted f-structure that is shared across the functional uncertainty. It subsumes the subj and xcomp obj values, causing them to have all of the same syntactic features except for case.

The same logical relations are depicted more intuitively with the abbreviatory graphical convention shown in (40). While the gray brackets in this diagram are not formally part of the linguistic representation, they highlight that the functional identity induced by the restricted unbounded dependency holds only between the enclosed proper subsets of the features of the subj and xcomp obj f-structures.

(40) Functional binding of case-restricted subj (succinct)



In sum, the English *tough* construction involves an unbounded connection between two grammatical functions, the subj in the matrix clause and an obj embedded in its complement. While this has the potential of creating an undesired f-structure conflict between the values of the clause-specific case features, that potential conflict can be avoided if an anaphoric relationship disrupts the functional identity across the clauses or if only the pred value is shared. An alternative solution uses the f-structure restriction operator to suppress only the case feature without disturbing other patterns of agreement.

7 Relative Clauses

English relative clauses blend the double function assignments of the *tough* construction with the double uncertainties of constituent questions, as exemplified in (41).[6]

(41) The shop [[the owner of which] [Sue knows __]] sells books.

With respect to function assignments, *shop* is understood as both the subject of the matrix predicate *sells* and the (oblique) object of *owner*. With respect to uncertainties, the f-structure of the clause-initial *owner* phrase is the object of *knows* in this example but it could also bind to a function in a deeper complement. And the relative pronoun *which* can also appear at an arbitrary depth inside the clause-initial phrase. The examples (42a–42d) of what Ross (1967) called "Pied-piping" show some of the positions possible for the relative pronoun; example (42e) shows that the relative pronoun must appear somewhere.

(42) a. The man who we elected …
b. The woman to whom we gave the book …
c. The boy whose book Bill said was stolen …
d. Reports the height of the lettering on the covers of which the government prescribes … (Ross 1967)
e. * The shop the owner of the car Sue knows sells books.

F-structure (43) lays out the significant grammatical relationships of sentence (41). The uncertainty of the within-clause function for the clause-initial phrase is resolved by the blue OBJ path in RelTopicPaths, and that phrase also maps to the i-structure topic. The relative pronoun is identified as the HEAD of the clause (the solid line) by virtue of the attributes on the green path from RelHeadPaths. The dashed line between the HEAD and the nominal predicate indicates a connection of obligatory anaphoric control, as in the *tough* f-structure (36a), that avoids any CASE-like inconsistencies that might stem from the double function assignment.

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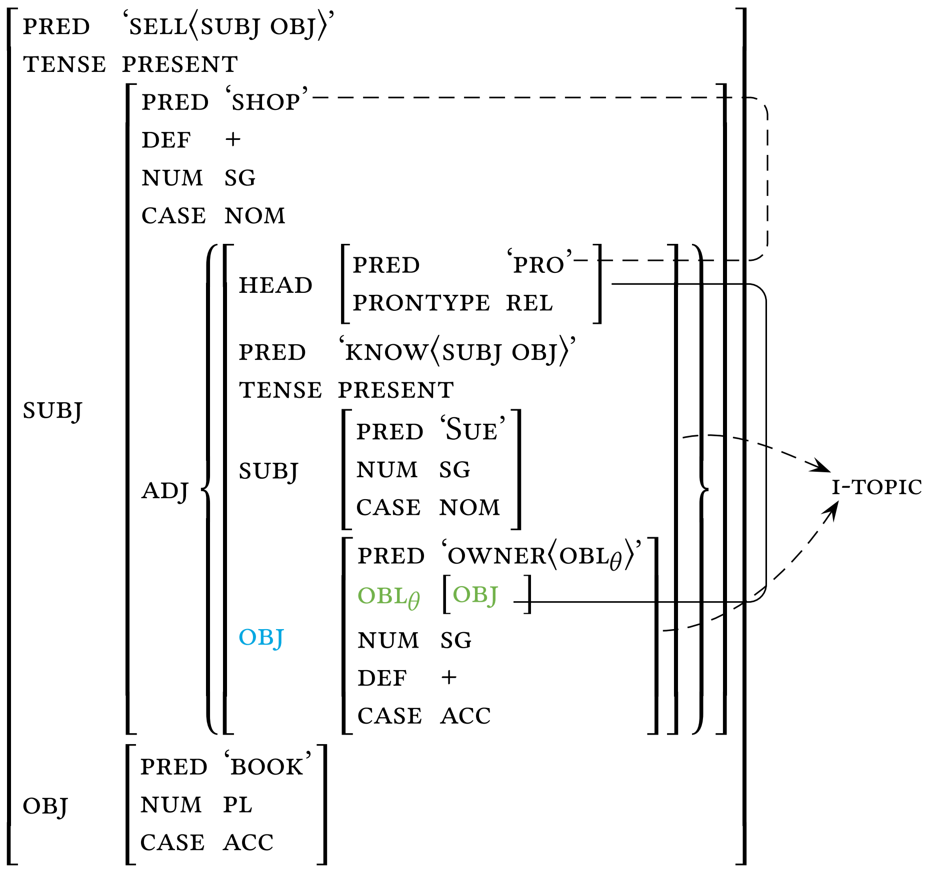
[6] As mentioned earlier, the underscore indicating the position of the 'gap' is provided only as a reader's guide to the intended interpretation. As discussed in Section 8.3, it is quite a separate question whether it should also indicate the presence of an empty node in the syntactic representation.

(43)



This f-structure is derived by the rules and lexical entry in (44). According to rule (44a), the f-structure of a single relative clause is added to the adjunct set of the NP; the recursion through the NP category allows for NP’s with multiple clauses. Rule (44b) describes the internal structure of the relative clause itself. The f-structure of the clause-initial phrase is linked to its within-clause function through a path in RelTopicPaths and is also projected to the i-structure topic by the topic template. The head at the top is set to the relative pronoun required at the end of one of the RelHeadPaths. The dashed anaphoric connection is not established in the syntax.

(44) a. $$\text{NP} \longrightarrow \underset{\uparrow=\downarrow}{\text{NP}} \qquad \underset{\downarrow\in(\uparrow\ \textsc{adj})}{\text{CP}}$$

b. $$\text{CP} \longrightarrow \begin{array}{c}\text{XP}\\ @(\textsc{topic}\uparrow\downarrow)\\ (\uparrow \textsc{RelTopicPaths})=\downarrow\\ (\uparrow \textsc{head})=(\downarrow \textsc{RelHeadPaths}\ \&\ \textsc{RelPro})\end{array} \qquad \begin{array}{c}\text{C}'\\ \uparrow=\downarrow\\ \\ \\ \end{array}$$

where RelTopicPaths is {COMP, XCOMP, ...}* \COMP
RelHeadPaths is {SPEC*, [(OBL$_\theta$) OBJ]*}
RelPro is GF* $\underset{(\rightarrow \text{ PRONTYPE}) =_c \text{REL}}{\text{GF}}$

c. *which* Pro (↑ PRED) = ‘PRO’
(↑ PRONTYPE) = REL

Sentence (45) exemplifies a pattern for English relative clauses that is not derived by rule (44b).

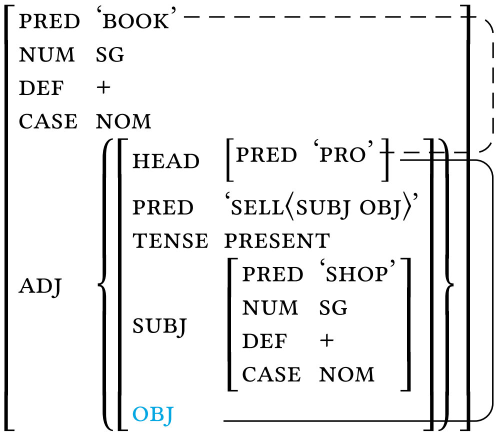
(45) The books (that) the shop sells __ are expensive.

The embedded clause in this sentence does not begin with an external XP topic phrase. Rather, the XP position of (44b) is either filled with the complementizer *that* or is left completely empty, and in either case there is no explicit relative pronoun to trigger an anaphoric interpretation. The alternative CP expansion in (46) accounts for these c-structure configurations, simulates the anaphoric link by introducing a null pronoun, and identifies directly the within-clause function for the value of the HEAD attribute.

(46) CP ⟶ *that* | *e* C′
@(TOPIC ↑ (↑ HEAD)) ↑=↓
(↑ RelTopicPaths) = (↑ HEAD)
(↑ HEAD PRED) = ‘PRO’

This produces (47) as the f-structure for the relativized matrix subject NP in (45) (now omitting the projection arrows that presumably map the HEAD by default to the i-structure topic).

(47)



The HEAD ‘PRO’ is an essential ingredient of this commonly accepted analysis of relative clauses. On this account the semantic connection between the head noun and its role within the clause is established without a direct syntactic relationship. This has the advantage that unwanted inconsistencies of any double-function syntactic feature values cannot arise (cf. the anaphoric solution for *tough*). However, Falk (2010) puts forth several arguments against what he describes as this “anaphorically mediated” analysis.

On one line of attack he points to the contrast in (48). While the word *headway* in the idiom *make headway* can be the head of a relative clause (48a), it cannot otherwise be an antecedent for a referential pronoun (48b).

(48) a. Mary praised the headway that John made.
b. * Mary always praises headway when John makes it.

As another argument, he notes (citing Maxwell 1979) that languages with pronounless relative clauses are quite common among the 49 languages listed in the NP accessibility database of Keenan & Comrie (1979). He illustrates this with examples from a number of languages, including the ones in (49) (*that* is a complementizer in the English translations, not a pronoun).

(49) a. Hebrew (from Falk 2010)
meabed hatamlilim še Bill maadif.
processor DEF.texts COMP Bill prefers
‘the word processor that Bill prefers’

b. Japanese (from Keenan & Comrie 1979)
Watashi wa sono otoko ga tataita inu o miru.
I TOP that man NOM struck dog ACC see
‘I see the dog that the man struck.’

Some languages allow relative clauses with or without relative pronouns, like English, but relative pronouns simply do not exist in Japanese and other languages. Falk thus suggests that relative clauses without mediating pronouns are the typical case cross-linguistically, and that English examples like (41) are more the exception than the rule. A general account of head dependencies, he concludes, should not rely on the machinery of anaphoric binding.

Falk (2010) thus proposes an anaphorically-unmediated account of the connection between the f-structure of the relativized NP and the HEAD f-structure of the clause. The restriction operator is used to prevent selected features from clashing, along the lines of the *tough* analysis in (38) above. His proposal in essence is to augment the relative clause introduction rule (44a) with an equation that identifies the NP's (restricted) f-structure with the (restricted) HEAD of the clause (50).[7]

(50) $$\text{NP} \longrightarrow \underset{\uparrow=\downarrow}{\text{NP}} \qquad \underset{\substack{\downarrow\in(\uparrow\ \text{ADJ})\\ \uparrow\backslash_{\{\text{CASE, ADJ}\}} = (\downarrow\ \text{HEAD})\backslash_{\{\text{CASE, ADJ}\}}}}{\text{CP}}$$

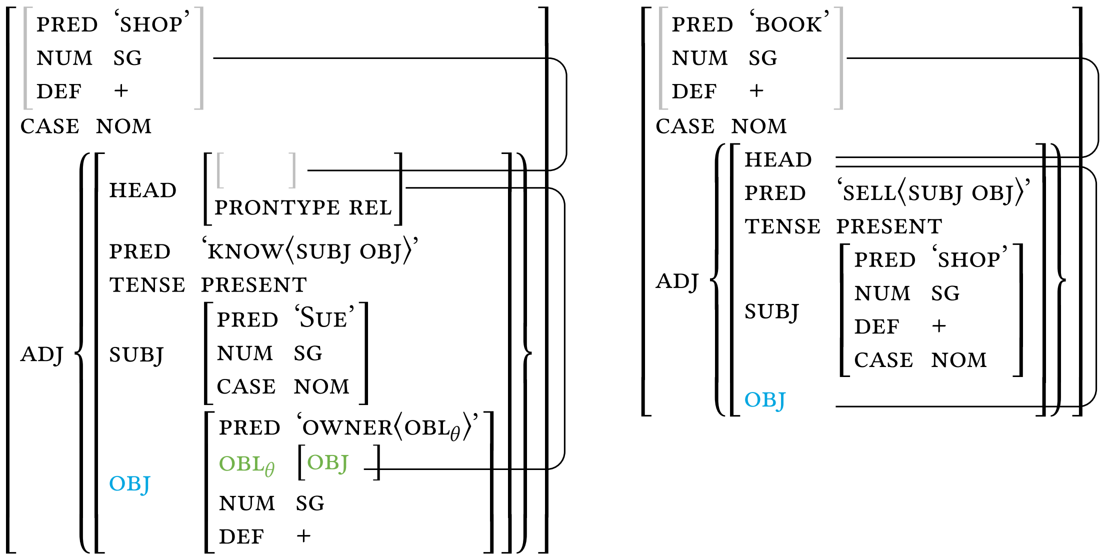
This permits the CASE feature of the NP and the relative HEAD to disagree; the relative-containing ADJ set is also restricted to avoid the technical confusion of circularity. The modified rule figures in the derivation of relative clauses with or without relative pronouns. English clauses with pronoun-containing initial XP phrases are still derived by rule (44b), but the relative pronoun no longer introduces its own pronominal PRED (51a). Instead the HEAD explicitly shares the head noun's PRED, thus establishing the semantic connection. Rule (46) is also simplified, since the null 'PRO' is not needed to compensate for the absence of an initial XP (51b).

(51) a. *which* Pro (↑ PRONTYPE) = REL

b. $$\text{CP} \longrightarrow \underset{\substack{@(\text{TOPIC}\ \uparrow\ (\uparrow\ \text{HEAD}))\\ (\uparrow\ \text{HEAD}) = (\uparrow\ \text{RelTopicPaths})}}{\textit{that}\,|\,e} \qquad \underset{\uparrow=\downarrow}{\text{C}'}$$

With these revisions the f-structure (52a) is provided for the relativized NP *shop* in (41) and (52b) is provided for *book* in (45).

(52) a. b.



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[7] The attribute HEAD is neutral with respect to Falk's semantically-oriented OPER attribute and the attribute RELPRO that aligns more with previous anaphora-based solutions.

In these structures the link between the restricted HEAD f-structures is strictly local. The links within the clause are unbounded, as indicated by the colored attributes from paths in the RelTopicPaths and RelHeadPaths uncertainty languages.

8 Further constraints on uncertainty paths

In modern LFG theory the admissibility of particular unbounded dependencies is determined first and foremost by the attribute strings in the uncertainty path-languages. But these dependencies have been challenging for linguistic description because they are also conditioned in different constructions and different languages by second-order interactions with other structural properties. Dependencies and the phrases they pass through must sometimes be aligned with respect to special morphological or phonological feature values (Section 8.1). Separate dependencies in some languages cannot pass through the same f-structures, giving rise to island effects (Section 8.2). Unbounded dependencies are of course related indirectly to word order by virtue of a grammar's normal c-structure rules and f-structure annotations, but they may also be sensitive to additional linear order constraints (Section 8.3).

8.1 Marking of intervening f-structures

Zaenen (1983) discussed a number of languages in which f-structures on a path between a filler and its clause-internal function differ in form from f-structures that are not in the domain of an unbounded dependency. She specifically considered Irish and Kikuyu, but since then many more cases have been discussed in the literature (see e.g. van Urk 2020). Here I focus on just the Irish examples of the phenomenon, as illustrated by the contrasts in (53) (data originally from McCloskey 1979).[8]

(53) Path-dependent complementizer selection in Irish

a. Deir siad goN/*aL síleann an t-athair goN/*aL bpósfaidh Síle é.
Say they that thinks the father that will-marry Sheila him
'They say that the father thinks Sheila will marry him.'

---

[8] In the linguistic literature the complementizer *a* is typically written as *aL* or *aN*, indicating that it triggers a lenition mutation or a nasalization mutation on the following word.

b. An fear aL/*goN deir siad a shíleann an t-athair aL/*goN
The man that say they that thinks the father that
phósfaidh Síle.
will-marry Sheila
‘The man that they say that the father thinks Sheila will marry __.’

Embedded complements not on a binding path (53a) are introduced by the complementizer *goN* and not *aL*, while *aL* is required for complements that the relative-clause dependency passes through (53b). This pattern has a simple account if all and only intervening f-structures on a dependency path are marked with a distinguishing diacritic feature [UBD GAP] (for “gapped unbounded dependency”). That feature would then be available for checking by the complementizers’ lexical annotations (54).[9]

(54) Irish complementizers

aL	C	(↑ UBD)
goN	C	¬(↑ UBD)

The positive existential constraint would not be satisfied if *aL* appears with a COMP that does not have a UBD feature, and the negative existential for *goN* would fail if that feature is present.

Working within the original Kaplan & Bresnan (1982) c-structure formulation of unbounded dependencies (Section 3.1), Zaenen (1983) added the f-structure marking feature (BND in her account) at sentential bounding nodes in a successive-cyclic fashion. In the modern functional framework, a basic uncertainty leaves no footprints as it passes through the intervening f-structures along a path, but its presence can be made known by adding off-path annotations to the attributes of the regular expression. Off-path constraints were formalized originally by Kaplan & Maxwell (1996) and Crouch et al. (2011); see also Dalrymple et al. (2019).

An off-path annotation is a functional description attached to an attribute in an ordinary functional designator, much like traditional descriptions are attached to c-structure categories. The difference is that an off-path annotation can use metavariables ← and → instead of (or in addition to) ↑ and ↓. These are instantiated to the f-structure containing the annotated attribute and the value of that attribute in the containing f-structure, respectively. A formal definition is given in (55).

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[9] This is a respelling of the LDD (“long distance dependency”) feature that appears in Dalrymple et al. (2019) and elsewhere. Ash Asudeh (p.c.) argues that UBD is a more accurate designation, since some instances of these constructions are actually quite short. Falk (2009) proposes a feature WHPATH for related path-marking purposes.

(55) Off-path annotations

$(f \underset{D}{a}) = v$ iff $(f\ a) = v$ and $D_{\substack{\leftarrow/f \\ \rightarrow/v}}$ is satisfied, where

D is a functional description and

$D_{\substack{\leftarrow/f \\ \rightarrow/v}}$ is the result of substituting f for ← and v for → in D.

This definition extends the notation and meaning of primitive function-application designators (12a) and thus immediately carries over to the path languages of functional uncertainties (cf. (13a)).

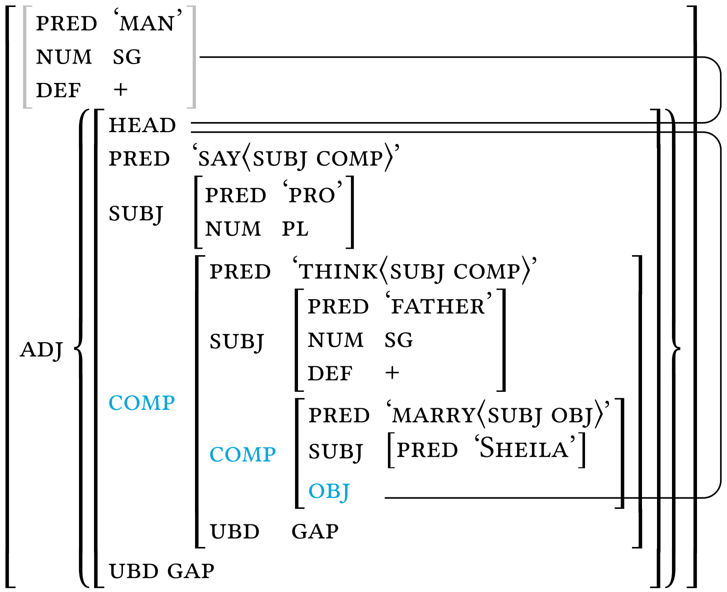
Off-path annotations were first used in a functional account of Irish complementizer marking that was developed in unpublished research by Mary Dalrymple, Ronald Kaplan, John Maxwell, and Annie Zaenen; Dalrymple (2001) provided the first published account of this approach. In essence, the uncertainty expression defined in (56a) inserts the UBD feature at every intervening f-structure without imposing any further restrictions on the grammatical functions along the path. The RelTopicPaths schema (56b) then applies regular-language intersection to mark the attributes of whatever path language is separately specified.

(56) a. $\text{Mark} = \underset{(\leftarrow\ \text{UBD})=\text{GAP}}{\text{GF}^{*}}\ \ \text{GF}$

b. RelTopicPaths = […] & Mark

The off-path annotation adds the UBD features parallel to the COMPs in (57), the f-structure for (the English gloss of) sentence (53b), and the lexical constraints (54) then assure the proper distribution of complementizers.

(57)



Asudeh (2012) discusses the more complicated relative clause patterns of Irish described by McCloskey (2002). Generally, the head nominal is assigned a within-clause function that has no surface realization (a gap), as in (57), if every intervening clause is marked with *aL*. But if the nasalization mutation triggered by *aN* appears at any clause along the way, then additional UBD marking is suspended and the head must bind to an explicit resumptive pronoun found in that clause or below. McCloskey (2002) illustrates this pattern with the relative clause in (58).

(58) Irish

aon	duine	a	cheap	sé	a	raibh	ruainne	tobak	aige
any	person	aL	thought	he	aN	was	scrap	tobacco	at-him

‘anyone that he thought had a scrap of tobacco’

This motivates the more elaborate version of the marking language shown in (59a). Here the f-structures on an arbitrary (possibly empty) prefix of an uncertainty path are marked with the feature [UBD GAP], as before. But at any point along the path the marking value for embedded f-structures can optionally switch to RES(umptive). Intersecting the language RESOLVE in (59b) forces the uncertainty to resolve to a resumptive pronoun only when the RES value has been chosen.

(59) Irish gap marking (with resumptives)

a. $\textsc{Mark} = \underset{(\leftarrow\ \textsc{ubd}) = \textsc{gap}}{\textsc{gf}^*} \quad (\underset{(\leftarrow\ \textsc{ubd}) = \textsc{res}}{\textsc{gf}^*})$

b. $\textsc{Resolve} = \textsc{gf}^* \underset{(\leftarrow\ \textsc{ubd}) = \textsc{res} \text{ iff } (\rightarrow\ \textsc{prontype}) =_c \textsc{res}}{\textsc{gf}}$

c. $\textsc{RelTopicPaths} = [\ \ldots\ ]\ \&\ \textsc{Mark}\ \&\ \textsc{Resolve}$

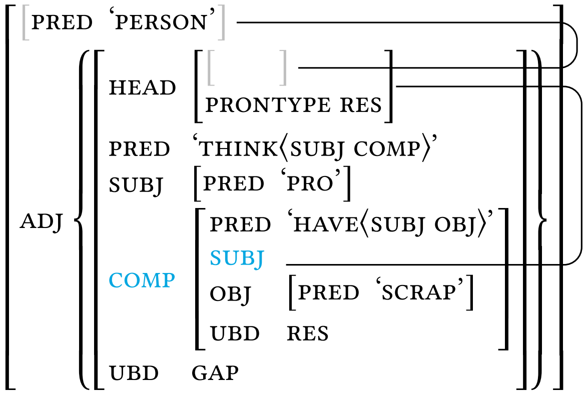
The lexical annotations (60) then make sure that the complementizers along the way are properly correlated with how the uncertainty is resolved at the bottom.

(60)

aL	C	$(\uparrow \textsc{ubd}) =_c \textsc{gap}$
aN	C	$(\uparrow \textsc{ubd}) =_c \textsc{res}$

For the relative clause (58) this analysis gives rise to the abbreviated f-structure (61).

(61)



Asudeh (2012) provides an alternative treatment of this and other patterns of Irish relatives. On his account the entire head f-structure, not just an atomic feature, is instantiated at every clause along the path. In this successive cyclic COMP-to-COMP arrangement, the head appears in the *aN*-complementizer clause in particular, and the pronoun binding is then set up there by a new uncertainty launched by *aN*'s lexical annotations. The marking strategy (59a), by comparison, offers the transition from gap to pronoun as a feature-controlled choice at any point within a single uncertainty language. It allows both the gap and the pronoun to be bound in the same end-to-end fashion, without any intermediate landing sites. This produces a less cluttered f-structure while making the claim that features of the particular head do not interact with properties of any intermediate clauses.

For Irish it is the selection of complementizers that interacts with unbounded dependency paths. The Kikuyu data cited by Zaenen (1983) and Dalrymple (2001) show that the verbs in intervening f-structures may also be sensitive to the presence of a dependency. This effect may be seen also in English: unbounded dependencies freely propagate through the complements of some verbs (62a) while (at least for some speakers) the complements of other verbs act as barriers (62b).

(62) a. Mary, we thought that Henry called.
b. * Mary, we whispered that Henry called.

Verbs like *think* are called bridge verbs, while *whisper* belongs to the class of nonbridge verbs. If the simpler MARK in (56a) is applied to the sets of English uncertainty paths, then the difference in behavior is accounted for by the negative existential in (63b).[10]

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[10] Dalrymple et al. (2019) formalize the bridging restriction by pairing a negative defining equation (↑ LDD) = − on *whisper* with an off-path negative value constraint (↑ LDD) ≠ − in the un-

(63) a. *think* V (↑ pred) = ‘think⟨subj comp⟩’

b. *whisper* V (↑ pred) = ‘whisper⟨subj comp⟩’
¬(↑ ubd)

This captures the syntactic difference between bridge and nonbridge verbs, but that difference may be a structural reflection of a more basic semantic or pragmatic difference. Erteschik-Shir (1973) suggested that verbs that imply the manner of saying something are more likely to form islands than verbs that simply describe what is being said. It is not clear whether the various constraints on unbounded dependencies that can be formalized with LFG’s syntactic machinery are better explained by appeal to other components of grammar, or to principles of cognition, pragmatics, or computation.

In these illustrations the unbounded dependency announces itself by the value it defines for the special ubd feature, and that value can then be examined to limit the f-structures that the dependency passes through. English adjuncts appear to interact with unbounded dependencies in a different way. Sentence (64a) was cited earlier to show that adjuncts can be topicalized and that the topicalization path-language (for English, not Icelandic) should include adj (∈) as an option. But the ungrammaticality of example (64c) indicates that an additional restriction must be imposed on the general pattern (examples from Dalrymple 2001).

(64) a. This room Julius teaches his class in __.

b. We think that David laughed after we selected Chris.

c. * Chris, we think that David laughed after we selected __.

This difference has been ascribed to the fact that the adj clause is tensed in (64c) but not (64a), although there may be other pragmatic or semantic factors also at work (see Toivonen 2021 and references cited there).

Taking the bridge verbs as a model, tensed adjuncts could be excluded from unbounded dependencies by adding a negative existential constraint ¬(↑ ubd) to every tensed verb. But it is more economical to leave all the verbs alone and instead to refine just the uncertainty so that it cannot pass to or through a tense-marked adj element. The path language (65a) and the intersection (65b) impose that constraint on TopicPaths (Dalrymple 2001 and Dalrymple et al. 2019 formulate tac in a slightly different but equivalent way).

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certainty. The ldd feature thus always appears in the complement f-structures of nonbridge verbs, even if not in the context of an unbounded dependency. In the solution outlined here that feature appears always and only along a dependency path and is available there for the bridge verb to test.

(65) Tensed Adjunct Constraint[11]

a. $\textsc{tac} = \backslash[\ \underset{(\rightarrow\ \in\ \textsc{tense})}{\textsc{adj}}\ ]^*$

b. $\textsc{TopicPaths} = [\ \{\textsc{comp}, \textsc{xcomp}, \textsc{adj}\ (\in)\}^*\ \backslash\textsc{comp}]\ \&\ \textsc{mark}\ \&\ \textsc{tac}$

The TAC restriction can be applied with a similar intersection to FocusPaths and the path languages of other constructions, as appropriate.

However, examples (66) indicate that grammaticality is not correlated with the presence of absence of the TENSE feature. The participial adjunct in (66a) is untensed and therefore the inadmissible dependency in (66b) would not be ruled out by the Tensed Adjunct Constraint.

(66) a. The cat slept after devouring the rat.

b. * What did the cat sleep after devouring __?

Instead, what is common to the ungrammatical examples in (64) and (66) is the presence of a subject, either derived from an explicit phrase (64c) or inserted as an anaphorically controlled null pronoun (66b). Unbounded dependencies may thus be more sensitive to the constraint as formulated in (67).

(67) Subject Adjunct Constraint

$\textsc{sac} = \backslash[\ \underset{(\rightarrow\ \in\ \textsc{subj})}{\textsc{adj}}\ ]^*$

Like many other conditions, restrictions on adjunct dependencies seem to be language-particular and not universal. Swedish for example seems to be more flexible than English in this regard (see Müller 2019). It is an advantage of the LFG approach that such constraints can be expressed easily within the formalism without appeal to extragrammatical (and often false) general principles.

8.2 Classical island constraints

Early interest in unbounded dependencies was mainly stimulated by the constraints on them that were first described in detail by Ross (1967). Working within a framework of transformational rules, Ross gave a list of "island" configurations that block the movement of constituents from one clause to another. He observed in particular that sentential subjects, coordinate structures, and complex NPs all seem to interfere with unbounded relationships, as the contrasts in (68) suggest (after Ross 1967).

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[11] Intersection and term-complementation of off-path annotations can be reduced to more primitive expressions by noting the equivalences of $\underset{D_1}{a}\ \&\ \underset{D_2}{a}$ and $\underset{D_1 \wedge D_2}{a}$ and of $\backslash[\ \underset{D}{a}\ ]$ and $\{\ \underset{D}{\backslash a},\ \underset{\neg D}{a}\ \}$.

(68) Sentential Subject Constraint

a. The reporters expected that the principal would fire some teacher.

b. The teacher who the reporters expected that the principal would fire __ …

c. That the principal would fire some teacher was expected by the reporters.

d. * The teacher who that the principal would fire __ was expected by the reporters …

Coordinate Structure Constraint

e. Henry plays the lute and sings madrigals.

f. * The lute which Henry plays __ and sings madrigals …

g. * The madrigals which Henry plays the lute and sings __ …

Complex NP Constraint

h. Phineas knows a girl who __ is jealous of Maxime.

i. * Who does Phineas know a girl who __ is jealous of __?

j. * Maxime, Phineas knows a girl who __ is jealous of __.

It appeared that transformations cannot move the constituents of sentential subjects (68a–68d), that parts of individual conjuncts in a coordination cannot be moved (68e–68g), and that the complex NPs of relative clauses also form a barrier (68h–68j). Ross formulated these island constraints in phrase-structure terms and appealed to extra-grammatical (and presumably universal) stipulations to impose them on the otherwise unfettered operation of individual transformational rules.

Later transformational accounts maintained the view that unbounded dependencies are allowed except when they would cross into phrasal islands, and this conception was carried over into the early c-structure-based LFG approach. Kaplan & Bresnan (1982) and Zaenen (1983) provided a grammar-internal way of limiting the range of the bounded-domination metavariables ⇑ and ⇓ and thus enabled more fine-grained characterizations of island configurations. They permitted particular categories in c-structure rules to be marked as “bounding categories”, and nodes licensed by those categories were not allowed on the dominance paths connecting co-instantiations of ⇑ and ⇓. For example, the ungrammaticality of (68i) would follow on that theory if the CP under NP in rule (44a) is marked as a bounding category. But there is no need for such categorial distinctions in the modern LFG theory of unbounded dependencies, since the vocabulary of grammatical functions and features provides a natural platform for expressing such island-like restrictions.

Ross' Sentential Subject Constraint, for instance, can be expressed by the term-complement formula (69a). This defines paths of arbitrary length that do not pass through subjects and that bottom out in any grammatical function. And the constraint could then be enforced by intersecting this with any other long distance regular language, as in (69b). Any paths with SUBJ-containing prefixes would no longer be available.

(69) a. SSC = \SUBJ* GF
b. RelTopicPaths = […] & SSC (English)
c. RelTopicPaths = SUBJ$^+$ (Tagalog)

This restriction would be helpful for English relatives if there is an explanatory advantage in stating the basic path language in a simple but overly general way (e.g. [GF* \COMP]). But it would not be needed if the regular expression for the basic uncertainty defines the admissible paths more precisely. Either way, this is clearly not a universal constraint: Kroeger (1993) observes that the path language for Tagalog unbounded dependencies contains *only* subjects, as in (69c). Such an extragrammatical condition may have been the only way of regulating the operation of transformational rules, but it serves no particular purpose in the setting of functional uncertainty.

Coordinate structures in LFG are represented formally as conjunct-containing sets under distributive attributes, and their behavior with respect to f-structure well-formedness is specified in (12e), repeated here for convenience. A set satisfies a distributive f-structure property if all of its elements satisfy that property. While this account of coordination is defined only for local f-structure configurations, unbounded dependencies simply inherit that local behavior by virtue of the incremental, single-attribute expansion of functional uncertainty as spelled out in (13a), also repeated.

(12e) $(f\ a) = v$ iff f is a set and
$(g\ a) = v$ for all $g \in f$ if a is a distributive attribute
$\langle a, v \rangle \in f$ if a is a nondistributive attribute.

(13a) If Paths is a set of attribute strings,
$(f\ \textsc{Paths}) = v$ iff $((f\ a)\ \mathit{Suff}(a, \textsc{Paths})) = v$.

The pattern of coordinate structure violations illustrated in (68e-g), and in (10) above, follows immediately from this independent theory of coordination: without further stipulation, a dependency that crosses into a coordination cannot affect just one of the conjuncts.[12]

An NP is “complex” for Ross if it immediately dominates a clausal category (CP now, S as originally formulated). The essence of the Complex NP Constraint is that no unbounded dependency can relate an element outside such an NP to an element inside the dominated clause. Examples (68i) and (68j) are ungrammatical on this theory because the relativized NPs are complex in this way and thus are opaque to the question and topicalization dependencies. Our framework offers a different account of their ill-formedness: the clauses are represented in f-structure as adjuncts of the head noun *girl* and so do not satisfy Subject Adjunct Constraint installed in the English FocusPaths and TopicPaths path sets. As noted above, tac is not universal, it applies in English but not for instance to Swedish dependencies. It is not surprising that the Complex NP Constraint also does not seem to operate in Swedish (Müller 2019).

The CNPC characterizes English relative clauses (with assignments to adj) as islands for unbounded dependencies. It does not cover other cases where dependencies seem to be mutually exclusive. Example (70b) shows that two question dependencies cannot overlap, (70c) shows that a topicalization cannot pass into a question, and (70d) shows that a question also obstructs a relative clause dependency. None of these involve complex NPs.

(70) a. Phineas wonders which girl is jealous of Maxime.
b. * Who does Phineas wonder which girl __ is jealous of __?
c. * Maxime, Phineas wondered which girl __ is jealous of __.
d. * The girl that Phineas wondered who __ is jealous of __ left.

On one approach the path languages for each of the outer dependencies can be conditioned against tell-tale properties of the innner question f-structure, presuming that those are recognizable and independently motivated (for example,

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[12] The suffix language for a chosen attribute must propagate into each conjunct, but Kaplan & Zaenen (1989) note that the residual uncertainties are then not required to resolve all in the same way:

(i) Mary, John expected to see __ and give the book to __.

Here the set of xcomp suffix paths resolves to obj in the first complement but obl_θ in the second. In contrast, Saiki (1985) observes that some Japanese relative clauses are constrained so that the dependencies in all conjuncts must resolve either to a subject or to a non-subject. This constraint can be imposed by intersecting [gf^* subj | gf^* \subj] with the basic Japanese path specification.

if a grammaticized focus attribute is still needed for some other reason). Falk (2009) proposes instead to make use of the path-marking feature ubd (his wh-path) that is already needed for verb and complementizer selection. It is the inner construction that then determines whether to protect itself from other unbounded dependencies. English embedded questions thus become dependency islands when a negative ubd constraint is added to the rule (71) that introduces them.

(71)
$$\begin{array}{lcc} \text{CP} \longrightarrow & \text{XP} & \text{IP} \\ & @(\text{FocusQ}\ \uparrow\ \downarrow\ (\downarrow \text{WhPaths}\ \&\ \text{WhPro})) & \uparrow=\downarrow \\ & (\uparrow \text{FocusPaths}) = \downarrow & \\ & \neg(\uparrow \text{ubd}) & \end{array}$$

It may not be an accident that the constraint that blocks an outer unbounded dependency co-occurs with an equation that launches an inner one, as in this rule. Some but not all languages may use this as a strategy to keep at bay the confusion of too many overlapping uncertainties.

8.3 Constraints on linear order

In the unbounded dependency constructions examined so far, an uncertainty is launched from an overt c-structure constituent or lexical item and binds the content of that element to a remote position in f-structure. The uncertainty is outside-in for most of the constructions, where the external element is realized perhaps far away from the normal c-structure location of its within-clause function assignment. The uncertainty is inside-out when the overt element of a dependency is in situ, as in the Mandarin example (21). These purely functional accounts go through without making reference to c-structure positions that correspond to the other, covert ends (bottom or top) of the dependencies. So far there has been no need for the phonologically empty nodes or traces that have been an essential ingredient of other theories of syntactic binding.

However, there are well known cases to suggest that the bottom end of an outside-in uncertainty must be grounded at a specific c-structure position, that the external element must be associated with a within-clause c-structure position in addition to a within-clause function. The weak crossover pattern in (72), first discussed by Wasow (1979), has received the most attention. Controlling for other possibly relevant factors, this shows an interaction between the linear position of the pronoun and the within-clause position where the obj or obl$_\theta$ function assigned to *who* would normally be expressed. The pronoun *his* and *who* cannot refer to the same individual if the pronoun comes before the assumed within-clause position of *who*:

(72) Weak crossover (examples from Dalrymple et al. 2001)

a. * Who$_i$ did his$_i$ mother greet __?
(cannot mean: Whose$_i$ mother greeted him$_i$?)

b. * Who$_i$ did Sue talk to his$_i$ mother about __?

c. Who$_i$ did Sue talk to __ about his$_i$ mother ?

The English contrast in (73) has also been taken as evidence that within-clause locations must be assigned to the external elements of question and *tough* constructions (see Kaplan & Bresnan (1982) and references cited therein). Sentence (73b) is uninterpretable because the link from *sonata* to its putative within-clause position crosses over the link from the overt appearance of *violin* to its covert linear position.

(73) Nested syntactic dependencies

a. Which violin is this sonata easy to play __ on __.

b. * Which sonata is that violin easy to play __ on __.

The ordering patterns illustrated by these examples are not found in all languages. Maling & Zaenen (1982), for example, note that crossing dependencies are acceptable in Norwegian and only dispreferred in Swedish. It must therefore be possible to parameterize or otherwise express these restrictions in the grammars of individual languages.

8.3.1 Ordering by (empty) trace nodes

Bresnan (2001) proposed to handle the linear ordering facts of weak crossover within a larger cross-linguistic theory of anaphoric binding.[13] She expands the NP at the within-clause position to an empty string, and then arranges for the ϕ

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[13] For the general theory of anaphoric binding this proposal is part of, see Rákosi 2023 [this volume]. On the Bresnan (2001) theory a pronominal cannot be more “prominent” than its potential antecedents, where prominence for a given language may be based on relative positions on a hierarchy of grammatical functions (subj is more prominent than obj), on a hierarchy of thematic roles (agent is more prominent than patient), or on the linear order of corresponding c-structure nodes. Only the linear prominence condition is relevant for these particular examples of weak crossover in English.

correspondence function to map both the trace node and the NP at *who* to the same f-structure (e.g. OBJ or OBL_θ). That many-to-one correspondence is set up by converting the uncertainty from outside-in to inside-out and shifting its launch site to the new trace node, as illustrated in (74).[14]

(74) a. CP ⟶ XP IP
@(FocusQ ↑ ↓ (↓ WhPaths & WhPro)) ↑=↓
~~(↑ FocusPaths) = ↓~~
¬(↑ UBD)

b. NP ⟶ *e*
↑= (FocusPaths ↑)

With node mappings set up in this way, the weak crossover constraint on linear order can be stated in terms of the f(unctional)-precedence relation defined in (75): a pronoun cannot f-precede its antecedent.[15]

(75) Functional precedence (Bresnan 2001)
f f-precedes g ($f <_f g$) iff the rightmost node in $\varphi^{-1}(f)$ c-precedes the rightmost node in $\varphi^{-1}(g)$.

However, separating the uncertainty specification from the dependency's overt element comes at a descriptive cost. Without some further stipulation the grammar would accept a phrase in the XP position of (74a) even when it corresponds to no FocusPath trace node in the clause c-structure and thus is assigned no within-clause function. This issue has been addressed by introducing a global condition on well formed f-structures, the Extended Coherence Condition. This was first proposed by Zaenen (1985); this version is taken from Dalrymple (2001):[16]

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[14] This analysis was also carried over into Bresnan et al. (2016), but the later co-authors are not in full agreement about the status of empty elements and whether dependencies should run outside-in or inside-out (Ash Asudeh, p.c.).

[15] Bresnan's f-precedence definition (75) differs from the proposals of other authors. It compares the positions of only the right-most nodes of the inverse-ϕ images, while Kaplan & Zaenen (1989) and others take into account all nodes in the correspondence.

(i) Functional precedence (Kaplan & Zaenen 1989)
$f <_f g$ iff for all $n_1 \in \varphi^{-1}(f)$ and all $n_2 \in \varphi^{-1}(g)$, n_1 c-precedes n_2 ($n_1 <_c n_2$).

These definitions are equivalent for purposes of this discussion.

[16] If grammaticized discourse functions are not represented in f-structure, the intuition behind this constraint would have to be reformulated as a condition on i-structure correspondences.

(76) Extended Coherence Condition
FOCUS and TOPIC must be linked to the semantic predicate argument structure of the sentence in which they occur, either by functionally or anaphorically binding an argument.

This important requirement can be reconstrued as a well-formedness condition on grammars rather than on representations. Functional binding is guaranteed if a simple existential constraint (77) is attached by convention as an additional annotation to the filler XP in (74a).

(77) Extended coherence constraint
$(\text{GF} \downarrow)$

Depending on how the relationships of anaphoric binding are made formally explicit, a similar constraint can be defined for those linkages.

Another convention is needed to prevent the proliferation of trace nodes at different c-structure positions whose inside-out uncertainties would bind a single filler to the same or different within-clause functions (but see Section 9). One motivation for Bresnan's Economy of Expression principle (78) is to exclude derivations that contain such unwarranted trace bindings.[17]

(78) Economy of Expression (Bresnan et al. 2016)
All syntactic phrase structure nodes are optional and are not used unless required by independent principles (completeness, coherence, semantic expressivity).

Extended Coherence and Economy help to control the promiscuous behavior of trace-launched uncertainties, those that are not directly associated with overt triggering configurations.[18]

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[17] Separately, Dalrymple et al. (2015) present a critical discussion of Economy as a general principle of syntax.

[18] Although it has not been explored in the literature and I am not advocating for it here, there is a trace-based alternative that may be somewhat less unattractive. On this analysis the trace is used only to establish a within-clause linear position for the uncertainty: it does not serve as a launching site. The uncertainty remains with the overt external element, but each path language (e.g. FocusPaths) is intersected with the off-path annotations in Locate (i) to guarantee that it ends at a function assigned at a c-structure trace node. The bookkeeping feature TRACE is defined at all and only trace nodes.

(i) $$\text{Locate} = \text{GF}^* \underset{\substack{(\rightarrow\ \text{TRACE})\\ (\rightarrow\ \text{UBD}) = \text{GAP}}}{\text{GF}} \qquad \text{NP} \longrightarrow \underset{\substack{(\uparrow\ \text{TRACE}) = +\\ (\uparrow\ \text{UBD})}}{e}$$

As a final observation, it is also not clear whether or how well the Bresnan account of weak crossover ordering extends to characterize the nested dependency pattern in examples (73), given that the path languages for the question and *tough* constructions are not the same. Careful regulation of empty-node ordering offered a solution to the *sonata/violin* contrast in the original LFG theory of unbounded dependencies (Kaplan & Bresnan 1982), but the c-structure stipulations of that theory do not naturally carry over to the path languages of modern approaches.

8.3.2 Ordering by coarguments

Dalrymple et al. (2001) use a different definition of linear prominence based on the notion of coargumenthood and a relation between the pronoun and the f-structure that contains the wh-term (called the "operator"). With this formulation they show that the linear order constraints of weak crossover can be modeled without appealing to traces. They define coarguments as the arguments and adjuncts of a single predicate[19] and propose that both of the following prominence conditions must be satisfied:

(79) Let CoargOp and CoargPro be coargument f-structures such that CoargOp contains the within-clause function of the operator (wh-term) and CoargPro contains the pronoun. Then:

Syntactic [= Functional] Prominence: An operator O is more prominent than a pronoun P if and only if CoargOp is at least as high as CoargPro on the functional hierarchy.

Linear Prominence: An operator O is more prominent than a pronoun P if and only if CoargOp f-precedes CoargPro.

The key idea is that Linear Prominence depends on the f-precedence relations of the coarguments, the clause-internal f-structure sisters that contain the operator and pronoun. The positions of the nodes that the outside-in uncertainty maps to the coarguments in the weak crossover example (72a) are indicated in (80a). Note that CoargOp is located only at the leading position because its function OBJ is not projected from any clause-internal (trace) node. This sentence meets the Linear Prominence requirement, but fails the Syntactic Prominence test because OBJ is lower than SUBJ on the function hierarchy.

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[19] Dalrymple et al. (2019) note that "co-dependent" may be a more accurate label for this concept, since adjuncts are included along with arguments. Here I continue to use the terminology of the original paper.

(80) a. * Who$_i$ did [his$_i$ mother] greet?
CoargOp CoargPro

b. * Who$_i$ did Sue talk [to his$_i$ mother] about?
CoargPro CoargOp

c. Who$_i$ did Sue talk to [about his$_i$ mother]?
CoargOp CoargPro

For examples (72b) and (72c) the oblique functions are at the same position on the functional hierarchy so they both meet the Syntactic Prominence condition. This grammaticality difference follows from the locations of the within-clause coargument nodes as annotated in (80b) and (80c) respectively. CoargPro is the OBL$_{\text{TO}}$ of *talk* in (80b) (because *his* is contained in the *to*-phrase) and CoargOp is the OBL$_{\text{ABOUT}}$ (because the outside-in uncertainty resolves to that function). The sentence is ungrammatical because the nodes mapping to CoargPro and CoargOp are in the wrong order. The Coargs and their order are switched in the grammatical sentence (80c).

On this proposal, the operator's within-clause function is first determined by an outside-in uncertainty. After that the coarguments are identified in the clause at which the paths to the operator and pronoun functions first diverge. Linear order is then defined on the nodes that map to those overt, lexicalized coargument functions. Weak crossover is the target of this particular account, but coargument precedence may apply more generally. The nested dependency constraint (73) may follow from a different coargument ordering requirement once the coargument functions are identified for the *violin* and *sonata* phrases.

(81) a. [Which violin] is [this sonata] easy to play on?
1 2/Coarg2 Coarg1

b. * [Which sonata] is [that violin] easy to play on?
1/Coarg1 2 Coarg2

The formal details of such an ordering principle have not yet been worked out.

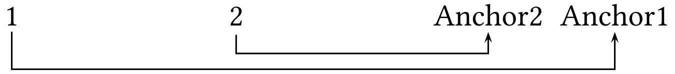
8.3.3 Ordering by subcategorizing PREDicates

The subcategorizing predicate for a given grammatical function is the semantic form that licenses that function in a local f-structure, via the Coherence and Completeness conditions. The value of those conditions in linguistic description is obvious, but Kaplan & Maxwell (1988a) noted that they are also key to the computationally efficient resolution of functional uncertainties. A typical uncertainty allows for the full array of grammatical functions each of which must be hypothesized in principle at every level of embedding. The overall computational complexity is much reduced if that exploration is deferred until the subcategorizing predicate is reached: the possible realizations can then be limited to all and only the functions that it governs. Kaplan (1989a) made a related psycholinguistic processing observation: the results of early trace-inspired measures of word-by-word cognitive load experiments (Kaplan 1974, Wanner & Maratsos 1978) could also be attributed to additional activity when the subcategorizing predicate is first encountered. It was not recognized in these early studies that subcategorizing predicates could also be the basis for a trace-free account of linear order grammaticality conditions.

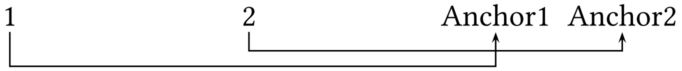
Pickering & Barry (1991) made a much more systematic sentence-processing argument that overt subcategorizing predicates and not empty categories determine how external elements are integrated into embedded clauses. Adopting their Direct Association Hypothesis, Dalrymple & King (2013) sketch an account of nested dependencies that depends on the linear order of the predicates that subcategorize for the bottom functions of overlapping uncertainty paths. They use the term "anchor" for the subcategorizing predicate of the bottom function, as illustrated in (82).[20]

(82) Anchor ordering

a. [Which violin] is [this sonata] easy to play on?



b. * [Which sonata] is [this violin] easy to play on?



In (82a) *violin* is anchored at the *on* predicate, as indicated by the arrow, because the outer uncertainty resolves to *on*'s OBJ. Similarly, the anchor for *sonata* is *play*. The anchoring predicates are the same in (82b), but they occur in the opposite linear order. Dalrymple and King make precise what it means for two dependencies to interact (intuitively, that the outer dependency unfolds through a clause

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[20] This notion of "anchor" should not be confused with the formal definition used in the decidability proofs for LFG parsing and generation (Kaplan & Wedekind 2023 [this volume]).

containing the inner one). The difference between (82a) and (82b) then follows from their nesting condition: if two dependencies 1 and 2 interact, then Anchor1 must not precede Anchor2. Nadathur (2013) accounts for the linear order of weak crossover by a separate anchor-ordering constraint: the anchor of the operator must precede the pronoun.

Although Dalrymple & King (2013) and Nadathur (2013) do not give a detailed specification of their outside-in, anchor-based approaches to linear order, the basic notions are easy to represent within the existing LFG formalism. First, the anchor of an uncertainty path is the PRED of the f-structure one up from the bottom. The off-path annotation on the path language (83) picks out that PRED and adds it as a diacritic feature to the f-structure at the top of the path, where the uncertainty is launched.

(83) $$\text{ANCHOR} = \text{GF}^{*} \quad \underset{(\uparrow\ \text{ANC}) = (\leftarrow\ \text{PRED})}{\text{GF}}$$

The effect of intersecting ANCHOR with any other path language (e.g. FOCUSPATHS or TOUGHPATHS) is to make the within-clause anchor directly available at the top, presumably at the operator's f-structure.

Second, PRED semantic forms in LFG are composite entities that encapsulate succinctly a collection of syntactic and semantic properties. These are accessible by distinguished attributes REL, ARG1, ARG2, etc. Semantic forms are also instantiated, and Kaplan & Wedekind 2023 [this volume] make explicit that the instantiating index of a PRED is the value of another distinguished attribute SOURCE. Moreover, the value of SOURCE is the daughter node, formally denoted by $*$, at which the PRED is introduced into the f-description. Thus a defining equation (84) is implicitly carried along with every PRED.

(84) PRED instantiation (from Kaplan & Wedekind 2023 [this volume])
$$(\uparrow\ \text{PRED SOURCE}) = *$$

A PRED-precedence relation (85) follows naturally from the immediate connection between instantiated semantic forms and c-structure nodes: semantic forms are ordered by the c-structure order of their instantiation SOURCE nodes.

(85) PRED precedence
$$p_1 <_p p_2 \text{ iff } (p_1\ \text{SOURCE}) <_c (p_2\ \text{SOURCE}).$$

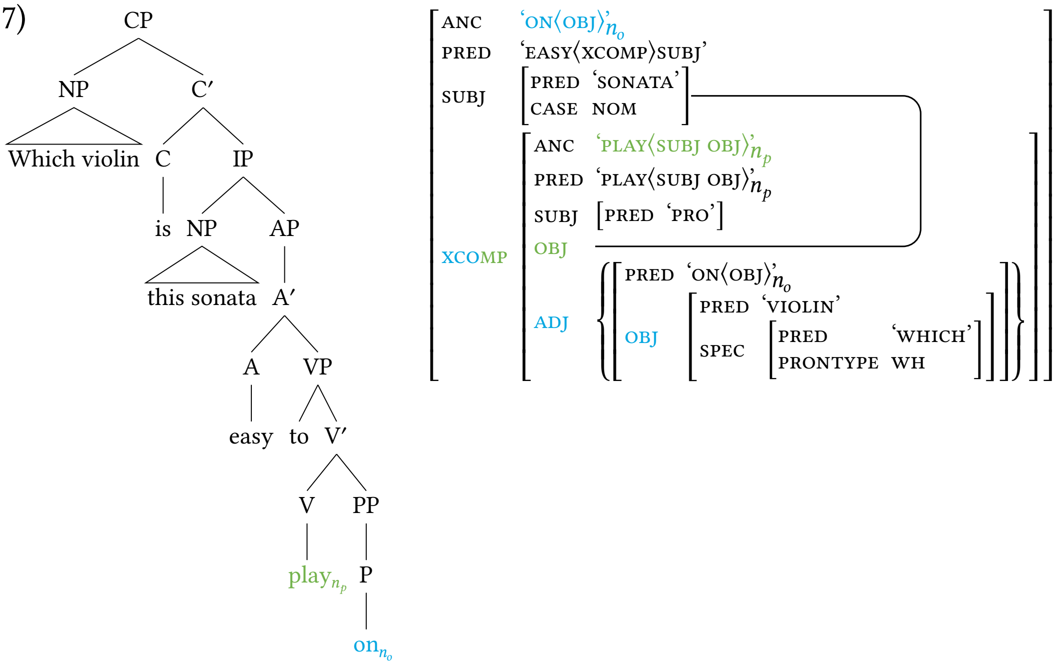
This is a simpler relation than f-precedence since it is defined directly on singleton nodes, not on ϕ^{-1} sets of nodes. Finally, the path language (86) encodes the nested-order constraint.

(86) $$\text{Nested} = \underset{(\uparrow \text{ANC}) \not\prec_p (\rightarrow\ \text{ANC})}{\text{GF}^* \qquad\quad \text{GF}}$$

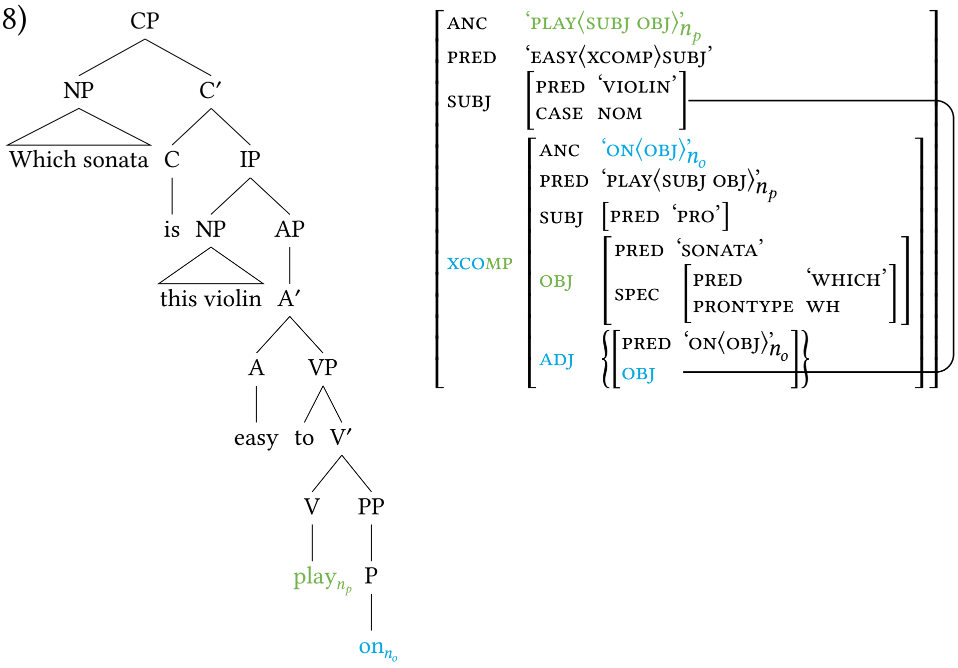
(↑ ANC) is the anchor of the outer uncertainty (*on* in (82a), *play* in (82b)). That remains constant as the uncertainty unfolds. If the outer uncertainty (the *wh* phrase) overlaps an inner uncertainty (*easy*), the ordering condition will compare their two anchors. The nesting follows from the fact that the hierarchical positions of the anchors in f-structure are reversed relative to the linear c-structure order. The nested-order constraint can be imposed (for a language where it applies) by intersecting (86) with the path languages for the various constructions.

The c-structure and f-structures for the nested sentence (82a) are sketched in (87). The attributes and anchor are blue for the outer question dependency and green for the inner *easy* dependency. The outer path overlaps the inner path at the XCOMP of *easy* and then diverges. At that point (↑ ANC) in the question uncertainty denotes the *on* semantic form with source node n_o and the source of (→ ANC), the *play* form, is node n_p. The nesting test succeeds because n_o does not precede n_p. For the ungrammatical (82b) the anchors are reversed (88) and the test fails.

(87)



(88)



9 Multiple gap constructions

It is unremarkable in LFG that a given subsidiary f-structure may appear as the values of several attributes at different levels inside a higher structure. This is a consequence of the equality relation in functional descriptions and is the basis for accounts of functional control, agreement, distributed coordination, and the unbounded dependency of *tough* adjectives (and other unbounded dependencies if grammaticized discourse functions are retained in f-structure). Other identities might be consistent with the set of assertions in an f-description, but the linguistically-relevant minimal models contain only those that follow from the basic propositions and the transitivity of equality. This simple picture is violated by the well-known instances wherein a single unbounded-dependency filler appears to resolve to more than one (uncoordinated) within-clause grammatical function (in LFG terms) or somehow binds to more than one trace position (in other frameworks).

Sentence (89) from Engdahl (1983) is a paradigmatic example of such a multiple gap dependency.

(89) Which articles did John file __ without reading __?

This is understood as asking about a particular set of articles that were filed by John but not read by him. The second gap is usually described as "parasitic" on the first because of the contrast in (90) (following the literature, the parasitic gap is now labeled with the subscript *p*).

(90) a. * Which articles did John file the book without reading __$_p$?
b. Which articles did John file __ without reading more than their titles?

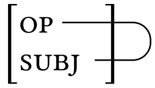
Example (90a) is ungrammatical for the usual reason that its putative gap is in an island-forming adjunct with respect to unbounded dependencies (in an LFG analysis its FocusPaths uncertainty would not satisfy the path language sac, the Subject Adjunct Constraint (67)). (89) shows that that barrier is inactive in the presence of the earlier gap, and (90b) shows that resolving to the direct object does not require the support of an adjunct gap.

Multigap dependencies have received relatively little attention in LFG compared to other grammatical frameworks. If an outside-in uncertainty is used to characterize an unbounded dependency, the natural interpretation is that the minimal model for the resulting f-description will establish only one within-clause function for the clause-initial phrase. And even if some technical adjustment is made to allow for multiple function assignments in general, it would still be necessary to account for the fact that the sac constraint of the normal FocusPaths can be abrogated just in (89) and similar multigap configurations.

Alsina (2008) discusses parasitic gaps in the context of a new general architecture for structure sharing in LFG. On his proposal the f-structure for a sentence is not the minimal model for an f-description derived from the annotations of particular c-structure rules. Rather, the universe of all formally well-formed f-structures, with unlimited structure-sharing relationships, is filtered by a collection of restrictive principles, and the sentence is assigned all and only the f-structures that are not thereby eliminated. As an example, the filter (91a) disallows structure-sharing of an op and subj at the same level (recall that op(erator) is the undifferentiating attribute that Alsina uses to represent the filler in f-structure).

(91) Alsina's (2008) "Same-clause op-subj ban"

a. *



b. For all f-structures f, $(f\ \textsc{op}) \neq (f\ \textsc{subj})$.

A formal expression of this principle is given in (91b). The basic proposition is expressed in the ordinary notation of functional annotations. But this differs from the annotations of the conventional LFG architecture in that the f-structure variable is instantiated by universal quantification over the space of all f-structures and not by mapping particular c-structure nodes through the ϕ correspondence. Alsina (2008) argues that this new architecture and the set of principles he puts forward can provide a unified treatment of bounded (raising) and unbounded dependencies, and that appropriate f-structures can be assigned to sentences with parasitic gaps. This architecture and its principles have not yet been widely adopted, however.

Falk (2011) addresses the multigap problem by an alternative analysis within the conventional LFG architecture. He reasons that if a single uncertainty can license only one dependency and if a sentence has multiple dependencies for one filler, then the f-description for that sentence must have multiple uncertainties. Further, since the number of dependencies in a multigap sentence is determined by the number of within-clause functions assigned to a given filler, the uncertainties for those dependencies must be introduced inside-out at each of the gap locations and not outside-in at the single clause-initial phrase. Thus, he proposes a trace-based, inside-out analysis that freely anticipates any number of unbounded dependencies, even though there may be no local evidence to trigger the empty c-structure nodes. Falk reviews much of the literature on parasitic gaps and other multiple gap constructions, suggesting that many of their restrictions are due to mixtures of pragmatic and processing factors and others are the result of syntactic constraints carried by the inside-out uncertainty paths with their off-path annotations.

The key fact about parasitic gaps is that they are, indeed, parasitic. That fact is not exploited directly by either the Alsina (2008) or Falk (2011) solutions to the multigap problem. In an intuitively straightforward account, an outside-in uncertainty launched at the filler phrase would resolve to the main gap (OBJ in (89)) in the ordinary one-to-one way. But then, optionally, a secondary uncertainty would be launched to bind that same filler also to the grammatical function of the parasitic gap. This is what happens if the PARA path language (92a) is imposed by intersection on the FocusPaths uncertainty (92b).

(92) a. $\textsc{para} = \textsc{gf}^{*} \underset{(\rightarrow\, = (\leftarrow\ \textsc{adj} \in \textsc{gf}^{+}))}{\backslash \textsc{subj}}$

b. FocusPaths = [...] & PARA & SAC

If FocusPaths resolves to a non-SUBJ within-clause function, the right arrow → in the optional off-path annotation denotes the top-level filler f-structure. Thus, if the option is taken, this equation launches a new uncertainty that must resolve to some function inside one of the elements of an ADJ set. By virtue of the left arrow ←, that ADJ must be an f-structure sister of the non-SUBJ. The non-SUBJ restriction is included in this example to illustrate one way of accounting for the ungrammaticality of (93); obviously, other factors may also be at work.

(93) * Which articles did you say __ got filed by John without him reading $\_\__p$?
(from Engdahl 1983)

The underlying idea of this solution is that a single filler can be bound to two gaps within an outside-in, one-to-one setting if one uncertainty is allowed to launch another one. The details of an analysis along these lines remain to be developed.

In fact, Falk (2011) notes that parasitic gaps may be a special case of a more general pattern of multiple-gap constructions. Sentences (94b–94c) show that each of the gaps in (94a) can be filled without the support of the other one.

(94) a. Who did you tell __ that you would visit __ ?
b. Who did you tell __ that you would visit your brother?
c. Who did you tell your brother that you would visit __ ?

This pattern can be assimilated to the PARA outside-in off-path solution simply by enlarging the path language of the secondary uncertainty. For this example COMP OBJ would be added as an alternative to the paths beginning with ADJ. There is still an asymmetry between the dependencies for the two gaps: only the primary uncertainty (resolving to the shorter path) is launched from the top, while the secondary one is optionally introduced at the bottom of the first. On this theory what distinguishes adjunct parasitic gaps from other multiple gap examples is just the adjunct island created by the intersection of SAC with the primary path language; that constraint is not incorporated into the secondary uncertainty.[21]

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[21] Further research and consideration of more examples might show that multiple gaps operate symmetrically and that the sequential chaining of secondary uncertainties is therefore inadequate. That would add weight to Falk's (2011) preference for an inside-out solution. Another possibility, indifferent as to inside-out or outside-in, is to extend the interpretation of uncertainty languages in general so that multiple gaps are no longer seen as exceptional:

(i) Multi-gap functional uncertainty
If PATHS is a set of attribute strings and $\emptyset \subset \mathrm{P} \subseteq \mathit{Pref}(\textsc{Paths})$,
$(f\ \textsc{Paths}) = v$ iff $((f\ a)\ \ \mathit{Suff}(a, \textsc{Paths})) = v$ for all $a \in \mathrm{P}$
where $\mathit{Pref}(\textsc{Paths}) = \{a \mid a\sigma \in \textsc{Paths}\}$.
(the set of single-attribute prefixes of strings in PATHS)

A subset P of the available attributes would be selected at each point as an uncertainty unfolds, and the uncertain suffix of each of those attributes must recursively resolve. This is an easy adjustment, technically, but it may be difficult to define path languages so that P subsets properly handle any cross-path interactions.

10 Summary

Unbounded dependencies interact in complicated ways with the syntactic properties that define the local organization of clauses and sentences. This chapter provides a sample, clearly incomplete, of the many theoretical and empirical issues that have been discussed in the LFG literature and in the linguistic literature more broadly. The earliest LFG approaches to such dependencies were modeled after the phrase structure solutions of other frameworks, but it is now generally recognized that the functional configurations enshrined in f-structure support the most natural and direct descriptions and explanations. Accounts based directly on f-structure were made possible by extending the basic LFG formalism with the technical device of functional uncertainty.

Functional uncertainty permits the backbone dependencies of topicalization, constituent questions, relative clauses, and the *tough* construction to be stated as regular languages containing the f-structure paths that connect fillers to their within-clause functions. But unbounded dependencies are additionally challenging because they can be sensitive to various features of the f-structures they pass through. The intervening f-structures may be marked in distinctive ways, they may form dependency-blocking islands, and there may be restrictions based on linear order. This chapter has suggested that many of these ancillary effects can be accounted for by attaching off-path annotations to the uncertainty-path attributes.

In sum, the combination of functional uncertainty with off-path annotations is an expressive tool for describing the rich and varied properties of unbounded dependencies. It integrates well with the other formal devices of LFG theory, and it is the foundation for modern LFG treatments of these phenomena.

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Chapter 11

Negation

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Negation is one of the few grammatical features observed in all languages. While typically thought of as a property of predicates, it can be manifested in a wide range of structural positions associated with verbs (typically, V, I or $\hat{\mathrm{I}}$ or as a verbal adjunct, represented as NEG), but is also observed on other parts of speech (e.g. D/N, C, P and CONJ) and is sometimes expressed across two or more nodes within c-structure (e.g. Butt et al. 1999, Alsharif & Sadler 2009, Laczkó 2014, Bond 2016, Alruwaili & Sadler 2018).

In the most straightforward cases there is one representation of negation at f-structure, with a binary feature indicating the presence or absence of this value. However, distributional differences between superficially similar negators, and evidence from structures with multiple negative forms within a single clause, suggest that more than one feature may be necessary to account for the syntactic and semantic effects observed in negative contexts. For instance, when a negation scopes over a sub-constituent in c-structure (so-called constituent negation or cneg) which is part of a finite syntactic structure which is also negated (known as eventuality negation or eneg) two representations of negation appear to be required within the same f-structure (Przepiórkowski & Patejuk 2015). The distribution of Negative Concord Items (NCIs), Negative Polarity Items (NPIs) and case-forms licenced by negation also suggests that multiple features must also play an important role in accounting for restrictions on the occurrence of certain forms in antiveridical contexts (Sells 2000, Camilleri & Sadler 2017).

1 Introduction

No theoretical model of language is complete without a way to represent negation or the range of grammatical effects that it induces in linguistic structures.

Oliver Bond. 2023. Negation. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 483–522. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185956

Superficially, this is necessary because negation is one of the few grammatical categories that is uncontroversially universal in nature. Yet, as we will see, this does not mean that negation is especially uniform across languages: the cross-linguistic manifestations of negation are diverse and the structural consequences associated with the presence of negation are manifold and varied.[1]

For the purposes of the current chapter, I take negation to be the formal manifestation of a semantic operator $\neg$ that combines with an argument A to form a complex semantic expression $\neg A$. In propositional logic, negation combines with a propositional argument P to form $\neg P$. The presence of negation indicates that the conditions under which the proposition P is true are not satisfied at reference time.

Consider the proposition P given in (1):

(1) P: Eva is an experienced astronaut.

The truth conditions for the proposition P in (1) are not met if Eva is considered to be an inexperienced astronaut, or if she isn't an astronaut at all. In such cases we can say that P is false, and express this using negation.[2] An important logical property of negation, is that if P is false, $\neg P$ must be true. Similarly, if $\neg P$ is true, P must be false. $\neg P$ can also be paraphrased as "it is not the case that P", as shown for (1) in (2). The ability to form this paraphrase has been proposed as a rough semantic test for what Jackendoff (1969) calls *sentential negation*.

(2) $\neg P$: It is not the case that Eva is an experienced astronaut.

Jackendoff's concept of sentential negation is associated with a wide-scope reading of negation. Negation is maximally wide-scoping when the whole proposition – including the subject – is in the scope of negation.[3] In practice, in natural languages, the subject is usually an established discourse referent outside the

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[1] For instance, negation is frequently seen as an important diagnostic tool for discriminating between different lexical categories (e.g. Stassen 1997) or structures (e.g. Brown & Sells 2016), where differential behaviour under negation is used to support linguistic argumentation. At the same time, what we intuitively think of as negation is, itself, commonly subject to diagnostics, which attempt to distinguish negatives from affirmatives, or to distinguish different subtypes of the phenomena (e.g. Jespersen 1917; Klima 1964; Jackendoff 1969; de Haan 1997; Zanuttini 2001; Giannakidou 2006; Przepiórkowski & Patejuk 2015).

[2] In this chapter, I discuss only contradictory negation. See Horn (2020) for a recent discussion.

[3] In strictly semantic terms, the scope of negation describes its operational domain. It is said to be wide, rather than narrow, when other semantic operations occur *before* negation applies. Negation with propositional scope is also commonly referred to as EXTERNAL NEGATION because the negative operation is external to the proposition.

scope of negation (Keenan 1976; Givón 1979). Consequently, the negative structures that are typically reported in grammars and general discussions of negation are examples of PREDICATE NEGATION, where negation is an evaluation of the relationship between the subject and the predicate.[4] What sentential negation and predicate negation share in common is that the *main predicate* is within the scope of negation, and the negative operator scopes over other predicate level operators (see Payne 1985; Acquaviva 1997, De Clercq 2020).

Some examples of clauses in which the predicate is negated can be seen in (3)-(5) from Polish, Modern Standard Arabic and Eleme (Niger Congo, Ogonoid; Nigeria). In the Polish example in (3) negation is marked with a negative particle *nie* (see Section 2.1). In (4), from Modern Standard Arabic, negation is expressed by a negative auxiliary *laysuu* (see Section 2.3). In the Eleme example in (5), negation is signalled through morphological means, and the affirmative verb form is quite distinct from the form employed in the negative (see Section 2.2).

(3) Polish (Przepiórkowski & Patejuk 2015: 324; own data)

a. Janek lubi Marię.
Janek.NOM likes Maria.ACC
'Janek likes Maria.'

b. Janek nie lubi Marii.
Janek.NOM NEG likes Maria.GEN
'Janek doesn't like Maria.'

(4) Modern Standard Arabic (Alsharif & Sadler 2009: 23; own data)

a. al-awlad-u ya-ktub-uu-n
the-boys-NOM 3M-study.IPFV-3MP-IND
The boys write/are writing.

b. al-awlad-u lays-uu ya-ktub-uu-n
the-boys-NOM NEG-3MP 3M-write.IPFV-3MP-IND
The boys do not write/are not writing.

(5) Eleme (Bond 2016: 283; own data)

a. òsáro è-dé-a òfí́
Osaro 3[SG]-eat-HAB mango
'Osaro (usually) eats mango.'

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[4] cf. Jespersen's (1917) NEXAL NEGATION, Klima's (1964) SENTENCE NEGATION, and Payne's (1985) STANDARD NEGATION.

b. òsáro è-dé~dè òfí
Osaro 3[SG]-NEG~eat[HAB] mango
‘Osaro doesn’t (usually) eat mango.’

As well as having means to negate the main predicate of the clause, languages frequently have negators with distinct behavioural properties that do not have scope over the finite predicate and hence can be said to have low(er) negative scope (De Clercq 2020). Negators of this type are typically bundled together in descriptions as examples of CONSTITUENT NEGATION. The term ‘constituent negation’ has its origins in the work of Klima (1964), who formulated a range of now famous tests to distinguish it from negation with scope over the predicate (see Payne 1985, de Haan 1997 and De Clercq 2020 for discussion). An example of constituent negation in English can be seen in (6). Here a verbless secondary predication modifying a noun is in the scope of negation, but not the main predicate. Such negators are said to have narrow scope.

(6) Dora found a job [not far away].
(cf. Dora found a job that is not far away.)

It is common to find that negators used to negate predicates may also be used in narrow scope negation (De Clercq 2020). The following Hungarian data from Laczkó (2014: 306–7) illustrate predicate negation (7a) and narrow-scope negation over the object referent (7b). Small caps indicate focussed elements. In (7a) negation scopes over the predicate, or put another way, the truth conditions for the relationship between the predicate and its subject are not met. In (7b), narrow scope negation indicates that it is the relationship between the object referent and the rest of the assertion that is relevant.

(7) Hungarian (Laczkó 2014: 306–307)

a. Péter nem hívta fel a barátjá-t.
Peter.NOM not called up the friend.his-ACC
‘Peter didn’t call up his friend.’

b. Péter NEM A BARÁTJÁ-T hívta fel
Peter.NOM not the friend.his-ACC called up
‘It wasn’t his friend that Peter called up.’

In (8) these two strategies are combined within the same clause, providing evidence for the need to be able to simultaneously distinguish these types of negation within formal models (see Section 3 for discussion).

(8) Hungarian (Laczkó 2014: 306–7)
Péter NEM A BARÁTJÁ-T nem hívta fel.
Peter.NOM not the friend.his-ACC not called up
'It wasn't his friend that Peter didn't call up.'

Cross-linguistically, narrow-scope negation is formally distinguished from wider-scoping predicate negation by a variety of means, including differences in syntax, the use of different negators or prosodic alternations, etc.

Other examples that are described as constituent negation involve negative quantifiers modifying a noun, as in (9). In such cases the negation of the predicate is achieved through a more complex process of logical implication:

(9) Dora found no [reason to worry].
(cf. Dora didn't find a reason to worry.)

Informally, we can say of (9) that if Dora found no reason to worry, the reasons to worry equal zero, therefore Dora didn't find any (i.e. > 0) reason to worry. Quantifiers interact with negation in a number of complex ways and the literature on this topic is extensive (see Krifka 1995; de Swart 2009; Penka 2010 amongst others). While negation and quantification have been subject to some discussion in the LFG literature (Fry 1999; Dalrymple 2001: 291–295; 309–311), I will leave this topic aside.

While syntax and semantics often align, the scope of negation should really be considered to be a semantic phenomenon (see Penka 2016 for an overview of negation in formal semantics), and must be analysable within the semantic component of grammar in parallel to considering how this is played out in syntax and prosody. In practice, when authors talk about scope, they often treat it as a syntactic phenomenon because of differences in the syntactic domain in which the effects of negation can be observed (see Reinhart 1979; Szabolcsi 2012). Because of this, the term SCOPE is typically also used to refer to the syntactic domain in which the effects of negation are observed. However, it is useful to untangle these two properties of negative clauses. This is – in theory – easy to do in a model like LFG because syntax and semantics are dealt with in separate, yet parallel modules of grammar. Establishing the extent to which the two are independent is one of the major goals of investigating the syntax-semantics interface.

It should be clear from this brief overview that an adequate discussion of the topic necessitates not only an exploration of the formal devices used to express negation (and the domains in which the effects of negation are observed), but also how this relates to the semantic interpretation of the utterance.

Most analyses of negation in LFG to date have focussed on the syntactic properties of negation constructions by examining the role of negation in c-structure and f-structure, most notably Sells (2000) on Swedish, Alsharif & Sadler (2009) on Arabic, Przepiórkowski & Patejuk (2015) on Polish and Camilleri & Sadler (2017) on Maltese. Despite a growing body of work in this domain (some of which is briefly outlined in Dalrymple et al. 2019: 67–69), negation has remained focussed on the syntactic properties and effects of negation. A rare exception is Dalrymple & Nikolaeva (2011) who briefly discuss the semantic contribution of negation within the context of information structure, while Bond (2016) examines issues related to the morphological expression of negation (Section 2.2).

Negation is manifested using a variety of formal devices which differ according to the extent to which this affects (i) syntactic constituency of negative clauses and (ii) the domains in which operations sensitive to negation occur. In what follows, we first look at the arguments that support possible representations of syntactic components of grammar (Section 2) before exploring the representation of negation in a component of grammar unique to LFG, namely f-structure (Section 3).

2 Representations of negation as a formative

Negation of verbal predicates can be manifested in a wide variety of ways, most commonly by (adverbial) particles (Section 2.1), changes in verbal morphology (Section 2.2) or through the use of a negative auxiliary (Section 2.3). A combination of these strategies is also widely attested (Section 4).

2.1 Negative particles

A large body of cross-linguistic work (Dahl 1979; Dryer 1989; Payne 1985; Miestamo 2005; Dryer 2013) indicates that the most common way in which the world's languages express the negation of propositions about (epistemically unmodified) dynamic events, i.e STANDARD NEGATION (Payne 1985; Miestamo 2005) or 'clausal negation in declarative sentences' (Dryer 2013)) is through the use of a uninflecting negative particle. This is observed in at least 44% (n=502) of Dryer's 2013 sample of 1157 languages. Further languages in his sample including a particle as part of a more complex strategy consisting of multiple formatives (n=119), and others still classified as unclear with respect to whether they are particles or uninflecting negative auxiliary verbs (n=73).[5] Given their isomorphic nature,

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[5] The numbers from the *World Atlas of Language Structures* reported here are those from Dryer (2013); those presented in the earliest editions were lower due to a programming error.

Bond (2013) takes the expression of negation through the use of particles to be a property of canonical negation.

In typological work on negation, the term PARTICLE is used as a general term for an independent word whose distribution is not better characterised in reference to a larger class of items, and includes negators described as negative adverbs. The syntactic status of negative particles (in this typological sense) has been one of considerable attention within the theoretical syntactic literature (see Pollock 1989; Haegeman 1995; Zanuttini 1997; Rowlett 1998 among others), including LFG (see Butt et al. 1999; Przepiórkowski & Patejuk 2015). This is in part motivated by the fact that the negative particle in English (and similar forms in related languages) are usually described as adverbs. While they frequently share some of the properties of adverbs in the language in which they are found, they also tend to have special syntactic characteristics that make them distinct. These characteristics, such as restrictions on their syntactic position, or the inability to be modified, make them unlike regular phrasal heads (e.g. Butt et al. 1999: 141–142). Crucially, these properties differ even among closely related languages, demonstrating that adopting the category 'particle' in broadscale typological work presents a convenient opportunity to be vague rather than explicit about the syntactic properties of any given negative formative. For instance, taking a minimalist approach, Repp (2009) argues that while both are described as adverbs in their respective descriptive traditions, German *nicht* and English *not* have different syntactic behaviour. The former is proposed to be a simple adverbial adjoining to the verb phrase (VP) while the latter is a functional head projecting a NegP. Butt et al. (1999: 141–142) conclude that *nicht* and *not* both belong to a special category NEG that distinguishes them from other adverbs, with the differences in their distribution encoded in c-structure rules.

In many Chomskian treatments of negation in English, *not* is the specifier of NegP, a separate negative projection (see Pollock 1989; Repp 2009; amongst others). Even if the validity of the NegP approach seems appropriate in some analyses, the existence of such a functional head for all instances of negation would not be consistent with the lexicalist approach to syntax. Negation is commonly expressed through morphological alternations that suggest this is a considerably less useful tool for accounting for negation in languages where the category is expressed through non-concatenative morphology (Section 2.2).

This leads to us to the first problem of determining how negative particles should be represented in the X-bar theory employed to represent c-structure in most LFG work. Given that negation can be associated with almost any part of speech, and a functional projection in LFG is not required for the purposes of movement, is a NegP motivated within a declarative theory of syntax at all?

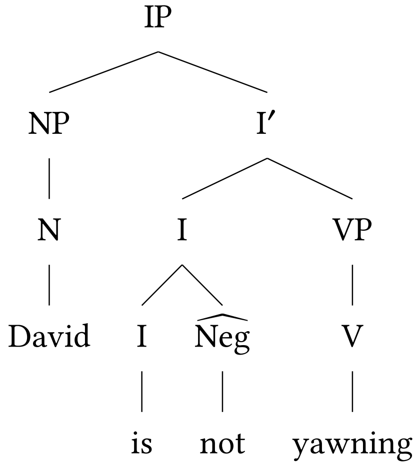
There are several possibilities with respect to dealing with this issue: first, that a node in constituent structure is required that has the properties of a regular phrasal head (e.g. AdvP), second that a special functional head is required (i.e. NegP), or third that the negative particle occupies a non-projecting phrase (in the sense of Toivonen 2003).

The first major paper dedicated to tackling negation with the LFG framework is Sells (2000), who proposes an account of negation in Swedish. Therein, he considers whether a NegP is required to account for the distribution of the negative adverb *inte*. He reviews the evidence in favour of positioning the Swedish negative adverb *inte* inside or outside the VP, concluding that neither the negation adverb *inte* nor negative quantifiers can appear within the VP. Sells observes that the unmarked position for negation is to the left of VP, though positions higher up in IP and CP are also possible. He concludes that *inte* occupies a special NEG node in c-structure, but argues against the view that a NegP is required to account for its syntactic properties.

As with Swedish *inte*, English *not* is usually described as an adverb, but they have different distributions. Since *not* must be preceded by a tensed auxiliary verb when expressing sentential negation, as in (10), Dalrymple (2001: 61) assumes that it is adjoined to the tensed verb in I, as illustrated in (11). A similar structure is proposed in Bresnan (2001a).

(10) David is not yawning.

(11) English non-projecting negative particle *not* (based on Dalrymple 2001: 61)



While brief, Dalrymple's (2001: 61) analysis captures an observation that some negative particles are non-projecting categories that are not heads of phrases, but adjoin to heads. Toivonen (2003) proposes that non-projecting categories have distinct characteristics that make then unlike regular phrases:

- They are independent words which do not project a phrase.
- They must adjoin to X^0 (i.e. at the lexical level).
- They cannot take complements or modifiers.

In (11), *Neg* is not a NegP, but a non-projecting word adjoined to I.

A similar analysis of negative particles is proposed by Alsharif & Sadler (2009) and Alsharif (2014), who examine negation in Modern Standard Arabic (MSA). MSA has three negative particles used with imperfective predicates *laa*, *lam* and *lan*. The particles differ according to the grammatical categories with which they combine. Each occurs with a verbal element as the main predicate: *laa* occurs with the indicative imperfective, *lam* with the jussive imperfective expressing negation in the past, and *lan* with the subjunctive imperfective, expressing negation in the future (Alsharif & Sadler 2009: 8). Regardless of combinatorial potential, their default syntactic distribution is the same – immediately before the auxiliary – as illustrated in (12).[6]

(12) MSA (Benmamoun 2000: 95 cited in Alsharif & Sadler 2009: 7-8)

a. t-tullaab-u laa ya-drus-uu-n
the-students-nom neg 3m-study.ipfv-3mpl-ind
'The students do not study/are not studying.'

b. t-tullaab-u lan ya-dhab-u
the-students-nom neg.fut 3m-go.ipfv-mpl.sbjv
'The students will not go.'

c. t-tullaab-u lam ya-dhab-uu
the-students-nom neg.pst 3m-go.ipfv-mpl.juss
'The students did not go.'

Given strong adjacency restrictions between the particle and the following auxiliary verb, Alsharif & Sadler (2009) propose they are non-projecting categories adjoined to I. The c-structure representation for (13) (without the time adverbial) is given in (14). Syntactically, the particle *laa* occupies a node $\widehat{\text{I}}$ that is defined according to that on which it is structurally dependent, I.

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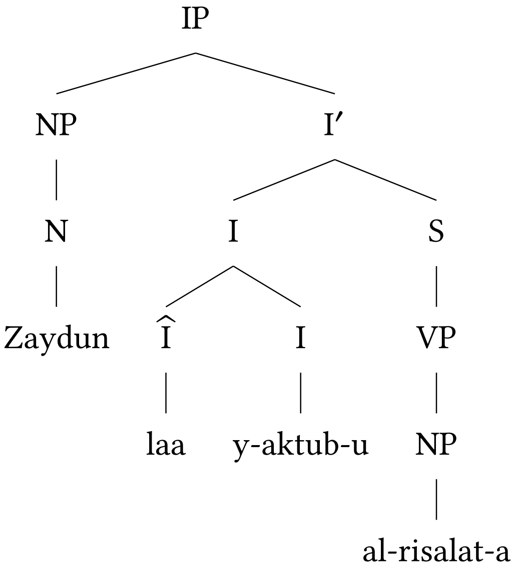
[6] I have adjusted the glosses in these examples to correct segmentation issues in the original examples.

(13) MSA (Alsharif & Sadler 2009: 7)

Zayd-un	laa	y-aktub-u	al-yawm-a	al-risalat-a
Zayd-NOM	NEG	3M-write.IPFV-3MS.IND	the-day-ACC	the-letter-ACC

Zayd is not writing the letter today.

(14) MSA non-projecting negative particle *laa* (Alsharif & Sadler 2009: 14)



The lexical entry for *laa* is given in (15).

(15) *laa* $\hat{\text{I}}$ (↑ TENSE PAST) ≠ +
(↑ POL) = NEG
(Alsharif & Sadler 2009: 16)

It specifies that its f-structure has the polarity value NEG , but also that it cannot have the tense value PAST. Equations of this type can be used to account for the distribution of different negative forms within the same language, as indicated by the lexical entries in (16) and (17) for *lam* and *lan*.

(16) *lam* $\hat{\text{I}}$ (↑ TENSE PAST) = +
(↑ POL) = NEG
(↑ MOOD) $=_c$ JUSS
(Alsharif & Sadler 2009: 16)

(17) *lan* $\hat{\text{I}}$ (↑ TENSE FUT) = +
(↑ POL) = NEG
(↑ MOOD) $=_c$ SBJV
(Alsharif & Sadler 2009: 16)

The possibility within LFG to formulate different lexical entries for different negators provides an additional opportunity to account for differences in their behavioural distribution and the features with which they are compatible.

2.2 Negative verbal morphology

Negation is indicated by verbal morphology in at least 36% of the word's languages (Dryer 2013).[7] There is a slight preference for prefixation of negative affixes over suffixation (Dryer 2013), which reflects a general cross-linguistic preference for negators to precede the verb (Dryer 1989).

In a lexicalist approach to syntax like LFG, it is notionally straightforward for negation to be expressed morphologically, but there is little consensus about how morphology itself should be modelled. The main issue is that affixes are often presented as having lexical entries that are distinct from their hosts. This suggests that an incremental model of morphology has been used in which morphosyntactic information gets added incrementally as morphemes are added to a stem (see Camilleri & Sadler (2017: 158) on the lexical entries for Polish *nie* discussed in Section 3.3). However, there are strong arguments for adopting a realizational approach in accounting for morphology, whereby a word's association with certain morphosyntactic properties licenses morphological operations. Under an approach of this kind, having distinct lexical entries for negative morphemes is highly questionable.

The first detailed LFG analysis of negation expressed through morphological means is provided in Bond (2016), who examines the expression of negation through tone and reduplication within Eleme (Niger-Congo, Cross River, Ogonoid) spoken in Rivers State, Nigeria. Like many other languages across Africa, Eleme has a multitude of means for expressing negation, many of which involve negation morphology. Negation in Eleme is distinctive from a cross-linguistic perspective in that in addition to affixation, negation of verbal predicates is also indicated though other morphological means, notably tonal alternations and stem reduplication. Two of the basic alternations, between perfectives and habituals are shown in (18) and (19).

Negation of perfectives is realised using a set of prefixes with the shape *rV́-*. The quality of the vowel is dependent on several factors: (i) the person and number of the subject, (ii) vowel harmony with the initial segment of the verbs stem (Bond 2016: 280).[8] The negative prefix is obligatorily realised on Negative Per-

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[7] This is a conservative figure calculated from the addition of two categories in Dryer's sample of 1157 languages: *negative affix* (n = 395) and *variation between negative word and affix* (n =21).

[8] There is also intra-speaker variation in the realisation of the initial consonant, which varies between an alveolar nasal and alveolar approximant.

fective verb forms.[9] It is the only clear exponent of negation in (18b). However, in certain discourse contexts, prefixation is accompanied by pre-reduplication of the initial mora of the verb stem – shown in parentheses in (18b). This results in full reduplication of monomoraic stems and partial reduplication of bimoraic stems (see Bond 2016: 281 for examples).

(18) Eleme (Bond 2016: 281)

a. ǹ-sí
1sg-go
'I went.'

b. rī́-(si)~sí
neg.1sg-(neg)~go
'I didn't go.'

Habitual predicates in Eleme are distinguished by the presence of a Habitual suffix *-a* on the lexical verb stem, as in (19a). Negative Habituals are formed through the obligatory pre-reduplication of the first mora of the verb stem, as in (19b). The presence of the Habitual suffix *-a* is not attested in Negative Habituals, giving rise to an asymmetric pattern of negation in the sense of Miestamo (2005). Negative Habituals do not have a negative prefix. In (19b), negation is expressed though stem reduplication and tone.

(19) Eleme (Bond 2016: 278)

a. ǹ-sí-a
1sg-go-hab
'I (usually) go.'

b. ǹ-sí~sì
1sg-neg~go
'I don't (usually) go.'

Some examples of transitive constructions are given in (20).

(20) Eleme (Bond 2016: 283; own data)

a. òsáro ré-de~dé òfī́
Osaro neg.3sg-(neg)~eat[hab] mango
''Osaro didn't eat (any) mango.'

---

[9] Perfectivity is a default category in Eleme and is not overtly realised on verb stems by segmental morphology.

b. òsáro è-dé~dè òfí́
Osaro 3[SG]-NEG~eat[PFV] mango
‘Osaro doesn’t (usually) eat mango.’

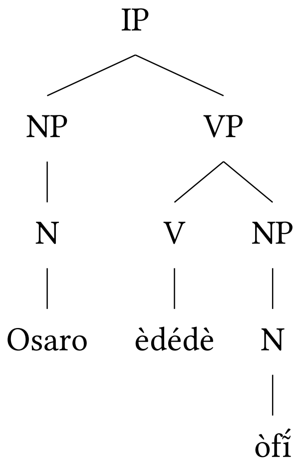
The examples show that there is no single affix that can be picked out for accounting for negation in Eleme, rather a number of different morphological processes are responsible for deriving negative verb stems (and a distinct theory of morphology is required to account for that because LFG does not yet have its own established native approach). In languages like Eleme, the feature responsible for contributing negation to the f-structure for clauses of this type comes directly from the lexical entry for the verb. Lexical entries for these verb forms are given in (21) and (22):

(21) *rédedé* V (↑ PRED) = ‘EAT⟨SUBJ,OBJ⟩’
(↑ POL) = NEG
(↑ ASP) = PFV
(↑ SUBJ PERS) = 3
(↑ SUBJ NUM) = SG

(22) *èdédè* V (↑ PRED) = ‘EAT⟨SUBJ,OBJ⟩’
(↑ POL) = NEG
(↑ ASP) = HAB
(↑ SUBJ PERS) = 3
(↑ SUBJ NUM) = SG

The c-structure for (20b) is provided in (23).

(23) C-structure containing an Eleme Negative Habitual verb *èdédè*



The central claim about negative verbs of this kind, whether negation is expressed by affixation, stem modification, reduplication, tone or any other morphological means, is that morphological negators do not occupy a syntactic node distinct from the element of which they are part, and any morphological exponent that can be identified as marking negation should be understood to be a property of a verb form (i.e. part of a paradigm) rather than having its own distinct lexical entry.

HPSG analyses of the morphological expression of negation (e.g. Borsley & Krer 2012, Kim 2000, Kim 2021) likewise propose that morphological exponence is dealt within the lexical component of grammar and, therefore, individual morphological exponents have no syntactic status distinct from the word of which they are part. Kim (2000) proposes that negation marked by affixation is achieved by a lexical rule (see Kim 2021 for a summary). The view of morphology proposed in Bond (2016) is a more complex one, chosen to deal with non-concatenative exponents as well as more straightforward instances of affixation. However, the basic underlying assumption is the same; morphology is governed by autonomous, non-syntactic principles (Bresnan & Mchombo 1995).

In derivational theories of syntax in which morphology is considered to be a post-syntactic process, there is no divide between the construction of words and sentences. In Distributed Morphology (DM), for instance, words are formed through syntactic operations like Merge and Move. Negative affixes – like other affixes expressing inflectional information – are realisations of abstract morphemes that are merged with roots. No such motivation for morphological operations needs to be justified within a lexicalist theory like LFG. There are two main approaches to accounting for reduplication in DM (see Frampton 2009, Haugen 2011 for discussion). Reduplication is proposed either to result from a readjustment operation on some stem triggered by a (typically null) affix, or through the insertion of a special type of affix which is inserted into a syntactic node in order to discharge some morphosyntactic feature(s), but which receives its own phonological content, distinct from its base. Recent proposals concerning the analysis of tone expressing grammatical categories can be found in Rolle (2018) and Pak (2019). See Chung (2007) on negation and suppletive forms in DM. A combination of these approaches would be required to account for morphologically complex expressions of negation like those seen here.

2.3 Negative auxiliaries

Negative auxiliaries are widely attested in the world's languages. Alongside the negative particles discussed in Section 2.1, MSA also has a negative auxiliary *laysa* employed in negative imperfectives.

Alsharif & Sadler (2009) argue that *laysa* is a fully projecting I, taking a range of complements. Unlike the particles discussed in Section 2.1, it is not subject to verb-adjacency restrictions, as illustrated in (24).[10] If the negative auxiliary verb is preceded by its subject, it agrees with it in gender and number. If the subject follows the auxiliary, number agreement is defective, and a default singular form is used.

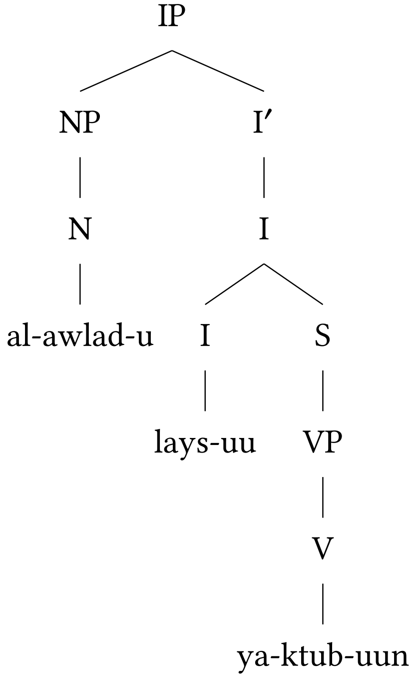
(24) MSA (Alsharif & Sadler 2009: 23)

a. al-awlad-u lays-uu ya-ktub-uun
the-boys-NOM NEG-3MP 3M-write.IPFV-3MP-IND
The boys do not write/are not writing.

b. lays-a al-awlad-u ya-ktub-uun
NEG-3MS the-boys-NOM 3M-write.IPFV-3MP-IND
The boys do not write/are not writing.

The corresponding c-structures for the examples in (24) are given in (25) and (26).

(25) MSA negative auxiliary *laysa* in S-AUX order (Alsharif & Sadler 2009: 23)



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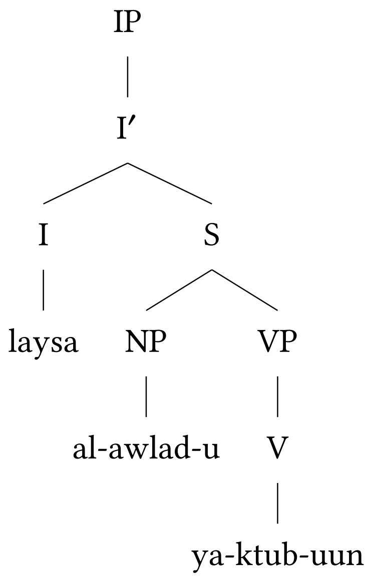
[10] The gloss in (24b) has been corrected from the original source to show that number on the negative auxiliary is defective when it precedes the subject (Alsharif & Sadler 2009: 7).

(26) MSA negative auxiliary *laysa* in AUX-S order (Alsharif & Sadler 2009: 23)



The differences between the behaviour of the negative particles (see discussion in Section 2.1) and the negative auxiliary in MSA are captured by differences in their lexical entries. The lexical entry for *laysa* is provided in (27).

(27) *laysa* I (↑ TENSE PAST) = −
(↑ TENSE FUT) = −
(↑ POL) = NEG
(↑ SUBJ PERS) = 3
(↑ SUBJ GEND) = MASC
V ∈ CAT(↑) ⇒ (↑ ASP) $=_c$ PROG
(Alsharif & Sadler 2009: 24)

Dalrymple & Nikolaeva (2011: 87) propose that English *didn't* also occupies the I node in c-structure (cf. *not* as a non-projecting head adjoined to I in Section 2.1).

3 Representations of negation as a feature

Negation is usually thought of as a property of a predicate, closely associated with verbal elements within the clause. Within f-structure representations, negation is typically represented in one of three distinct ways: as a feature-value pair (Section 3.1), as an adjunct with a negative value (Section 3.2), or by recognising that negation may be represented by multiple features within the same f-structure (Section 3.3).

3.1 Single feature-value pair

The majority of LFG analyses of negation treat negation as a value of predicate-level feature pol(arity). Like other attributes in the f-structure such as [tense] and [asp], the [pol] specification has more than one possible value, either represented as a binary feature (i.e. = ±pol or ±neg), or a feature with multiple values, e.g. [aff] and [neg]. The former approach is used by King (1995), Niño (1997), Butt et al. (1999), Bresnan (2001b: 183) and Dalrymple & Nikolaeva (2011: 87) , while Alsharif & Sadler (2009) and Bond (2016) employ the multiple value approach (i.e. pol: neg). Falk (2001: 12, 149) uses neg+ and pol: neg within the same book.

In each case, it is always possible to identify an inherently negative element; this element always contributes the specification [pol −], [neg +] or [pol neg] to f-structure. They are all used to represent exactly the same thing, using different notation systems. In the lexical entries so far, I have used the attribute pol, with the value neg, to account for sentential negation.

In the illustrations of the different proposals that follow, I use the representation system proposed in the original analysis.

Let's start by considering the English example in (28) from Dalrymple & Nikolaeva (2011: 87), with the f-structure in (29).

(28) John didn't love Rosa.

(29)
$$\begin{bmatrix} \textsc{pol} & - \\ \textsc{pred} & \text{‘}\textsc{love}\langle\textsc{subj}, \textsc{obj}\rangle\text{’} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘John’} \end{bmatrix} \\ \textsc{obj} & \begin{bmatrix} \textsc{pred} & \text{‘Rosa’} \end{bmatrix} \end{bmatrix}$$

Here, the only representation of negation in the f-structure is with the feature pol (Dalrymple & Nikolaeva 2011: 87). The '−' specification indicates that it does not have affirmative polarity.

3.2 Adjunct value

In contrast to introducing negation through a binary feature (e.g. neg), in some LFG analyses, negation is introduced as an appropriate element of the adj(unct) feature, as illustrated in (31) for (30), discussed in Przepiórkowski & Patejuk (2015: 323–324).[11]

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[11] Przepiórkowski & Patejuk (2015) state that, within PARGRAM, the majority of XLE implementations of negation to date take this approach, but this is not reflected in the LFG literature, in which verbal negation is nearly always represented by a feature in works that predate their paper (e.g. Sells 2000, Alsharif & Sadler 2009).

(30) John doesn't like Mary.

(31)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{like}\langle\textsc{subj, obj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{John}\text{'}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{Rosa}\text{'}\end{bmatrix} \\ \textsc{adj} & \left\{\begin{bmatrix}\textsc{pred} & \text{`}\textsc{not}\text{'} \\ \textsc{adj-type} & \textsc{neg}\end{bmatrix}\right\} \end{bmatrix}$$

Here, the ADJ(unct)-TYPE feature enables the syntactic properties of negative adjuncts to be distinguished from other adjuncts.[12] One rationale for adopting this approach is that it makes it easy to represent multiple negation (via multiple negative elements of the ADJ set). This is the approach taken by Laczkó (2014) in his account of negation in Hungarian, where both predicate negation and narrow-scope negation are treated as adjuncts because they can co-occur, as in (32) repeated from (8).

(32) Hungarian (Laczkó 2014: 307)
Péter NEM A BARÁTJÁ-T nem hívta fel.
Peter.NOM not the friend.his-ACC not called up
'It wasn't his friend that Peter didn't call up.'

Importantly, both instances of *nem* occur in the same clause, although not in the same f-structure (cf. the bi-clausal translation in English). The simplified f-structure in (33), representing (32), is consistent with the essence of Laczko's (2014) analysis of similar sentences.[13]

(33)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{call.up}\langle\textsc{subj, obj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{Peter}\text{'} \\ \textsc{case} & \textsc{nom}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{his friend}\text{'} \\ \textsc{case} & \textsc{acc} \\ \textsc{adj} & \left\{\begin{bmatrix}\textsc{pred} & \text{`}\textsc{not}\text{'} \\ \textsc{adj-type} & \textsc{neg}\end{bmatrix}\right\}\end{bmatrix} \\ \textsc{adj} & \left\{\begin{bmatrix}\textsc{pred} & \text{`}\textsc{not}\text{'} \\ \textsc{adj-type} & \textsc{neg}\end{bmatrix}\right\} \end{bmatrix}$$

---

[12] An anonymous reviewer points out that there are added complications associated with this model in accounting for the presence of *do* in English negatives if *not* is added as an adjunct.

[13] Laczko's (2014) formalisations are somewhat idiosyncratic in that his f-structure representations deviate from those typically seen in the LFG literature. While he does not actually provide an f-structure containing two instances of *nem*, there is much more analysis included in the paper than can be discussed here, and readers are directed to his paper for an extensive discussion of negation in Hungarian.

One of the major issues with this approach concerns how to limit the number of instances of the adjunct with clauses. Przepiórkowski & Patejuk (2015) report that in a later presentation, Laczkó (2015) revises his account, suggesting that two binary features may be necessary to account for the negation in Hungarian. He proposes distinguishing between ±POL and ±NEG, where each is a different feature (rather than different ways of notating the same feature).

3.3 Multiple feature-value pairs

Building on the observations made by Laczkó (2015) for Hungarian, Przepiórkowski & Patejuk (2015) propose that two different types of binary-valued attributes are required to account for negation in Polish. This distinction is motivated by (i) the distinctive behaviour of two sets of negative constructions in which the negator *nie* exhibits different degrees of syntactic independence, and (ii) the possibility that two instances of negation can occur within the same clause. This leads them to propose two distinct features known as EVENTUALITY NEGATION (ENEG) and CONSTITUENT NEGATION (CNEG).

While typically represented orthographically as a separate word, manifestations of *nie* can be broadly distinguished as 'bound' and 'independent'. Bound *nie* has a strong adjacency requirement with its host, and is described as a prefix that forms a prosodic unit with the stem to which it attaches (Kupść & Przepiórkowski 2002; Przepiórkowski & Patejuk 2015: 324). Negation expressed by prefixal *nie* cannot scope over co-ordinands, demonstrating that its semantic effects are bounded. It triggers a range of syntactic effects: first, it requires that otherwise accusative arguments of the element that is negated occur in the genitive case (the so-called 'genitive of negation'), seen in (34a), and second, it licences a syntactic domain in which negative indefinites occur, shown in (34b).

(34) Polish (Przepiórkowski & Patejuk 2015: 324)

a. Janek nie lubi Marii.
Janek.NOM NEG likes Maria.GEN
'Janek doesn't like Maria.'

b. Nikt nie lubi nikogo.
nobody.NW.NOM NEG likes nobody.NW.GEN
'Nobody likes anybody.'

Bound *nie* is associated with eventuality negation, so called because it is used to negate eventualities (i.e. events and states). The syntactic properties associated with ENEG are observed when *nie* is realised on verbs, adjectives and deadjectival adverbs, and it is for this reason that they favour the adoption of the term eventuality negation over sentential negation or predicate negation (Przepiórkowski & Patejuk (2015: 324–326) for discussion of this). Negative indefinite pronouns (see Section 5.2) are also licensed by the preposition *bez* 'without', leading Przepiórkowski & Patejuk (2015: 326) to suggest that this also introduces a value for the ENEG feature.

In contrast to the bound realisation, independent *nie* may be separated from the constituent over which it scopes (Przepiórkowski & Patejuk 2015: 329), indicating that it is not a morphological exponent of negation. This structural difference is reflected in a number of associated effects. Unlike the bound negator, it can scope over co-ordinands, and it does not licence negative case alternations or negative indefinites, as shown by the ungrammaticality either of the genitive object *Marii* or an negative indefinite pronoun object, in (35).

(35) Polish (Przepiórkowski & Patejuk 2015: 326)
Nie Janek lubi Marię \ *Marii \ *nikogo (lecz
NEG Janek.NOM likes Maria.ACC Maria.GEN nobody.NW.ACC/GEN but
Tomek).
Tomek.NOM
'It is not Janek that likes Maria (but Tomek).'

Crucially, the two different types of negation are sometimes attested in superficially similar environments, as seen with infinitival clauses. In (36), in which the infinitival clause, but not the head of the main predicate is within the scope of negation, the genitive of negation is not permitted. This is an example of CNEG. In (37), where the negated infinitival clause functions as the post-verbal subject, only genitive case is permitted: this is an example of ENEG. Similar effects are observed with the licensing of negative indefinites (Przepiórkowski & Patejuk 2015: 327).

(36) Polish (Przepiórkowski & Patejuk 2015: 326)
Ma skakać, a nie pisać wiersze \ *wierszy.
has jump.INF and NEG write.INF poems.ACC poems.GEN
'He is to jump, and not to write poems.' [of a sportsman]

(37) Polish (Przepiórkowski & Patejuk 2015: 327)
Poetyckim marzeniem Karpowicza było: nie pisać wierszy \
poetic.INS dream.INS Karpowicz.GEN was NEG write.INF poems.GEN
*wiersze.
poems.ACC
'The poetic dream of Karpowicz was not to write poems.'

Building on these observations, Camilleri & Sadler (2017: 158) propose the following (basic) lexical entries for the two types of negation, in order to provide an explicit characterisation of their differences:

(38) nie: ENEG (↑ ENEG) = +
(Camilleri & Sadler 2017: 158)

(39) nie: CNEG (↑ CNEG) = +
(Camilleri & Sadler 2017: 158)

In their formalisation, the lexical entries are identical other than the feature they introduce. However, since *nie* is a prefix when introducing the ENEG value, and is therefore part of the morphology of the verb, this should not be considered to have a lexical entry that is distinct from that of the verb form of which it is part (cf. Bond's 2016 analysis of negative verbs forms in Eleme, discussed in Section 2.2). A minimal lexical entry for *niepisác* is provided in (40).

(40) *niepisác* V (↑ PRED) = ‘WRITE⟨SUBJ, OBJ⟩’
(↑ ENEG) = +

These two different features are required to account for the fact that both types of negation may occur in the same clause, as shown in (41) (cf. ‘The Catholic Church not cannot…’). Przepiórkowski & Patejuk (2015: 327) do not distinguish the two types of negation in their glossing.

(41) Polish (Przepiórkowski & Patejuk 2015: 327)

Kościół	katolicki	nie	nie	portrafi,	ale	nie	chce.
church.NOM	catholic.NOM	NEG	NEG	can	but	ENEG	want

‘It's not that the Catholic Church cannot, but rather that it doesn't want to.’

Przepiórkowski & Patejuk (2015: 327) propose the following f-structure to account for the first part of (41):

(42)
$$\begin{bmatrix} \text{ENEG} & + \\ \text{CNEG} & + \\ \text{PRED} & \text{‘CAN}\langle\text{SUBJ, XCOMP’}\rangle \\ \text{SUBJ} & \left[\text{PRED ‘CATHOLIC CHURCH’}\right] \\ \text{XCOMP} & [\ldots] \end{bmatrix}$$

Other scholars have also observed that more than one negation may be required within a clause (e.g. Butt et al. 1999, Sells 2000, Laczkó 2014). We now explore this subject in Section 4 in relation to bipartite negation, and in Section 5 in relation to antiveridical contexts.

4 Multipartite negation

In many languages, negation is reflected in the formal properties of multiple elements with the clause. For instance, Standard (Written) French usually requires the use of preverbal *ne* and post-verbal *pas* in the formation of negative clauses.[14] In a very brief analysis, Butt et al. (1999: 142–143) propose that both elements should be represented in f-structure, with the initial component *ne* contributing a neg feature, and *pas* contributing a related feature neg-form, as illustrated for (43) in (44) from Dalrymple et al. (2019: 67).

(43) French (adapted from Butt et al. 1999: 143, following Dalrymple et al. 2019: 67)
David n' a pas mangé de soupe.
David neg have postneg eaten of soup
'David did not eat any soup.'

(44)

$$\left[\begin{array}{ll} \textsc{neg} & + \\ \textsc{neg-form} & \textsc{pas} \\ \textsc{pred} & \text{‘}\textsc{eat}\langle\textsc{subj}, \textsc{obj}\rangle\text{’} \\ \textsc{subj} & \left[\textsc{pred}\ \text{‘David’}\right] \\ \textsc{obj} & \left[\textsc{pred}\ \text{‘}\textsc{soup}\text{’}\right] \end{array}\right]$$

In the analysis of Butt et al. (1999: 142–143), the marker providing the neg + feature at f-structure may only appear if the neg-form feature, contributed by the other negative particle, is present.

Their proposal aims to capture the view that (i) two distinct manifestations of negation are required to negate a clause, (ii) that there is an asymmetry between the roles of the negators in terms of their featural specification, and (iii) that the presence of *ne* is dependent on the presence of some other negative formative. This helps to account for the distribution of *ne* in clauses like (45), where it co-occurs with the adverb *jamais* 'never'.[15] However, their analysis does not deal with the use of *pas* as the only negator of a clause, as typically found in spoken French varieties. In such cases, *pas* must either be treated as separate negative item that contributes a neg feature without *ne*, or a more serious revision to this analysis is required.

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[14] This is not true of colloquial varieties of French, in which *pas* is usually used without *ne*.

[15] However, *jamais* only has this interpretation within the context of negation, meaning 'ever' in non-negative contexts. If their analysis is correct, a separate lexical entry must exist for *jamais* when it is not negative, or this proposal requires revision in some other way.

(45) French (adapted from Butt et al. 1999: 143)
David ne mange jamais de soupe.
David NEG eat POSTNEG.NEVER of soup
'David never eats soup.'

Working with HPSG, Kim (2000, 2021) takes a different approach to analysing the distribution of *ne* and *pas* in spoken French, proposing that *ne-pas* are part of a single lexical entry, and in this sense parallel the type lexical entry for *not* in English.

Expression of negation by multiple negative formatives is extremely common in the Niger-Congo languages of Africa. For instance, this is the case in Ewe (Niger-Congo, Kwa; Ghana), where negation is simultaneously expressed by a negative particle *mé* that precedes the VP and a post-VP particle *o*, that follows objects and adverbial elements within the VP, as illustrated in (46).[16] Both NEG1 and NEG2 are obligatory.[17]

(46) Ewe (Collins et al. 2018: 333–334, 361)

a. Kofi mé-ɖu nú o
Kofi NEG1-eat thing NEG2
'Kofi didn't eat.'

b. nye-mé-ƒo nu kplé Kofí o
1SG-NEG1-hit mouth with Kofi NEG2
'I didn't speak with Kofi.'

c. Kofí mé-wɔ-a é-ƒé aƒéme-dɔ́ gbeɖé o
Kofi NEG1-do-HAB 3SG-POSS home-work ever NEG2
'Kofi never does his homework.'

When an auxiliary is present, it hosts the negative marker, as in (47) with the future auxiliary *-á* and in (48) with the 'not yet' auxiliary *kpɔ́*:

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[16] Although Collins et al. (2018) adopt an orthographic convention in which *mé* is written as a prefix, their description, taken together with discussion in Ameka (1991: 64–69) and Aboh (2010: 64–69), suggests that *mé* occupies a node in syntax distinct from its host. Ameka (1991: 64–69) notes that *mé* usually encliticises to the verb.

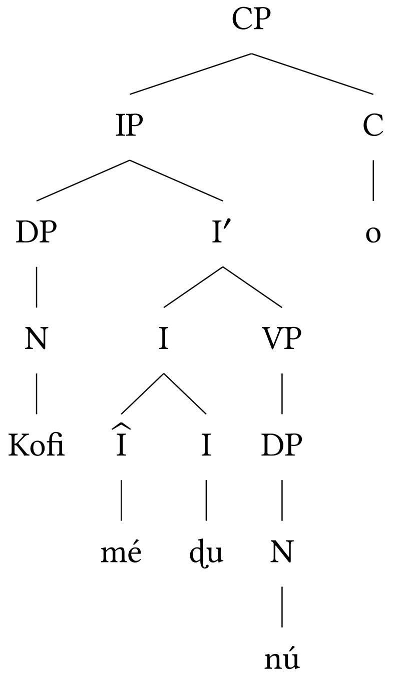
[17] This is unlike typical examples of negative concord, in which so called *n*-words are licensed only in the presence of sentential negation, and can be the answer to a sentence fragment question (see Section 5.2). Most fragment answers obligatorily require the presence of *o*, but this is because it occurs together with an NPI, not an *n*-word (Collins et al. 2018: 350–354).

(47) Ewe (Collins et al. 2018: 360)
nye-mé-á yi China gbeɖé o
1sg-neg1-fut go China ever neg2
‘I will never go to China.’

(48) Ewe (Ameka 1991: 50)[18]
nye-mé kpɔ́ wɔ dɔ lá o
1sg-neg mod do work def neg2
‘I have not had the opportunity to do the work’

Collins et al. (2018) analyse sentences such as those in (46) as having a structure in which neg1 and neg2 are not part of the same inflectional phrase. In their analysis, neg2 occupies a syntactic position outside the TP (this would be an IP in a typical LFG analysis), in the specifier position of a C (see Collins et al. 2018: 293 for the structure). The c-structure in (49) reflects the principal aspects of their descriptive analysis, although the neg1 particle *mé* is analysed as adjoined to I (rather than as the specifier of T), in a similar way to the analysis from Alsharif & Sadler (2009) discussed in Section 2.1. Assuming that *o* takes an IP complement, neg2 is rendered here as C (rather than in the specifier position of an empty C).

(49) Ewe bipartite negation based on Collins et al. (2018: 293)



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[18] The glosses have been adjusted slightly to reflect the conventions in Collins et al. (2018), but the text line remains unchanged.

As with French, the question arises as to whether these two manifestations of negation should be represented in f-structure by multiple features, or whether a single feature is sufficient. I propose that it is the latter that is true; despite having multiple attestations within the clause, only one f-structural representation of negation is required, as illustrated by the f-structure in (50).[19]

This corresponds to the f-structure in (50).

(50)
$$\begin{bmatrix} \textsc{eneg} & + \\ \textsc{compform} & \textsc{neg} \\ \textsc{pred} & \text{`}\textsc{eat}\langle\textsc{subj}, \textsc{obj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{Kofi}\text{'}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{thing}\text{'}\end{bmatrix} \end{bmatrix}$$

Crucially, both negative elements are obligatory, but, in the analysis I propose for Ewe in (50), the negative particles constrain a single attribute-value pair. This type of analysis is commonly encountered when dealing with features in LFG – for instance when featural specifications of a GF (e.g. SUBJ) are specified by both the predicate and its subject noun phrase (see Dalrymple 2001: 100–104 for an introduction). Because it is possible and indeed common for two f-structure descriptions to constrain the same attribute value pairs, it should not be particularly strange that negation can also behave in this way. In other languages, where the value of the POL feature must be contributed by a single form, and where multiple contributions are consequently disallowed, then an instantiated symbol can be used as the value of the POL attribute. See Section 5.2 for an example of the usage of this symbol.

In order to ensure that both elements are present in a well formed negative sentence, a constraining equation needs to be specified to impose an additional requirement on the minimal solution obtained from the defining equations in the f-description. A complete analysis of these structures requires that the presence of *o* is constrained (since it is obligatory here). Without a very detailed examination of the Ewe negation system, it is difficult to say exactly what type of constraint might be most appropriate. However analyses of other languages with bipartite negation have involved the addition of a special feature in f-structure, NEG-FORM, which must be contributed by the second negative formative (see Section 3.1).

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[19] Cf. the representation of clitic doubling in Dalrymple (2001: 79–81).

5 Negative Sensitive Items

Much of the theoretical literature on the syntax of negation examines the distribution of so-called Negative Sensitive Items (NSIs), that is, words whose distribution is sensitive to the presence of negation within a clause. Here we consider three types of sensitivity. The first, which I will refer to as Polarity Sensitive Cases (PSCs) is discussed in Section 5.1. Two further main types of NSIs are distinguished in the literature: Negative Concord Items (NCIs), introduced in Section 5.2, and Negative Polarity Items (NPIs), discussed in Section 5.3.

5.1 Polarity Sensitive Case

Polarity Sensitive Cases are observed when the case-marking of an argument is sensitive to the polarity of its clause. The most well-known example of this is seen in the genitive of negation in Slavic languages (e.g. Neidle 1988, Brown 1999). The basic contrast in case assignment is illustrated by (51) and (52) from Patejuk & Przepiórkowski (2014) using Polish examples from the Polish National Corpus.

(51) Polish (Patejuk & Przepiórkowski 2014: 431)
Poczytam książkę.
read.1SG book.ACC
'I'll read a book.'

(52) Polish (Patejuk & Przepiórkowski 2014: 431)
Nie poczytają książki czy gazety.
read.3PL NEG book.GEN or newspaper.GEN
'They won't read a book or a newspaper.'

Patejuk & Przepiórkowski (2014) propose that structural case assignment generalisations of this type could be formalised using constraints placed in the lexical entries of verbs that follow this pattern.

The STRCASE constraint in (53) indicates that verbs that follow structural case assignment rules follow different disjunctive constraints, labelled as AFFIRMATIVE and NEGATIVE. Note that in Patejuk and Przepiórkowski's (2014) analysis, negation is assumed to be a binary feature represented by the attribute NEG in f-structure.

(53) $\text{STRCASE} \equiv [\text{AFFIRMATIVE} \vee \text{NEGATIVE}]$

(54) $\text{AFFIRMATIVE} \equiv [\neg(\uparrow \text{NEG}) \wedge (\uparrow \text{OBJ CASE}) =_c \text{ACC}]$

(55) $\text{NEGATIVE} \equiv [(\uparrow \text{NEG}) =_c + \wedge (\uparrow \text{OBJ CASE}) =_c \text{GEN}]$

The AFFIRMATIVE constraint in (54) ensures that when there is no negation in the f-structure of the head ($\neg(\uparrow \text{NEG})$) , the object is marked for accusative case: $(\uparrow \text{OBJ CASE}) =_c \text{ACC}$. The NEGATIVE constraint in (55) ensures that when the f-structure of the head is negative ($(\uparrow \text{NEG}) =_c +$), the object is marked for genitive case: $(\uparrow \text{OBJ CASE}) =_c \text{GEN}$.

Patejuk & Przepiórkowski (2014) demonstrate that while such constraints can account for simple cases of structural case assignment, case assignment in constructions with control or raising verbs combining with (open) infinitival arguments (i.e. XCOMPs) do not follow these constraints. Consider (56). In this example, the verb *chcesz* 'want' takes an infinitival complement whose subject is controlled by the subject of the higher verb.

The verb subcategorising for the object (i.e. the infinitival verb *poczytać* 'read') is not negative, yet the genitive of negation is still required because *chcesz* 'want' is negative. Negation is present in (56), but it is 'non-local' to the infinitival clause of the verb subcategorising for the object.

(56) Polish (Patejuk & Przepiórkowski 2014: 432)
Nie chcesz poczytać Kodeksu.
NEG want.2SG read.INF Code.GEN
'You don't want to read the Code.'

While the genitive of negation is possible when negation is non-local, they observe that there appears to be some variation as to whether the lower object should occur in the accusative or in the genitive, citing semantic and structural or linear distance factors as potentially important.

For instance, in (57), the object is marked for accusative case (*książkę* 'book'), even though there is (non-local) verbal negation present higher in the structure of the sentence (at the main verb *chce* 'wants'). This illustrates that the presence of negation in a higher clause is not sufficient to ensure that the genitive of negation occurs.

(57) Polish (Patejuk & Przepiórkowski 2014: 432)
Mama nie chce iść poczytać książkę.
mum NEG want.3SG go.INF read.INF book.ACC
'Mum doesn't want to go and read a book.'

To account for this difference in case-marking, they propose that the constraints in (53)–(55) could be rewritten as (58)–(60).

(58) $\textsc{strcase} \equiv [\textsc{affirmative} \vee \textsc{negative}]$

(59) $\textsc{affirmative} \equiv [\neg(\uparrow \textsc{neg}) \wedge (\uparrow \textsc{obj case}) =_c \textsc{acc}]$

(60) $\textsc{negative} \equiv [((\textsc{xcomp}^{*} \uparrow)\ \textsc{neg}) =_c + \wedge (\uparrow \textsc{obj case}) =_c \textsc{gen}]$

The constraint in (59) states that accusative case is necessary whenever there is no local negation, while (60) indicates that genitive case is possible whenever sentential negation is available somewhere in the verb chain, locally or non-locally. Specifically, this is achieved by using an inside-out path $((\textsc{xcomp}^{*} \uparrow)\ \textsc{neg}) =_c +$ which makes it possible to reach into any number of successive higher predicates subcategorising for an infinitival complement (i.e. an XCOMP), and check if any of these predicates is negated.

5.2 Negative Concord Items

In many languages negation may be expressed through the use of negative indefinite pronouns such as English *nothing* and Polish *nikt* 'nobody'. Haspelmath (1997) argues that there are three main subtypes of construction involving negative indefinite pronouns. First, in some languages there are negative indefinites that always co-occur with verbal negation, e.g. the Polish *ni-* series, as in (61).

(61) Polish (Haspelmath 1997: 194)

a. Nikt nie przyszedł.
nobody NEG come.PST.3SG
'Nobody came.'

b. Nie widziałam nikogo.
NEG saw nobody
'I saw nobody.'

The second type of negative indefinites do not usually co-occur with verbal negation, e.g. the Standard British English *no*-series: *Nobody came* and *I saw nobody*. If they do co-occur, they are rejected by speakers, or are interpreted as having a 'double negative' reading cf. *Nobody didn't come* (=*Everybody came*).[20]

His third type of negative indefinites sometimes co-occur with verbal negation and sometimes do not, e.g. the Spanish *n*-series, exemplified in (62).[21]

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[20] Negative indefinites in the *no*-series in some other varieties of English do not behave in this manner, and thus they belong to one of the other types.

[21] The fact that the languages used to exemplify these types all come from European languages indicates the prevalence of indefinite pronouns in this area. It is largely unknown to what extent indefinite pronouns might be restricted by areal or genetic factors.

(62) Spanish (Haspelmath 1997: 201)

a. Nadie vino.
nobody came
'Nobody came.'

b. No vi a nadie.
NEG I.saw ACC nobody
'I saw nobody.'

The role that a negative pronoun plays in negating a clause depends on its ability to appear independently of another negation strategy. Negative pronouns like those in Polish which do not appear without an expression of negation are Negative Concord Items (NCIs), sometimes known as *n*-words. By definition, NCIs never occur outside of negative contexts, and when they combine with other expressions of negation, they contribute to a single semantic negation (Labov 1972). NCIs must combine with sentential negation as in (34b) and (61) with Polish *nikt* 'nobody'. NCIs are important tools for investigating the domains in which negation has structural affects. The following definition, based on Giannakidou (2006: 328), is adopted by Camilleri & Sadler (2017: 150):

(63) An *n*-word or NCI is understood to be an expression α that can be used in structures containing sentential negation or another α -expression to yield a reading equivalent to one logical negation, and which can provide a negative fragment answer.

Because NCIs in Polish always occur with another negator, the lexical entries for *n*-words such as *nikt* 'nobody.NOM' and *nikogo* 'nobody.ACC/GEN' must include a constraining equation that ensures their f-structure is specified for eventuality negation (Przepiórkowski & Patejuk 2015: 331):

(64) *nikt* N (↑ CASE) = NOM
((XCOMP* GF+ ↑) ENEG) $=_c$ +

(65) *nikogo* N (↑ CASE) ∈ {ACC, GEN}
((XCOMP* GF+ ↑) ENEG) $=_c$ +

There is much more to say about how differences in the distribution of NCIs cross-linguistically could be modelled in LFG, but I leave this aside as a topic for further investigation.

5.3 Negative Polarity Items

Negative Polarity Items (NPIs) are a set of elements that, while not inherently negative, are licensed within a set of restricted contexts including negative ones. Examples from English include the indefinite quantifier *any* and the adverb *yet*, as illustrated in (66).

(66) a. Isaac wouldn't give her any/*Isaac would give her any.
b. Eva hasn't finished yet/*Eva has finished yet.

Since NPIs are also observed in a range of other syntactic contexts, such as comparatives, modal and conditional contexts and polar interrogatives, as in (67), they are not inherently negative, and the term, attributed to Baker (1970) by Haspelmath (1997), is somewhat misleading.

(67) a. Would Isaac give her any?
b. Has Eva finished yet?

However, assuming that all items described as NPIs can be minimally licensed in negative contexts, they can be further divided into two main types, that may exist within one and the same language:

- Weak Negative Polarity Items: NPIs that exhibit a range of non-negative contexts of use. These are sometimes referred to as Affected Polarity Items (api) (Giannakidou 1998).
- Strong Negative Polarity Items: NPIs that are only licensed in antiveridical contexts (Giannakidou 1998), i.e. sentential negation and '*without*' clauses (cf. eventuality negation).

For Weak Polarity Items, such as those in (66) and (67), negation is a sufficient, but not necessary condition for the licensing. For Strong Negative Polarity items, the context must be antiveridical (see Zwarts 1995 and Giannakidou 1998).

Consider the technical definition in (68) from Giannakidou (2002), who treats veridicality as a propositional operator:

(68) A propositional operator F is veridical iff Fp entails p: $Fp \rightarrow p$; otherwise F is nonveridical. Additionally, a nonveridical operator F is antiveridical iff Fp entails not p: $Fp \rightarrow \neg p$.

A veridical context is one in which the semantic or grammatical assertion about the truth of an utterance is made. The presence of a veridicality entails that the truth conditions for the underlying proposition are met, while non-veridical expressions do not entail that the truth-conditions for the underlying proposition have been met. Though (69a) is veridical, with or without the auxiliary, (69b-69c) are both nonveridical.

(69) a. I (do) like her.
     b. I might like her.
     c. I don't like her.

Nonveridical operators are antiveridical if (and only if) the truth conditions for the underlying proposition are not met, as in (69c). Strong NPIs are sensitive to such environments.

These differences in behaviour raise important questions about how best to account for the distribution of NSIs and in which structures of grammar – essentially – to what extent can and should the distribution of NCIs and NPIs be accounted for through c-structure and f-structure representations. Problems of this kind have been addressed by Sells (2000) in relation to Swedish, and Camilleri & Sadler (2017) with respect to Maltese.

Camilleri & Sadler (2017) examine the relationship between sentential negation in Maltese and the set of negative sensitive items (NSIs). They demonstrate that the *n*-series of negative indefinites in Maltese exhibit mixed behaviour with respect to the environments in which they occur (Camilleri & Sadler 2017: 154–156). The majority of items can occur in a range of non-veridical contexts, and are not limited to antiveridical ones, exemplifying properties consistent with being classified as weak NPIs. However two NSIs show a more limited distribution: the determiner *ebda* is strictly limited to antiveridical contexts (and thus is a Strong NPI), while *ħadd* is largely restricted outside of antiveridical contexts, showing less categorical behaviour.

In finite verbal predicates in Maltese, negation is expressed through the use of the particle *ma* together with a verbal form inflected with the suffix *-x*, as illustrated in (70) and (71).[22]

(70) Maltese (Camilleri & Sadler 2017: 147)
Ma qraj-t-x il-ktieb.
neg read.pfv-1sg-nvm def-book
'I didn't read the book.'

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[22] I have adjusted the glosses in these examples so that *-x* is glossed as nvm rather than neg, to reflect the final analysis proposed by Camilleri & Sadler (2017). .

(71) Maltese (Camilleri & Sadler 2017: 147)
Ma n-iekol-x ħafna.
NEG 1-eat.IPFV.SG-NVM a.lot
'I don't eat a lot.'

Imperfectives can also be negated using a different strategy otherwise associated with non-verbal predicates and non-finite forms. In (72) , *m(a)-* is prefixed to a form identical to a nominative pronominal, which, like the verbs in (70) and (71), is suffixed with *-x*. This pronominal may occur in a default third person singular masculine form, or vary according to the features of the subject, as shown here.

(72) Maltese (Camilleri & Sadler 2017: 148)
Mhux ~ minix n-iekol ħafna.
NEG.3SGM.NVM ~ NEG.1SG.NVM 1-eat.IPFV.SG a.lot
'I am not eating a lot.'

Although the formation of negative indicative clauses of the type in (70) and (71) involves both the particle *ma* and the suffix *-x*, verb forms only inflected with *-x* cannot license a domain in which items from the *n*-series or any NSI are permitted. Rather, such items are in complementary distribution with *-x*. Camilleri & Sadler (2017: 150) consequently propose that *ma* expresses eventuality negation (ENEG), that introduces a syntactic requirement for a further element, which they call a non-veridical marker (NVM). In examples like (70) and (71), the presence of *-x* on the verb satisfies this requirement, while in examples like (73) it is satisfied by the presence of an NCI, such as *xejn* 'nothing'.

(73) Maltese (Camilleri & Sadler 2017: 159)
Ma qraj-t xejn.
NEG read.PFV-1SG nothing
'I read nothing.'

Examples such as (74) indicated that the NCI satisfying this requirement need not be local, and can be deeply embedded.

(74) Maltese (Camilleri & Sadler 2017: 153)
Ma smaj-t li qal-u li
NEG hear.PFV-1SG COMP say.PFV.3-PL COMP
qal-t-i-l-hom li gèand-hom
say.PFV.3SGF-EPENT.VWL-DAT-3PL COMP have-3PL.GEN

j-i-xtr-u xejn.
3-FRM.VWL-buy.IPFV-PL nothing
'I didn't hear that they said she told them they have to buy anything.'

This is prohibited if the embedded clause containing the negative indefinite is itself marked with *ma*. Camilleri & Sadler (2017) propose the following lexical entries to account for this:

(75) *xejn* N $(\uparrow \text{NVM}) = +$
(Camilleri & Sadler 2017: 159)

(76) *-x* $(\uparrow \text{NVM}) = +$
$\neg(\uparrow \{\text{XCOMP}|\text{COMP}|\text{ADJ}\}^{*}\ \text{GF}^{+}\ \text{NVM}) = +$
$\neg(\rightarrow \text{ENEG})$
(Camilleri & Sadler 2017: 160)

The entry for *xejn* in (75) ensures that its f-structure has the NVM value +. The entry for *-x* – which should really be understood to be part of the lexical entry for the verb form of which it is part – does a similar thing. It ensures that its f-structure instantiates the NVM feature with the value +. But the second line of (76) further stipulates that this form is incompatible with any XCOMP, COMP, ADJ or grammatical function with NVM+ (e.g. *xejn*), except embedded clauses which are themselves marked for sentential negation.

The entry for *ma* in (77) contributes the ENEG feature with the value +. The underscore following the + marks the feature as 'instantiated'. This means it is required to be uniquely contributed, so expressed only once in the f-structure. It also places the requirement that an element NVM is present, but this may be non-local or local. The path definition for GF is given in (78).

(77) *ma* ENEG $(\uparrow \text{ENEG}) = +\_$
$\{ (\uparrow \{\text{XCOMP}|\text{COMP}|\text{ADJ}\}^{*}\ \text{GF}^{+}\ \text{NVM}) \mid (\uparrow \text{NVM}) \} =_{c} +$
$\neg(\rightarrow \text{ENEG})$
(Camilleri & Sadler 2017: 160)

(78) $\text{GF} \equiv \{ \text{SUBJ} \mid \text{OBJ} \mid \text{OBJ}_{\theta} \mid \text{OBL} \mid \text{POSS} \mid \underset{\neg(\rightarrow \text{TENSE})}{\text{ADJ} \in} \}$

Camilleri & Sadler's (2017) observation that some formal elements that at first sight look like negator (e.g. *-x*) may actually be better described as non-veridical markers is an important development not only in terms of descriptive linguistics, but also in the context of how co-occurrence of different elements in negative construction can be constrained.

6 Conclusion

Negation is found in every language, yet can be manifested in a vast number of ways and forms that can occur in practically every position in c-structure. While Chomskian models of syntax usually adopt an approach in which negators head their own functional projection NegP, with LFG, negators occupy the structural position that most closely accounts for their distribution. This allows for an approach in which cross-linguistic variation in the distribution and category of negative word forms is captured using existing means for determining and modelling constituency. Indeed, in many languages negators exhibit properties of non-projecting heads, indicating that adopting a single functional phrase type fails to capture the variation encountered across languages.

While a range of approaches have been proposed to model the featural properties of negation, recent research into modelling negation with LFG suggests that two different f-structure features are required to account for the distribution of negative forms and the syntactic and semantic domains that they license. These are known as ENEG, or eventuality negation, and CNEG or constituent negation. The presence of ENEG is typically associated with a broader range of syntactic and semantic effects than CNEG. The pragmatic distribution is also different, with CNEG notably employed in cases where there is a negated proposition.

While they typically occur independently of one another, a formal analysis of negation requires the availability of both features for negation, such that both may simultaneously be present in f-structure. The distribution of Negative Concord Items (NCIs), Negative Polarity Items (NPIs) and case-forms licensed by negation also suggests that multiple features must also play an important role in accounting for restrictions on the occurrence of certain forms in antiveridical contexts.

As a lexicalist model of grammar, many facets of the distribution of negative formatives are accounted for by their lexical entry. This is most clearly observed when the presence of one negator places a stipulation on the occurrence of another, or some other marker of non-veridicality.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

aff	affirmative
api	Affected Polarity Item
cneg	constituent negation
eneg	eventuality negation
epent.vwl	epenthetic vowel
frm.vwl	form vowel
hab	habitual
juss	jussive
mod	modal
MSA	Modern Standard Arabic
NCI	Negative Concord Item
neg1	first negative formative in multipartite expression of negation
neg2	second negative formative in multipartite expression of negation
NegP	negation phrase
NPI	Negative Polarity Item
NSI	Negative Sensitive Item
nvm	non-veridical marker
nw	n-word
pol	polarity
postneg	post verbal negator

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Chapter 12

Noun phrases in LFG

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In this chapter we consider the analysis of noun phrases in LFG. As a preliminary, in Section 1 we go through a number of criteria that can be used to distinguish noun phrases from other phrase types. Degree of configurationality at clause level and its consequences for c-structure is a well-studied phenomenon in the LFG literature, and in Section 2 we evaluate how the conclusions drawn for clausal structure can be applied to noun phrases. In Section 3 we review the different approaches that have been taken to the functional structure and argument structure of noun phrases. In Section 4 we explore briefly how discourse functions may be expressed within the noun phrase.

1 Defining noun phrases

Before discussing the syntax of noun phrases, it is helpful to consider briefly the definition or delimitation of the category: how do we know what is and is not a noun phrase, and what are the essential properties of the class of noun phrases? In regard to most relevant phenomena in most languages, there is little difficulty in distinguishing a particular class of words which we label as "nouns" in distinction from verbs and other categories such as adjectives, adverbs, adpositions etc. We informally utilize different criteria in making these distinctions: the core meaning and basic function of the words, their morphology and the structure of the phrases they head. Some words, and some phrases, may be more problematic, however, aligning with our basic category of nouns in some respects, but

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not in others. Moreover, if we want to talk about the properties and analysis of noun phrases crosslinguistically, we need to be clear about the criteria used for categorization, and to ensure that our criteria for categorization are applicable crosslinguistically.

According to Kornfilt & Whitman (2011: 1297–1298), approaches to categorizing phrases and words can be broadly divided into two types: "distributionalist" approaches define categories with exclusive reference to syntactic criteria, while "essentialist" approaches make use of nonsyntactic criteria, such as lexical semantics. Some approaches to categorization make use of both types of criteria; this is true, for example, of Baker's (2003) theory of syntactic categories.

Given the separation of syntax and semantics in the LFG architecture, "essentialist" criteria have relatively little weight in the definition of categories in LFG. As discussed by Lowe (2020), there are three types of "distributionalist" criteria commonly used for defining categories in LFG, by authors such as Spencer (2015) and Bresnan et al. (2016); we discuss each of these in turn.

The first type of criteria is the internal syntax of the phrase in question; that is, what sorts of words and phrases may appear together with the head inside the phrase in question. For example, we might say that noun phrases typically may contain determiners (in those languages that have them) and adjectives, while other types of phrase cannot contain these. There may also be differences in the configurational possibilities of different phrase types. For example, under some approaches to the phrase structure of English, noun phrases are the only lexical phrase type which contain a specifier (e.g. Dalrymple 2001); for others (e.g. Falk 2001b) no lexical phrases may contain specifiers, while functional phrases can. We discuss the phrasal structure of noun phrases in detail in Section 2.

Furthermore, there may be differences between phrases of different categories in terms of the grammatical functions which can appear with them, i.e. in terms of which grammatical functions a head of a particular category may or may not subcategorize for. Given the LFG architecture and the concept of structure-function mapping principles (Bresnan et al. 2016: 105, 117, see also Section 3), these issues are related to configurational differences between phrase types, but are not fully defined by them. For example, a grammatical function POSS for the possessor in a noun phrase is often assumed, and sometimes contrasted with SUBJ, such that POSS may be a grammatical function exclusively associated with noun phrases, and SUBJ a grammatical function exclusively associated with verb phrases. Similarly, it is widely assumed that nouns and adjectives do not, at least usually, subcategorize for OBJ (though see Mittendorf & Sadler 2008, Al Sharifi & Sadler 2009, and Vincent & Börjars 2010 for OBJ with adjectives and Lowe 2017 for further discussion). We discuss grammatical functions within the noun phrase in detail in Section 3, and discourse functions within the noun phrase in Section 4.

The second type of criteria used for defining categories within LFG is the external syntax of the phrase in question (labelled "distribution" by Lowe 2020). This means that there are a certain set of positions within other phrase types where noun phrases may appear, and others where they may not. For example, in English, noun phrases may appear in the specifier of IP, in the complement position of VP and PP, but not in the complement position of AdjP or NP (though see references to OBJ with adjectives above).

The third type of criterion used for defining categories in LFG is the morphosyntax of the head of a phrase (or of the phrase itself): typically languages show differences between the morphosyntactic properties of, say, nouns, adjectives, and verbs. In many Indo-European languages, for example, nouns inflect for case and number, while verbs inflect for tense/aspect, person and number; adjectives inflect for case and number, but also inflect for gender, which is an inherent property of nouns.

The use of all three types of criteria is widespread in LFG approaches to categorization. Although each of the criteria can be problematic when applied in individual cases, in most cases the three types of criteria align unproblematically, such that it is relatively easy to distinguish broad categories of noun phrases, adjective phrases, verb phrases, etc. For example, while there are differences in the internal syntactic possibilities of noun phrases and verb phrases, there is also a degree of overlap: some noun phrases may be indistinguishable from verb phrases, purely in terms of their internal syntax. In such cases, however, external syntax and morphosyntactic criteria may help to distinguish noun phrases from verb phrases.

In rare cases there are serious mismatches between the criteria for categorization. This is perhaps most common in the case of noun-verb mixed categories: phrases which show properties of both noun and verb categorization. We avoid discussions of such mixed categories in this paper (for discussion see Lowe 2020), restricting ourselves to phrases which can (fairly) unambiguously be defined as purely noun phrases based on the sorts of criteria discussed above.

2 Configurationality and noun phrases

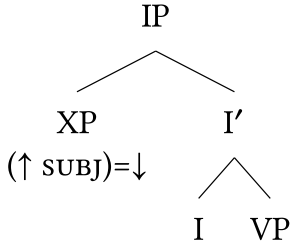
In this section we investigate the analysis of the surface configurational structure, the c-structure, of noun phrases in LFG. We consider how generalizations developed for degrees of configurationality at clausal level can be applied to noun constituents and how these can be represented at c-structure (cf. Andrews 2023 [this volume]).

Abney (1987) changed the way in which noun phrases are analysed within mainstream generative approaches to syntax. Projecting functional categories at clausal level had been introduced in the work that led to the publication of Chomsky (1986), and Abney's work was intended as "a defense of the hypothesis that the noun phrase is headed by a *functional element* (...) D, identified with the determiner. In this way, the structure of the noun phrase parallels that of the sentence, which is headed by Infl(ection)" (Abney 1987: 3).

In this chapter, we will make comparisons between clausal and nominal constituents, but not with the aim of emphasizing parallels. Within LFG, the approaches to c-, f- and a-structure have been developed more on the basis of clausal structures than anything else, and we will explore the extent to which the resulting assumptions can be applied also to noun constituents. Our aim here is not to provide full analyses of any language, but to illustrate how a particular interpretation of a data set might be analysed in LFG.

Three levels of configurationality are generally distinguished within LFG at clausal level: configurational, illustrated in (1), part-configurational (3) and non-configurational (5), with S being an exocentric clause-level category (Andrews 2023 [this volume]). If we assume a corresponding exocentric category NOM for noun phrases, then we can set up the parallel noun phrase structures in (2), (4) and (6). Different combinations of these options may be motivated for different languages; for discussion see Nordlinger (1998) and Bresnan et al. (2016: 118–9). Specifiers of functional projections are assumed to be either syntactically prominent, illustrated here with SUBJ and POSS, or information-structurally prominent functions, here we have used DF for discourse function (see Snijders 2015, Bresnan et al. 2016: 104–11 and Dalrymple et al. 2019: 121–6). As we will see in Section 3, functions such as SUBJ and POSS may be seen to have a dual role in this respect. We will return to what DF may mean for noun phrases in Section 4. In (1) – (4), we have only annotated the specifier node, for information about annotations and how they work, see Belyaev 2023c: Section 4.2 [this volume] and Belyaev 2023a: Section 4.1 [this volume].

(1)



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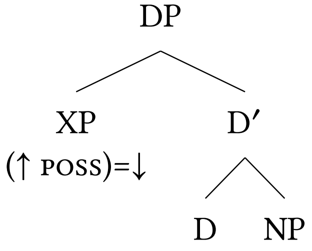

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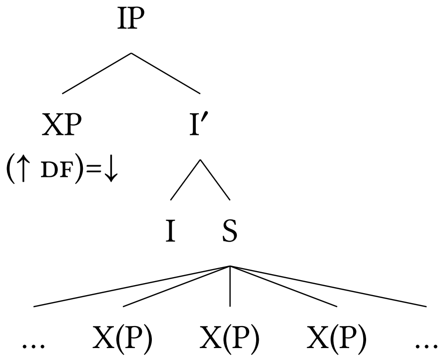

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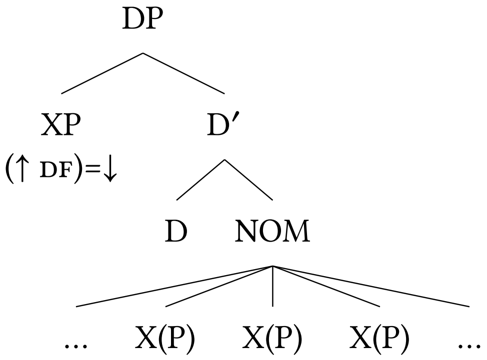

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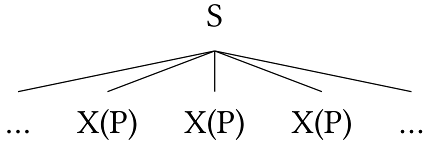

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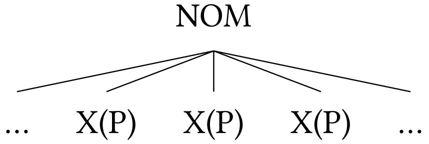

2.1 Degrees of configurationality

Criteria commonly applied to strings to establish degrees of configurationality are (i) word order, (ii) capacity for discontinuity, and (iii) structural vs. non-structural determination of grammatical functions (for an excellent summary of arguments, see Nordlinger 1998).[1]

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[1] The concept of null anaphora is also called upon quite widely to justify a configurational analysis of languages like Warlpiri that are characterized by freedom of word order (see for instance Jelinek 1984, Hale 1993). This approach has been criticized by Austin & Bresnan (1996) for lacking empirical support when a broader set of languages is considered, and we will not consider this further here.

English is a language in which noun phrases display strict word order and relatively little discontinuity. Examples of discontinuity such as (7) are generally not taken to indicate non-configurationality, but are assumed to be due to a more general principle of extraposition due to weight. Noun phrase internal grammatical functions such as POSS are generally marked by structural position in English (though see Section 3 for more detailed discussion).

(7) A *book* was published last year *on a new theory.*

English noun phrases can therefore be assumed to be thoroughly configurational and best represented by a tree such as (2), though we will return to the issue of functional categories in Section 2.2.

Turning now to the other end of the configurationality spectrum, for a number of languages which may at first sight appear to have non-configurational noun phrases, it has been argued that they do not in fact have noun phrases at all (see for instance Blake 1983). A string of elements that refer to the same referent – we will use the term NOMINAL STRING for these – whether continuous or not, may in some languages be best analysed as a number of independent nominal elements in apposition. In order to find a language with non-configurational noun phrases we must therefore first make sure that there is reason to assume that there are noun phrases in the language. Louagie & Verstraete (2016), in an evaluation of claims about non-configurationality in noun phrases in Australian languages, propose five criteria for establishing whether nominal strings form noun phrases: (i) contiguity, (ii) word order, (iii) diagnostic slots, (iv) phrasal case marking and (v) intonation.

Contiguity (i) is a necessary but not sufficient criterion; where the elements do occur together, they could still be assumed to occur in apposition, just as in the discontinuous examples. For our purposes, (relative) freedom of word order (ii) within a string for which there is other evidence of it forming a constituent will be taken as evidence of a flat structure. Some of the languages we will consider have an identifiable position (iii) at clausal level in which only a single constituent can occur, hence if a nominal string can occur in this position it can be assumed to form a structural unit. In a similar vein, if case is marked only once in a nominal string (iv), this string can be assumed to form a constituent. If a nominal string has a single intonation contour (v), it can be assumed to form a noun phrase (see also Schultze-Berndt & Simard 2012). The conclusion Louagie & Verstraete draw is that statements about the lack of noun phrase constituents in Australian languages have been overstated, but this is to some extent dependent on how they apply the criteria. For instance, whereas discontinuity has been taken as evidence against constituency, they say that "the existence of discontinuous constructions is not invariably an argument against NP constituency" (2016: 28).

With respect to Warrongo (Pama-Nyungan), Louagie & Verstraete (2016: 35) conclude: "This is really the only type of language where flexibility provides evidence against constituency." This is based on the description by Tsunoda, who argues on the basis of evidence such as (8) that "the relative order of NP constituents is not fixed and it is difficult to generalize about it" (2011: 347).[2]

(8) Warrongo

a. yarro-∅ gajarra-∅ ngali-ngo
this-acc possum-acc 1du-gen
'this possum of ours' (Tsunoda 2011: 348)

b. yarro-∅ ngaygo gajarra-∅
this-acc 1sg.gen possum-acc
'this possum of mine' (Tsunoda 2011: 348)

c. yino gornggal-∅ ngona-∅ nyon.gol-∅ jarribarra-∅
2sg.gen husband-acc that-acc one-acc good-acc
'that one good husband of yours' (Tsunoda 2011: 347)

d. ngaygo yarro-∅ jarribara-∅ wobirri-∅
1sg.gen this-acc good-acc English.bee-acc
'this nice English bee of mine' (Tsunoda 2011: 347)

Though nominal strings in Warrongo are generally contiguous, there are examples of discontinuity, as exemplified in (9).

(9) Warrongo

a. yinda **gagal**-∅ wajo-ya **bori**-∅.
2sg.erg big-acc burn-imp fire-acc
'Make a big fire.' (Tsunoda 2011: 349)

b. **gajarra**-∅ nyola ganyji-n **goman**-∅.
possum-acc 3sg.erg carry-nfut another-acc
'She carried [i.e. brought] another possum.' (Tsunoda 2011: 349)

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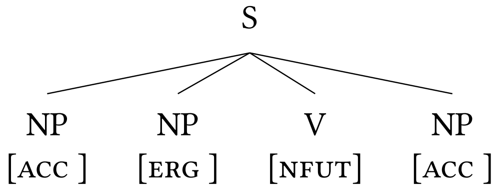
[2] We use the Leipzig glossing rules also when these have not been used in the source of the example. For a number of glosses used in our sources, there is no equivalent in the Leipzig glossing rules, and we have maintained the original. This applies to the following: an action nominal, dub dubitative, emph emphatic, min minimal, pot potential, only restrictive and seq sequential.

The examples in (8) and (9) show that each element of the nominal string is separately case marked, apart from the genitive possessor, regardless of whether the string is contiguous or not. Furthermore, with the exception of the genitive, the parts can each form an independent noun phrase. There is no diagnostic slot at clause level in Warrongo, and we do not have enough information about prosody to use that as evidence. Hence, based on the evidence available, we can assume that Warrongo is best analysed as a language where each part of a nominal string forms an independent nominal phrase, even when there is no discontinuity, so that in both (8) and (9), the individual words occur as daughters of a flat clausal structure. Though it is not our aim to provide a detailed analysis of Warrongo clause structure, our conclusions can be illustrated schematically as in (10) for (9b), where the case feature on the initial and final elements would ensure that they both become associated with obj in the associated f-structure (compare the analysis of Kalkatungu in Blake 1983).

(10)



We turn now to Bilinarra (Pama-Nyungan), as described by Meakins & Nordlinger (2014). Discontinuous noun phrases are possible in Bilinarra, as illustrated in (11), and for these cases Meakins & Nordlinger (2014: 107–108) assume an analysis where each part forms a structurally independent constituent, in line with the conclusions drawn about Warrongo above.

(11) Bilinarra (Meakins & Nordlinger 2014: 108)
Ngurra-nggurra=rna=rla ga-nggu, **ngayiny-jirri**, warrba=ma.
house-all=1min.s=3obl take-pot 1min.dat-all clothes=top
'I'm going to take them to **the house**, to **my** (house), the clothes I mean.'

However, there is also evidence in Bilinarra that contiguous nominal strings do form constituents and hence can be NPs. Pronominal clitics, such as *yi* in (12), can occur in different positions in the clause, but most commonly occur in second position. When they do, they can be preceded by a word or a phrase. When a nominal string occurs in this pre-clitic position, as in (12a) it can be assumed to form a constituent. It should be added here that the clitic can also be preceded by just one word of a nominal string as illustrated in (12b), and in such cases Meakins & Nordlinger analyse all elements of the string as separate noun phrases in apposition.

(12) Bilinarra

a. Ngayiny-ju=ma ngamayi-lu=ma=**yi** wanyja-rni
1min.dat-erg=top mother-erg=top=1min.obj leave-pst
yabagaru=rni.
small=only
'My mother left me as a child.' (Meakins & Nordlinger 2014: 102)

b. Yalu-lu=**yi** ngumbid-du ba-ni, garndi-lu.
that-erg=1min.obj man-erg hit-pst stick-erg
'That one, the man hit me with a stick.' (Meakins & Nordlinger 2014: 102)

Prosodic criteria are also used by Meakins & Nordlinger to identify a difference between strings that form noun phrases and strings that involve separate constituent parts in apposition. In (13a), the comma between *nyanuny-jirri* and *munuwu-yirri* indicates an intonational break and the possessor and the noun are assumed to form two phrases in apposition. In (13b), on the other hand, the two form part of the same prosodic unit and can be assumed to form a noun phrase constituent like they do in (12a). The resulting difference in meaning is captured by the idiomatic translations.

(13) Bilinarra (Meakins & Nordlinger 2014: 103)

a. Jardila=ma ya-n.gu=nga na, lurrbu na, **nyanuny-jirri**,
tomorrow=top go-pot=dub seq return seq 3min.dat-all
munuwu-yirri.
home-all
'Tomorrow she might go home **to hers**, **to home**.'

b. Jardila=ma ya-n.gu=nga na, lurrbu na, **nyanuny-jirri**
tomorrow=top go-pot=dub seq return seq 3min.dat-all
munuwu-yirri.
home-all
'Tomorrow she might go home **to her home**.'

We can then follow Meakins & Nordlinger and assume that nominal strings may form noun phrases in Bilinarra; when the string is contiguous, not interrupted by a pronominal clitic and forms one prosodic unit. On the assumption that there is no evidence in favour of a functional projection in Bilinarra (see Section 2.2), we can assume that a tree like that in (6) is appropriate for these noun phrases. For examples of other languages that warrant (partially) flat analyses of noun phrases, see for instance Simpson (1991) on Warlpiri, Raza & Ahmed Khan (2011) on Urdu, Lowe (2015) on Old English, Börjars et al. (2016) on Old Icelandic and for constraints on discontinuity of Latin noun phrases see Snijders (2012).

2.2 Headedness of noun phrases

There were early suggestions in the literature that noun phrases may in fact be headed by determiners (see for instance Lyons 1977 and Hudson 1984) and a debate between Zwicky (1985) and Hudson (1987) attempted to establish criteria on the basis of which the issue could be settled. However, these criteria do not lead to an unambiguous empirical conclusion, but theoretical assumptions determine the choice. Generally, after Abney (1987) all noun phrases were assumed to be (at least) DPs within Chomskyan approaches, but more recently the suggestion has been made within this architecture that a DP may not be motivated for all noun phrases (Bošković 2008, 2012). LFG generally takes a more restrictive approach to functional categories; they are assumed when a functional feature is associated with a particular structural position (Kroeger 1993: 6, Börjars et al. 1999, Sadler 2000: 92, 108). LFG's universal principles of endocentric structure-function association also state that the specifier of a functional category hosts a DF (Bresnan et al. 2016: 105, 117, see also Section 3), so that if a DF can be found to be associated with a particular structural position, this can be used to argue in favour of a functional category (see Section 4 for further discussion). Only one functional category is generally assumed within noun phrases, though there are some language-specific exceptions, for instance as in the analysis of Welsh by Mittendorf & Sadler (2005) and Chinese by Börjars et al. (2018); for further examples, see Dalrymple et al. (2019: 102–103).[3]

There has not been much discussion in the LFG literature of the headedness of noun phrases. Bresnan et al. (2016) assume that English noun phrases are DPs, but without much motivation. Dalrymple (2001) analyses them as NPs, with determiners located in specifier of NP, and this is maintained in Dalrymple et al. "for simplicity" (2019: 101). NP analyses for English can also be found in Chisarik & Payne (2003), Arnold & Sadler (2014), and Lowe (2015).[4] Börjars et al. (2019) include a brief discussion of the issue and conclude that there is no unambiguous evidence either way in the case of English noun phrases, but analyse them as DPs on the basis of the definiteness feature being associated with the left edge.

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[3] Mittendorf & Sadler (2005) say explicitly "Determining the precise c-structure is not our main concern here."

[4] However, in Lowe (2015) an NP-internal possessor is a DP, and the *'s* is structure shared.

Sadler (2000: 92) argues explicitly for an NP analysis of Welsh on the basis of lack of evidence for a DP. POSS, which shares some properties with SUBJ and hence is a DF, occurs in the specifier position of NP in this analysis. However, Sadler points out in a footnote that "the discourse-oriented functions are canonically associated with specifier of functional categories" (2000: 97) and suggests an alternative DP analysis in which POSS is found in the specifier of DP position. Charters (2014: 211) also uses the role of the specifier of a functional category in determining the headedness of noun phrases: "These days a DP analysis is more generally assumed, is a "universal default" under the EMPs [Endocentric Mapping Principles] …". We will return to Sadler's analysis in Section 3.4.

There are languages for which the marking of definiteness can be argued to provide clearer evidence of headedness. Consider the Amharic data in (14), from Kramer (2010: 197–199).

(14) Amharic

a. bet=**u**
house=DEF
'the house' (Kramer 2010: 197)

b. tɨllɨ=**u** bet
big=DEF house
'the big house' (Kramer 2010: 198)

c. bätam tɨllɨ=**u** bet
very big=DEF house
'the very big house' (Kramer 2010: 198)

d. ɨʤʤɨg bätam tɨllɨ=**u** bet
really very big=DEF house
'the really very big house' (Kramer 2010: 198)

e. lä-mist-u tammaññ=**u** gäs'ä bahriy
to-wife-his faithful=DEF character
'the faithful-to-his-wife character' (Kramer 2010: 199)

f. ɨbab yä-gäddäl-ä=**w** lɨʤ
snake COMP-kill.PFV-3M.SG=DEF boy
'the boy who killed a snake' (Kramer 2010: 199)

Here we see that the definiteness marker attaches to the first constituent. The status of the definiteness marker is problematic.[5] The marker attaches to whatever word ends the first constituent, including nouns (14a), adjectives (14b–e) and finite verbs (14f). Following the arguments of Lowe (2016: 161), this freedom of attachment to in principle any word class suggests a clitic, an analysis also followed by Lyons (1999), and hence we have used = in the glossing. In that case, the definiteness marker is most naturally interpreted as a D head, with a specifier position preceding it. By the structure-function association principles, the specifier position would be expected to be able to house a DF, and this can indeed be argued to be the case in Amharic. In Amharic, possessors, which can be argued to have discourse-functional properties (see Section 3.2 for discussion), take the shape of a PP with the preposition *yä* as in (15), and are found in the pre-definiteness position.[6] The annotated tree is provided in (16).

(15) Amharic
yä=lɨʤ=**u** däbtär
of=boy=DEF notebook
'the boy's notebook' (Kramer 2010: 202)

If we apply the argument based on the relation between free word order and a flat structure conversely, and assume that lack of flexibility of word order indicates a hierarchical structure, then the tree in (16) would be appropriate for Amharic. This is a version of the skeletal tree in (2). However, as we shall see in Section 4, word order may be fixed even in languages for which there is evidence in favour of a flat structure; this is unproblematic to analyse within LFG.

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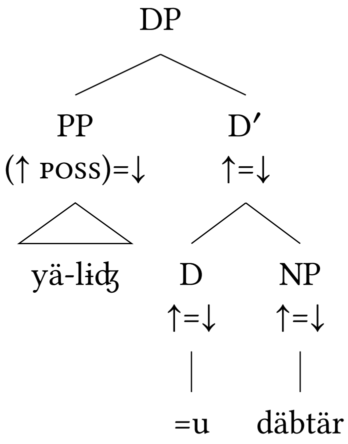
[5] Kramer formulates her analysis within Distributed Morphology, where the distinction between affix and clitic is not directly relevant. In her analysis the element is found under D, with an indication that it is bound, but this is the case regardless of the nature of its prosodic and morphological dependency.

[6] As noted, the status of the definiteness marker is problematic, and besides the evidence for clitic status there is also evidence for affixal status, including the possibility for multiple definiteness marking: in noun phrases with more than one modifier, the first one is obligatorily marked, and any following modifiers are optionally marked (Kramer 2010: 202). Beermann & Ephrem (2007) assume affixal status within their HPSG analysis. Even if the definiteness marker is taken to be an affix, it still unambiguously marks the right edge of a constituent which can host a DF function, and thus represents a specifier position. Similar distribution of DEF can be found in Balkan languages and there are a range of analyses, in part dependent on the view of the morpho-syntactic status of DEF (e.g. Sadock 1991: 117–120, Halpern 1995: 153–157, Dimitrova-Vulchanova & Tomić 2009, Bermúdez-Otero & Payne 2011, Franks 2015). We will return to elements that display properties of both affix and clitic in Section 3.4.

(16)



A DP analysis of noun phrases has been proposed also for Catalan (Alsina 2010),[7] Faroese (Börjars et al. 2016), German (Dipper 2005),[8] Hungarian (Laczkó 2007, 2017),[9] Low Saxon (Strunk 2005), Old English (Allen 2007) and Welsh (Mittendorf & Sadler 2005) (compare deP for Mandarin in Charters 2004). NP analyses have been proposed for Arabic (Al Sharifi & Sadler 2009), Chimane (Ritchie 2016), Hebrew (Falk 2001a, 2007, Spector 2009),[10] Hindi (Lee 2003), Hungarian (Chisarik & Payne 2001, 2003), Russian (King 1995), Swedish (Sells 2001), Tagalog (Kroeger 1993), Tz'utujil (Duncan 2003), Urdu (Bögel et al. 2008, Raza & Ahmed Khan 2011), Vedic (and other Early Indo-Aryan varieties) (Lowe 2017), Welsh (Sadler 2003, Mittendorf & Sadler 2008), and widely for Australian languages (e.g. Simpson 1991, Austin & Bresnan 1996, Nordlinger 1998 and many more). In many of these publications, establishing the structure and category status of the noun phrases is not the main issue, so that there are varying degrees of commitment to the structure assumed.

Complements of nouns are generally assumed to be the sister of N in c-structure, though as we shall see in Section 3.3.3, some argue that it is not possible to draw a clear structural distinction between complements and adjuncts. We will return to the f-structure feature of complements of nouns in Section 3.3. Modifying elements like APs or modifying PPs have the function ADJunct, and can be assumed to adjoin either at phrasal or X′ level (see Bresnan et al. 2016: 127, Butt et al. 1999: 105–114). In a DP analysis, they may attach either within the D spine or the N spine. Their position is established empirically, and there may be

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[7] This is an analysis within a lexical sharing approach.

[8] Note that Dipper has a flat structure under D′.

[9] Laczkó (2017: 250) comments: "when there is no need for a DP projection from an LFG perspective, I use the NP maximal projection".

[10] Though note that Falk (2001a) has a KP (case phrase) inside this NP.

arguments within a particular language for attaching different types of modifiers at different levels within the noun phrase.

3 Noun phrases, GFS and argument structure

In this section we review the different grammatical functions that have been used for noun phrases and the arguments for the different approaches. We also consider how the relevant aspects of the structure-function association principles apply within the noun phrase.

While there is in general a good understanding and broad agreement on how to identify and define the grammatical functions of arguments within verb phrases and clauses (Belyaev 2023b [this volume]), there are a variety of contrasting approaches to arguments within the noun phrase in LFG, and little sign of a developing consensus. We begin this discussion by considering the universal principles of endocentric structure-function association proposed by Bresnan et al. (2016: 105, 117):[11]

1. c-structure heads are f-structure heads;
2. complements of functional categories are f-structure coheads;
3. specifiers of functional categories are the grammatical discourse functions;
4. complements of lexical categories are nondiscourse argument functions or f-structure co-heads;
5. constituents adjoined to phrasal constituents are optionally nonargument functions.

These principles are fundamentally developed on the basis of, and exemplified using, verb phrases and clauses, but as universal principles of endocentric

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[11] In Dalrymple et al. (2019), some of these principles are modified slightly. Dalrymple et al. note that according to Laczkó (2014), Hungarian is an exception to Bresnan's claim that SUBJ cannot be the complement of a lexical category. Dalrymple et al. (2019: 121) further "propose that specifier positions are filled by phrases that are prominent either syntactically or in information-structural terms. …Syntactically prominent phrases that can appear in specifier positions in the clause are those bearing either the function SUBJ or the overlay function DIS heading a long-distance dependency. Information-structurally prominent phrases can also appear in specifier position; if they are not syntactically prominent, they may bear any grammatical function within the local clause."

structure-function mapping, there is an implicit assumption that these principles should hold also for noun phrases. One explicit acknowledgement of the applicability of these principles to noun phrases is by Sadler (2000: 94), who notes that her proposed annotated c-structure rules for Welsh NPs are "fully consistent with the structure-function mapping principles for configurational languages proposed in Bresnan 2000 [2001]."

Based on the current state of research, it seems that noun phrases crosslinguistically do in fact tend to conform to the structure-function association principles (but see also Section 4). However, this still leaves a significant degree of flexibility in how grammatical functions within the noun phrase may be analysed, as discussed in the rest of this section.

3.1 Types of nouns involving possessors (in the broadest sense)

We can distinguish at least three broad categories of noun: common nouns (e.g. *dog*, *book*), relational nouns (e.g. *sister*, *friend*), and nouns derived from verbs (e.g. *arrival*, *destruction*, *playing* etc.). Common nouns can unproblematically, and commonly do, occur without any dependent argument or possessor phrase, though they can, of course, have possessors. Relational nouns differ in that they seem to entail the existence of an entity to which the referent of the noun bears the relevant relation; and this entity is regularly expressed as a possessor phrase within the relational noun phrase. There are different types of nouns derived from verbs, and it is not always easy to distinguish the different types crosslinguistically (see amongst others Comrie 1976; Grimshaw 1990; Koptjevskaja-Tamm 1993, 2002).

But in different ways and to different degrees, all nouns derived from verbs necessarily bear a relation to a lexeme which has an argument structure (i.e. the verb), and thus can or do entail the existence of other participants corresponding to the arguments of the base verb, and may also inherit some of the selection properties of the base verb.

In the case of nouns derived from verbs, questions of nominal argument structure intersect with questions of verbal argument structure, and so it is here that the theoretical implications of the similarities and/or differences between nominal and verbal argument structure are most significant (for verbal argument structure and its mapping to f-structure, see Findlay et al. 2023 [this volume]). Within LFG, this was first explored by Rappaport (2006 [1983]). In event nominalizations, for instance, noun phrases may contain two phrases that bear a grammatical relation in a way that closely parallels that of a corresponding clause:

(17) a. The sea water constantly hit the loose stones on the beach.

b. the sea water's constant hitting of the loose stones on the beach

But there are a wide variety of views on the necessary inheritance of verbal argument structure by derived nouns. At one extreme, Rappaport (2006 [1983]: 135) assumes that "in the unmarked case, a derived nominal inherits the argument structure of its related verb". At the other, Lowe (2017: 15) argues that a derived noun like *destruction* (in e.g. *the destruction of the city by the invaders*) has no syntactic or semantic arguments, the agent and patient relations of the prepositional dependents being "pragmatically inferrable". In between these two positions, Butt et al. (1999: 46) treat phrases like *of the city* and *by the invaders* as adjuncts (like Lowe) but assume there is a dependency relation between the head noun and its modifiers at the level of semantics.

A key element of this debate is the greater optionality of the arguments found with derived nominals, compared with the obligatoriness of the arguments of corresponding verbs. But there is crosslinguistic variation here: Laczkó (1995, 2000) shows that argument realization is obligatory for Hungarian complex event nominals, and he therefore naturally adopts an analysis involving full verbal argument structure inheritance by the derived nominals.

3.2 GFs used for primary arguments

Many languages have a special marking for what we will call the primary argument of a noun; this will often be a possessor, or may be a thematic argument in the case of nouns derived from verbs. Some languages have more than one means of marking the arguments of nouns, but if so there is usually one means of marking which is the more common and basic, and which is thus in a second sense the more primary means of marking arguments of nouns. In English, this primary marking is the so-called genitive or possessive *'s* marker. Much of the following discussion is based on the English possessive *'s*, but the principles apply more widely to primary markers of arguments of nouns in other languages.

There are three main approaches to the analysis of primary-marked possessors in noun phrases. The most common assumption is that such possessors fill the grammatical function POSS (e.g. Rappaport 2006 [1983], Sadler 2000, Falk 2001b, Bresnan 2001, Bresnan et al. 2016, Laczkó 2000, 2007, 2017, Strunk 2005, Charters 2014, Lowe 2017, Dalrymple et al. 2019). A few authors, including Williford (1998), Butt et al. (1999), and Dalrymple (2001), treat these possessors rather as SPEC. However, the function SPEC is also widely used for the function of determiners and/or quantifiers, and as noted by Sadler (2000) and Falk (2002) this is problematic for languages in which determiners and possessors (e.g. Romanian) and/or quantifiers and possessors (e.g. English) can co-occur. On this basis Dalrymple et al. (2019: 83–84) argue that SPEC should be restricted to quantifiers; instead they use POSS for possessors and features such as DEF and DEIXIS for articles and demonstratives.[12]

Chisarik & Payne (2001, 2003) argue that primary possessors have the function SUBJ. The close relation between possessors and the SUBJ function is clear in the case of nouns derived from verbs (cf. 17), and is acknowledged also by some of those who treat possessors as POSS. For example, Sadler (2000: 106) defines POSS as a "SUBJective" function; similarly, Laczkó (2007: 358) refers to the "subject-like nature of the possessor". Like SUBJ, POSS includes discourse-functional properties, and may be associated with topicality (Rosenbach 2002); see further Section 4.

In some sense, POSS can be seen as the nominal equivalent of SUBJ, the most basic, most common, and semantically most variable verbal argument function. Yet there are important differences between the two. For example, expletives can fill SUBJ, but cannot be possessors in English:[13]

(18) a. There appears to be a reindeer on the roof.
b. * There's appearing to be a reindeer on the roof is an illusion.

(19) a. It appears that there's a reindeer on the roof.
b. ? Its appearing that there's a reindeer on the roof is an illusion.

SUBJ is generally assumed to be associated with specifier of IP, or to be morphologically marked as a SUBJ (or both); POSS is assumed to be associated with

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[12] It should be pointed out here that quantifiers have not been fully explored from a c-structure perspective. They are sometimes assumed to head a QP, but without detailed argumentation (e.g. Wescoat 2007, Bresnan et al. 2016: 211–212). A referee suggests that one reason form and function of quantifiers have not been so well-explored in LFG is that the distinction is either trivial or problematic for these elements. However, Dipper (2005) is an example of how the distinction can be made; she provides detailed argumentation that elements in German which function as quantifiers in fact belong to two different c-structure categories, some sharing properties with adjectives and some with determiners. Note that beyond LFG, Payne & Huddleston (2002) do distinguish between the category 'determinative', to which quantifiers belong, and the function "determiner". The semantics of quantifiers has been well explored in LFG; see Dalrymple et al. (2019: 302–312).

[13] The examples are taken from Bresnan et al. (2016: 315). A referee points out that the noun phrase status of the constituent built around *appearing* in (18b) and (19b) is controversial, and suggests that using *tend* and *tendency* in examples (18) and (19) would be more convincing.

a broad range of positions crosslinguistically.[14] The semantic relation between a poss and its possessum is considerably more flexible than that between a subj and its verbal head, and there does not appear to be a nominal equivalent of the Subject Condition (Findlay et al. 2023 [this volume]), for example.[15] Thus there does seem to be some justification for distinguishing subj from the grammatical function of possessors.

subj is a governable grammatical function, and so must be subcategorized for. The status of poss is arguable: some authors treat poss as an argument function, others as a non-argument function, and others as both. For Sadler (2000: 97), poss is a non-argument function for common nouns and an argument function for deverbal nouns, this is illustrated in (20).

(20) Welsh
a. *llyfr* N 'book⟨ ⟩(↑poss)' (common noun)
b. *disgrifiad* N 'description⟨(↑poss)⟩' (deverbal noun)

Bresnan et al. (2016: 315–319) assume a lexical predication template which converts nouns, including deverbal nouns, into predicates with an optional poss argument:[16]

(21) a. *horse* N (↑pred) = 'horse⟨ ⟩'
'horse⟨ ⟩' ⇒ 'horse-of⟨(↑ poss)⟩'
b. *singing* N (↑pred) = 'singing⟨(↑ obl$_{\text{of}}$)⟩'
'singing⟨(↑ obl$_{\text{of}}$)⟩' ⇒ 'singing-of⟨(↑poss) (↑ obl$_{\text{of}}$)⟩'

Laczkó (2007) proposes a slightly different lexical redundancy rule which converts a noun without argument structure into a one-place "raising" predicate, and a relational noun to an "equi" predicate:[17]

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[14] Charters (2014: 209) sums up: "Possessors have been said to occur in Spec NP (Sadler 2000, Charters 2004, Laczkó 2007, Lødrup 2011); Spec DP/FP (Charters 2004, Strunk 2005); adjoined to NP (Chisarik & Payne 2001); adjoined to N (Lødrup 2011), and in the complement of N (Chisarik & Payne 2001)."

[15] In fact, arguments of nouns are rarely obligatory, with only a few possible exceptions in English (like *behalf* and *sake*). To account for the obligatory realization of arguments with complex event nominals in Hungarian, Laczkó (1995) proposes a nominal equivalent to the subject condition, namely the "poss condition".

[16] Similarities and differences between poss and subj are referred to but poss is not classified with respect to argument or discourse function. For verbal gerunds like *Mary's frequently visiting Fred* poss is equated to subj.

[17] The templates used by both Bresnan and Laczkó have the effect of adding an optional argument. For an alternative way of capturing the optionality of arguments of nouns, see Lowe (2017: 293–294) with reference to Asudeh & Giorgolo (2012), Giorgolo & Asudeh (2012), and Asudeh et al. (2014).

(22) Hungarian

a. *kalap*$_1$ N ‘hat⟨ ⟩’ ⇒
kalap$_2$ N ‘hat⟨(↑xcomp)⟩(↑poss)’
(↑poss) = (↑xcomp poss)

b. *húg*$_1$ N ‘younger-sister-of⟨θ⟩’ ⇒
húg$_2$ N ‘younger-sister-of⟨(↑poss)(↑xcomp)⟩’
(↑poss) = (↑xcomp poss)

Payne et al. (2013: 804–805) argue that no clear distinction can be drawn between inherently relational and non-relational nouns, they propose to treat all nouns grammatically as nonrelational until combined with a dependent.

3.3 Secondary argument marking

In many languages the primary means of marking a possessor or other argument of a noun can only mark one such argument, and there is a secondary means of marking arguments which can be used alongside, or sometimes instead of, the primary marking. This is not the case in all languages, for example in Estonian the genitive case is the primary means of marking possession, but two arguments of a noun can be marked in the genitive:

(23) Estonian (Koptjevskaja-Tamm 2002: 732)

a. Jaan-i Inglisma-a kaart
Jan-gen.sg England-gen.sg map.nom.sg
‘Jan’s map of England’

b. Peetr-i maja-de ehita-mine
Peter-gen.sg house-gen.pl build-an.nom.sg
‘Peter’s building (of) houses’

In contrast, in English, as illustrated by the translations above, any second argument of a noun must be expressed by means of a prepositional phrase, and this can also be the case for single arguments of a noun. This can include possessors, marked in English with *of*.

The grammatical function of such secondary argument phrases, such as English *of* possessors, is also a matter of debate. Such possessors are sometimes treated as adj, e.g. by Butt et al. (1999), Sadler (2000), and Lowe (2017), sometimes as an obl$_{\text{of}}$, e.g. by Rappaport (2006 [1983]) and Bresnan et al. (2016).[18] We consider the major grammatical functions associated with secondary argument marking in the following subsections.

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[18] Laczkó (1995) permits English *of* possessors to realize either obl$_\theta$ or poss.

3.3.1 Secondary argument marking and OBJ

It is significant that while the close relation between POSS and SUBJ is widely recognized, and the two are sometimes conflated, a clear distinction is always maintained between secondarily marked possessor phrases and the OBJ function, despite, for example, the positional similarity between *of* possessors and objects (as seen in (17)). It is taken as a strong, if not definitional, generalization, that nouns cannot take OBJ (Bresnan & Kanerva 1989, Bresnan & Moshi 1990, Bresnan & Mugane 2006, Chisarik & Payne 2001, 2003, Lowe 2017, 2020). Lowe (2017, 2020) argues that noun phrases which appear to include object dependents are in fact mixed projections, incorporating a verbal projection which licenses the object.

Chisarik & Payne (2001, 2003) propose a specialized nominal argument function NCOMP/ADNOM, which is intended to capture the relevant similarities between the secondary possessor function and OBJ, while keeping them distinct. In argument structure terms, NCOMP is, like SUBJ and OBJ, an unrestricted function [−*r*]. Like SUBJ and unlike OBJ, however, NCOMP is also [−*o*] (for an explanation of these features, see Findlay et al. 2023 [this volume]).

As with POSS and SUBJ, secondarily marked possessors are considerably less semantically restricted than any corresponding verbal argument function (including OBJ). For example, secondarily marked possessors differ from clausal OBJ in that they can be mapped to Agent:

(24) a. the love of a good woman
b. the poor performance of the team

Moreover, primary and secondary possessors are unrestricted to different degrees. Payne & Huddleston (2002: 473–478) argue that the set of semantic relationships that can be expressed by an *of*-phrase in English is a proper superset of those that can be expressed by an *’s* phrase. For example, genitive POSS has to be affected: **history’s knowledge* vs. *knowledge of history*. The following examples, from Payne et al. (2013: 809), illustrate how widely the relation between a prepositional possessor and its head can (and must) be interpreted in English.

(25) a. David Peace’s Red Riding Quartet, which spins a fictional plot alongside **the murders of the Yorkshire Ripper**, is all the more potent for its true crime background.
b. One of two sisters who bombed the Old Bailey in the 1970s is in custody today being questioned about **the murders of two soldiers** in Northern Ireland in March.

c. Paul Temple is part of the era between **the upper class murders of Agatha Christie** and **the gritty murders of today**.

d. The driving rhythms of London's fiercely competitive cat-walks may seem a thousand miles away from **the cosy cottage murders of Miss Marple**, but they provide a perfect environment for the more chilling edge of Agatha Christie's short stories.

3.3.2 Secondary argument marking and ADJ

Sadler (2000: 94) claims that "there are several reasons for believing that PP dependents of nouns do not map to complement functions". She analyses PP dependents of nouns in Welsh as ADJ because they show relatively free word order with respect to each other, but are fixed with respect to a possessor DP/NP (2000: 94–97). The argument to some extent works also for English; in the following examples, the *of*-possessor phrase follows an optional *by*-phrase, even when the latter is heavy, as in (26b).[19]

(26) a. the description by the victims of their attacker

b. the description by the surgeon, Sir Zachary Cope, author of a highly regarded monograph on the early diagnosis of the acute abdomen, of his own experience with cholecystitis

3.3.3 Secondary argument marking and OBL

Rather than ADJ, Rappaport (2006 [1983]: 135–136) considers OBL_θ to be the best analysis of postnominal preposition phrases in English, on the grounds that postnominal noun phrases always "appear as the object of a preposition which reflects its thematic role." Possessive *of*-phrases are assumed to be $\text{OBL}_{\text{THEME}}$ explaining the restriction on *of*-phrases with some deverbal nouns:

(27) a. Randy instructed Deborah to meet him at two.

b. * Randy's instruction of Deborah to meet him at two

c. Randy's instructions to Deborah to meet him at two

(28) a. John fled the city.

b. * John's flight of the city

c. John's flight from the city

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[19] The example in (26b) is taken from Flegel (2002: 1379).

(29) *the destruction of the Romans (with *the Romans* as Agent)

Another argument in favour of OBL_θ over ADJ is the treatment of deverbal nouns from verbs like *put* which subcategorize for both OBJ and OBL_θ. If the verb *put* requires SUBJ, OBJ and OBL_{LOC}, does the gerund *putting* require POSS, OBL_{LOC} and ADJ? Given that the semantic restrictions on the locational phrase remain in the deverbal noun phrase, OBL_{LOC} seems reasonable; but then it seems odd to assume that the OBJ of the verb is demoted to ADJ, moving below the OBL_{LOC} argument on the grammatical function hierarchy (Belyaev 2023b [this volume]). It would mean that in examples such (30), the ADJ would naturally precede a subcategorized OBL.[20]

(30) a. All right, Republicans are denouncing President Donald Trump because of his apparent defense of Russian President Vladimir Putin and **his putting of the United States and Putin's Kremlin on moral equivalent grounds**.

b. her constant placing of the Hills on a pedestal

On the other hand, Payne et al. (2013: 795) argue that "the empirical facts show the distinction between complements and modifiers of nouns to be unfounded. There is no rational way to motivate drawing the distinction between them… We assume no structural differentiation of the phrases formerly classified as either complements or adjuncts: all nouns are treated grammatically as nonrelational until they combine with a dependent." Payne et al.'s analysis is not formalized within LFG, but correlates with recent LFG work by Przepiórkowski (2016, 2017), who argues against the argument vs. adjunct distinction. If this is accepted, the OBL_θ vs. ADJ question with respect to noun phrase dependents is moot.

In some languages, the distribution of primary and secondary argument marking differs from the patterns seen above in English. As shown by Laczkó (1995, 2000; see also Laczkó 2007, 2017), event nominalizations in Hungarian require the theme argument to be expressed as either a dative or a nominative possessor, whereas the agent must be treated as an adjectivalized postpositional modifier. There is therefore no mapping in Hungarian equivalent to the mapping involved in the English *Edith's smashing of the vase.*

For Laczkó (2000), the Hungarian linking pattern for event nominals is essentially ergative: the SUBJ of an intransitive event nominal and the OBJ of a tran-

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[20] The examples in (30a) and (30b) are from http://edition.cnn.com/TRANSCRIPTS/1702/06/nday.06.html (accessed 6 July 2021) and https://www.goodreads.com/review/show/1326602940 (accessed 6 July 2019), respectively.

sitive event nominal are mapped to poss, while the subj of a transitive event nominal is mapped to a *by*-phrase.

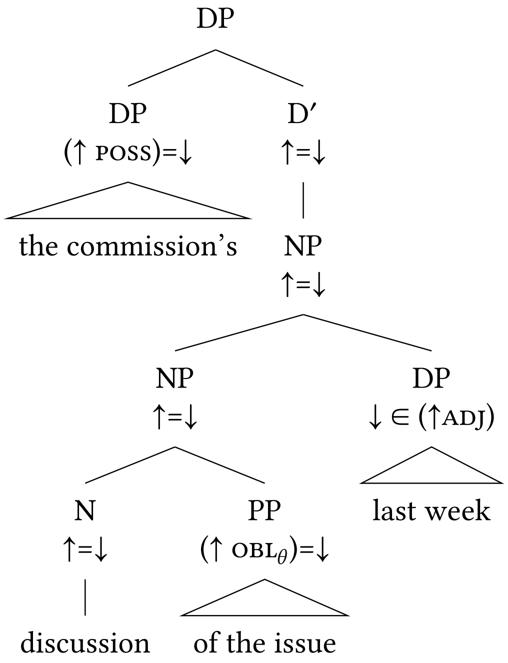
3.4 Sample analyses

It will have become clear from Section 3.2 and Section 3.3 that there are different views on what grammatical functions are available within the noun phrase and what their positions are within the c-structure. Here we will illustrate with two analyses of English noun phrases based on different assumptions, and one of Welsh, which shows interestingly different properties.

Based on some of the assumptions with respect to c-structure and noun-phrase internal grammatical functions, we would get the annotated tree in (32) for the noun phrase in (31), with the associated f-structure in (33), where we have simplified the pred values for the obl$_{\text{OF}}$ and the adj.

(31) the commission's discussion of the issue last week

(32)

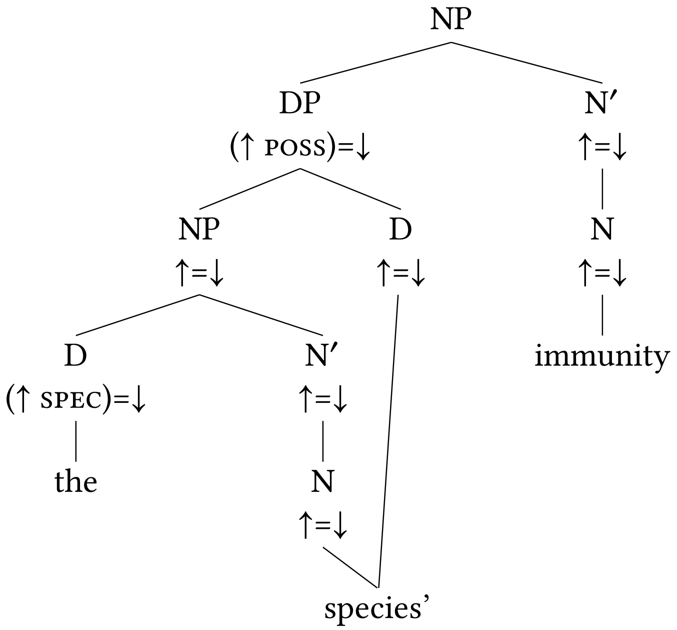


(33)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{discussion}\langle(\textsc{poss}),\ \textsc{obl}_{\textsc{of}}\rangle\text{'} \\ \textsc{obl}_{\textsc{of}} & \left[\textsc{pred}\ \ \text{`}\textsc{issue}\text{'}\right] \\ \textsc{poss} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{commission}\text{'} \\ \textsc{def} & + \end{array}\right] \\ \textsc{adj} & \left\{\left[\textsc{pred}\ \ \text{`}\textsc{last week}\text{'}\right]\right\} \end{array}\right]$$

In (32) and (33) we have opted to use the functions POSS and OBL_θ for the primary and secondary arguments, respectively, and assumed that these are optional arguments of *discussion*. With respect to c-structure, we have assumed that a distinction in attachment can be made between the complement *of the issue* and the adjunct *last week*, though we recognise that the arguments for this distinction are by no means unambiguous. There is no determiner element present in this analysis and hence the head of the DP is eliminated by what is generally referred to as the Principle of Economy of Expression (see Belyaev 2023a [this volume] for a summary, for different versions, see Bresnan et al. 2016: 90–2 and Toivonen 2003, and for a critical discussion see Dalrymple et al. (2015)). An alternative, if *'s* is analysed as a clitic, is to assume that it fills the D position (cf. similar assumptions for the Amharic definiteness marker in (16)), and this could then also account for the complementary distribution between the determiner and the POSS. However, Lowe (2016) provides arguments against this type of analysis and instead provides a lexical sharing analysis in which *'s* can be analysed as both an affix and a clitic. The lexical sharing analysis makes use of the dimension representing the string of words, the s-string, which is mapped to the hierarchical c-structure. Under certain circumstances, one element in the s-string can be associated with two nodes in the c-structure, and in this case *'s* is mapped both to the N and the D head of the possessor. In this analysis, though possessors are of category DP, non-possessor noun phrases are assumed to be of the category NP, where the specifier position can be filled either by a non-projecting D (represented as $\widehat{\text{D}}$ in LFG) (Belyaev 2023a: Section 2.1 [this volume]), or by a possessor DP, thereby accounting for the complementarity of possessors and determiners. The analysis is best demonstrated with an example where there is evidence of affix status, for instance where the *'s* is unexpressed because some property of the final word of the phrase it attaches to, as in (34), where *species* has the irregular "possessive" form *species'*. The annotated tree capturing the lexical sharing analysis is found in (35).

(34) the species’ immunity

(35)



Sadler (2000) provides an LFG analysis of Welsh noun phrases that she contrasts with the head movement analysis proposed by Rouveret (1994). Sadler assumes an NP structure, with the function poss found in the specifier of NP position.[21] This analysis captures the complementarity of a possessor and the definite determiner, which is a property also of Welsh, and it accounts for the definiteness of the noun phrase as a whole. The definiteness of a noun phrase containing a possessor is determined by the presence of the definite article *y*(*r*) within the possessor, and if there are nested possessors, within the most deeply embedded possessor. The complementarity is assumed to be a property of the definite article. The first equation in the lexical entry in (36) captures the complementarity and the second the definiteness feature.

(36) y*(*r*) ‘the’* ¬ (↑ poss)
(↑ def) = +

Consider the noun phrase in (37), where we have three layered possessors (note that ‘bank’ in ‘bank manager’ is realized as a possessor in Welsh).

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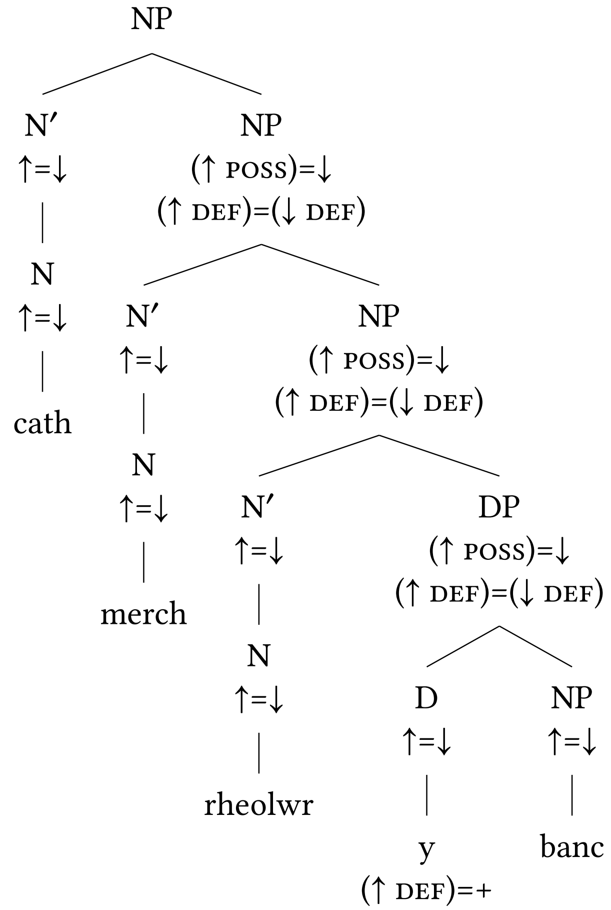
[21] Note that Sadler (2000: 97, fn 17) points out that if one accepts the claim that discourse-oriented functions such as poss are found in the specifier of a functional category, then a DP analysis of Welsh noun phrases would be appropriate, but states that the analysis developed in the paper can be recast in a DP structure.

(37) Welsh
cath merch rheolwr y banc
cat daughter manager the bank
‘the bank manager’s daughter’s cat’

The annotated c-structure tree assumed by Sadler (2000: 101) and the associated f-structure can be found in (38) and (39). Here we see how a possessor is annotated as sharing its DEF feature with its daughter, ensuring that the definiteness of the most deeply embedded possessor determines the definiteness of the noun phrase as a whole. In (39), we also see illustrated the difference in argument status of POSS between common (*cat* and *manager*) and relational (*daughter*) nouns illustrated for common and deverbal nouns in (20).

(38)



(39)
$$\left[\begin{array}{ll} \text{PRED} & \text{`CAT}\langle\,\rangle(\uparrow \text{POSS})\text{'} \\ \text{DEF} & + \\ \text{POSS} & \left[\begin{array}{ll} \text{PRED} & \text{`DAUGHTER}\langle(\uparrow \text{POSS})\rangle\text{'} \\ \text{DEF} & + \\ \text{POSS} & \left[\begin{array}{ll} \text{PRED} & \text{`MANAGER}\langle\,\rangle(\uparrow \text{POSS})\text{'} \\ \text{DEF} & + \\ \text{POSS} & \left[\begin{array}{ll} \text{PRED} & \text{`BANK'} \\ \text{DEF} & + \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right]$$

4 Noun phrases and "discourse functions"

In Section 3, we referred to the principle of structure-function association, which states that the specifier of functional categories houses discourse functions. This does not, of course mean that this is the only position where DFs can occur (see for instance Laczkó 2014, who provides evidence for a DF in the specifier of VP for Hungarian). Though noun phrases are unlikely to allow the same range of grammatical discourse functions as clausal constituents, languages may have positions reserved for emphasis or contrastive focus within the noun phrase, and in what follows we will use DF in its broadest sense as any information-structurally marked position (Zaenen 2023 [this volume]).

Babungo (Grassfields, Benue-Congo) has radically head-initial noun phrases. The examples in (40) illustrate this for a range of elements.[22]

(40) Babungo

a. ká wî
money that
'that money' (Schaub 1985: 73)

b. yílwáŋ têe
hammers five
'five hammers' (Schaub 1985: 74)

c. ŋgá kwàlə̀
antelope big
'a big antelope' (Schaub 1985: 72)

d. təsàw tə̂
pipes your
'your pipes' (Schaub 1985: 72)

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[22] PST2 and PST4 refer to different past tense markers.

e. ghɨ́ ꜝwée
loaf child
‘the loaf of the child’ (Schaub 1985: 76)

f. wěembwā fáŋ tǐi wi sɨ́ sáŋ (ŋwə́)
child who father his PST2 beat.PFV him
‘a child whom his father had beaten’ (Schaub 1985: 34)

g. shúu ŋìi wúumbǎ wī
mouth house friend his
‘the door of his friend’s house’ (Schaub 1985: 76)

Babungo has a number of elements indicating emphasis. The elements *ŋkèe* and *shèˈ*, which can be associated with noun phrases as in (41), are described as emphasis adverbials. However, since these can also modify PPs, A(P)s and Adv(P)s, we can assume they are external to the noun phrase.

(41) Babungo

a. ŋkèe ŋkáw kāŋ
very chair my
‘my own chair’ (Schaub 1985: 74)

b. shèˈ ŋkáw kə́bwə̄
only chair bad
‘only a bad chair’ (Schaub 1985: 74)

More relevant to our exploration of DFs within the noun phrase are the emphatic forms of possessors and demonstratives, which precede the noun, as illustrated in (42).[23]

(42) Babungo

a. yíŋkíi tɨ̄
that.EMPH tree
‘that particular tree’ (Schaub 1985: 73)

b. ntɨ̌ɨ tə́sáw
your.EMPH pipes
‘your own pipes’ (Schaub 1985: 73)

There is also a negation focus element *tǔu*, which may precede the head noun as in (43).

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[23] Emphatic demonstratives may also follow the noun (Schaub 1985: 73).

(43) Babungo

a. tǔu wə̀ mùˈ (nè kée lùu shɔ́ mē)
even person one PST4 NEG be there NEG
'Not even one person was there.' (Schaub 1985: 75)

b. (ŋwə́ nə̀ kée kɔ̀) tǔu fá (shée mē)
he PST4 NEG give.PFV even thing to.me NEG
'He didn't give me anything at all.' (Schaub 1985: 75)

As shown in (44), the emphasis adverbials, which we hypothesize occur outside the noun phrase, can co-occur with emphatic possessors and demonstratives.

(44) Babungo

a. shèˈ yíŋkíi ŋkáw
only that.EMPH chair
'only that particular chair' (Schaub 1985: 77)

b. shèˈ ŋkǎŋ ŋkáw kî
only my.EMPH chair that
'only that chair which is mine' (Schaub 1985: 77)

An unfocused demonstrative and an unfocused possessor can co-occur (45a), as can an focused possessive and an unfocused demonstrative (45b).

(45) Babungo

a. ŋkáw kāŋ kî
chair my that
'that chair of mine' (Schaub 1985: 77)

b. ŋkǎŋ ŋkáw kî
my.EMPH chair that
'that chair which is mine' (Schaub 1985: 77)

However, an emphatic demonstrative and an emphatic possessive cannot co-occur.[24] Similarly, the emphatic negative *tǔu* cannot co-occur with either the emphatic demonstrative or the emphatic possessive. The examples in (44) indicate that there is no general restriction on two emphatic elements being associated with the same noun phrase, so we can assume that the constraint that rules

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[24] Emphatic demonstratives cannot co-occur with any possessor.

out the co-occurrence of the emphatic demonstrative and the emphatic possessive or *tŭu* is a noun phrase internal structural constraint. In other words, there appears to be one unique dedicated information-structurally privileged position within the noun phrase. By structure-function mapping, we might expect this to be the specifier of a functional projection, and hence for the tree in (2) or (4) to be appropriate. However, there is no other obvious evidence of a functional projection. There is no article in Babungo; there is what is described as an "anaphoric demonstrative adjective"(Schaub 1985: 97), but its position would not be taken as evidence of it being a projecting D. Babungo has a strict ordering within the noun phrase: Head noun > A > Poss > Nom > Dem > Q > PP > RelC (Schaub 1985: 77), but no evidence of a hierarchical structure.[25] Since freedom of word order is generally taken as one piece of evidence in favour of a flat structure, in Section 2.2 we referred to the possibility of using the criterion conversely, to assume that strict word may indicate a hierarchical structure. However, the interpretation of the Babungo data that we have argued for here indicates that word order can be strict even when there is no other evidence of hierarchical structure. Such non-hierarchical ordering restrictions can be accounted for within LFG by means of LINEAR PRECEDENCE RULES (Dalrymple et al. 2019: 144–145). However, this is not something that has been extensively explored in the LFG literature. Interestingly, in contrast to Babungo, which is head-initial and can be argued to have an initial information-structurally priviliged position, Ingush (Northeast Caucasian) has consistently head-final noun phrases and has an information-structurally privileged post-nominal position (Nichols 2011), so in a sense provides a mirror image of Babungo.

We see evidence, then, that noun phrases in different languages may include positions specifically associated with discourse-function marking. However, such positions need not be specifiers of functional projections, but may instead be specifiers of lexical projections (parallel to Laczkó's DF specifier of VP in Hungarian). Relatively little work has been done on discourse-function marking within the noun phrase, however, and more work is needed to establish the patterns and constraints on this cross-linguistically.[26]

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[25] The only exceptions involve obligatory possession (inalienable and kinship), which occur between the head noun and the A .

[26] Authors who do consider the dimension of discourse structure within the noun phrase include Charters (2014) and Chisarik & Payne (2001, 2003).

5 Conclusion

In this chapter, we have explored aspects of the analysis of noun phrases in LFG. Relatively little work has been done within LFG on the c-structure of noun phrases, though there are some notable exceptions, to which we have referred in this chapter. Degrees of configurationality at clause level and how to analyse them has, however, been a focus of much LFG work. Therefore, in Section 2, we considered how these analyses could be transferred to noun phrases. We argued that examples can be found of strictly configurational, partly configurational and non-configurational noun phrases, so that the c-structure analyses of the three global levels of configurationality developed at clause level can be carried over to noun phrases. In Section 2.2 we also considered the use of functional categories in the noun phrase in light of the restricted approach generally taken to such categories within LFG.

The role of argument structure and grammatical functions within noun phrases is, on the other hand, well-studied within LFG. However, there is no consensus on which GFs are relevant within noun phrases, or how the arguments of nouns relate to those of verbs. In Section 3, we reviewed and evaluated a number of proposals from the literature. We also considered how principles of endocentric structure-function association (Bresnan et al. 2016: 105, 117) apply to the relation between grammatical functions and structure in noun phrases.

Though noun phrases are unlikely to involve the same range of information structural notions as clauses do, basic notions such as emphasis and contrast do apply. In Section 4, we argued that there are languages that have a position for a basic grammaticalized discourse function within the noun phrase. In the languages we considered, this is a position at the edge of the noun phrase, preceding the head in a head-initial language (Babungo) and following the head in a head-final language (Ingush). However, our consideration has been relatively superficial and the noun phrases of these languages deserve further consideration.

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Chapter 13

Pronoun incorporation

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In LFG, so-called ‘pro-drop’ is analyzed as pronoun incorporation, where the person and number marking on the head is the pronoun. The morphology on the head thus serves a dual function: it is an agreement marker when an independent noun or pronoun is present in the clause, and it is an incorporated pronoun when no independent nominal element is present. This chapter spells out the basic analysis of the interplay between pronoun incorporation and agreement marking in LFG. The analysis is illustrated with examples from subject, object, and possessive marking in multiple languages. The chapter also discusses cases where the agreement marker displays markedly different characteristics than the homophonous incorporated pronoun.

1 Introduction

In LFG, pro-drop is analyzed as pronoun incorporation. The term pro-drop (from the longer pronoun/pronominal dropping) refers to certain instances where a morphologically independent pronoun is not pronounced even though the sentence involves a pronominal interpretation. The pro-drop example in (1) is from Italian, a language that allows subject pro-drop (the example is from Burzio 1986: 92):

(1) Italian
Ho mangiato bene.
have.1sg eaten well
‘I have eaten well.’

Ida Toivonen. 2023. Pronoun incorporation. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 563–601. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185960

English is not a pro-drop language, and pronouns cannot be left unpronounced like subject pronouns can in Italian. However, possible pronoun omission is not an all-or-nothing phenomenon. Haegeman (1990) and Weir (2008) discuss the restricted omission of subjects which can occur in certain registers in English (especially so-called ‘diary drop’), and Cardinaletti (2014) shows that there is variation within Italian dialects regarding when pronouns can be dropped. The generalization remains that pronouns are omitted quite freely in most languages (e.g., Italian, Arabic, Chicheŵa), although some languages resist it (e.g., English, French).

The Italian example in (1) illustrates what is traditionally called pro-drop, where pronoun omission goes hand-in-hand with rich agreement marking on the verb (see, e.g., Chomsky 1981). The person, number and sometimes gender of the subject is indicated by the morphology on the verb, rendering the independent pronoun in a sense superfluous. This type of pro-drop is analyzed as pronoun incorporation in LFG: the agreement morpheme doubles as an incorporated pronoun.

Section 2 spells out the basics of this incorporation analysis of pro-drop, where the so-called agreement marker is in fact ambiguous between an agreement morpheme and a pronoun. When the independent pronoun is absent (‘dropped’), the morpheme is analyzed as a pronoun whose form is morphologically incorporated into the head. When the independent pronoun is present, the morpheme merely agrees with it.

Section 3 provides examples of pro-drop that illustrate the richness of the phenomenon. The term pro-drop is often used to refer exclusively to the omission of a subject pronoun, as in Italian, but the phenomenon is in fact not limited to subjects of finite verbs: any instance of INDEX agreement (Haug 2023 [this volume], Wechsler & Zlatić 2003) can involve pronoun incorporation.

Section 4 discusses the LFG analysis of pro-drop in light of the standard view of how agreement marking emerges through language change. The section reviews previous work which argues that the standard LFG analysis, positing ambiguity between agreement markers and pronouns, is natural given the grammaticalization path from independent pronoun to bound agreement morpheme.

Section 5 explores ambiguous forms that have grown apart beyond their mere status as pronoun or agreement marker. Many puzzling agreement phenomena from a variety of languages can be explained by the insight that the pronoun/agreement ambiguity assumed in LFG pro-drop analyses can lead to more radical differences between lexical entries that share a form.

Finally, Section 6 turns to a brief discussion of DISCOURSE PRO-DROP and TOPIC DROP. These two types of pro-drop have received less attention in the LFG literature, and, it seems, in the linguistics literature more generally. These types of pro-drop are not tied to rich agreement and therefore tend to be analyzed with different syntactic mechanisms than the Italian-style pro-drop that is the main concern of this chapter.

Reflecting the majority of LFG research concerned with pro-drop, this chapter focuses on the morphosyntactic aspects of pronoun incorporation. However, discourse-pragmatic factors are also highly relevant for a full understanding of the phenomenon. In cases where pro-drop is syntactically optional, the distribution of pronouns is determined by discourse factors. This is illustrated by the Spanish examples in (2) provided by Pešková (2013). In (2a), the independent subject *yo* of the second verb is obligatorily expressed, but in (2b), the inclusion of a subject before the second verb would be infelicitous on the intended interpretation where *Pedro* is the subject of both verbs:

(2) Spanish

a. Juan habla checo, pero yo hablo
John speak.3SG.PRES.IND Czech but I.NOM speak.1SG.PRES.IND
eslovaco.
Slovak
'John speaks Czech, but I speak Slovak.'

b. Pedro canta y toca la guitarra.
Peter sing.3SG.PRES.IND and play.3SG.PRES.IND the guitar
'Peter sings and plays the guitar.'

Example (2a) differs from (2b) in that the subject of the second verb in (2a) is a contrastive topic, and contrastive topics are cross-linguistically often marked by emphatic forms or stress. In Spanish and many other languages, pro-drop only occurs when an appropriate antecedent is readily accessible in the discourse context. However, establishing what counts as an appropriate antecedent is non-trivial and seems to vary across languages and dialects (see Alonso-Ovalle et al. 2002; Holmberg 2010; and references provided in those works).

The pragmatic aspect of pro-drop has been addressed within the LFG literature. For example, Dahlstrom (1991: Chapters 4–5) shows that Plains Cree independent pronouns are only included when they are used contrastively. A few other LFG proposals that address pro-drop at the discourse-pragmatic level are referred to in Section 6. However, unlike the morphosyntax of incorporation-style pro-drop (the Italian, Spanish and Finnish type), there is no unique analysis of the discourse factors that is uniformly adopted across the LFG community, and the important question of exactly when "optional" pronouns are expressed will therefore not be discussed in detail.

2 Pronoun incorporation and agreement in LFG

The standard analysis[1] of pro-drop in LFG posits that the person and number morphology on the head (which is typically a verb) *is* the pronoun. The "agreement" morphology can thus be thought of as an incorporated pronoun when no corresponding independent pronoun or NP is present in the string. This has been the basic analysis of regular pro-drop in LFG since Fassi Fehri (1984, 1988, 1993) and Bresnan & Mchombo (1987). However, the insight predates Fassi Fehri, Bresnan and Mchombo and indeed the LFG framework. The same underlying idea has long been adopted by some traditional grammarians describing languages with prolific pro-drop. It is, for example, implicity assumed by Ashton (1944), who notes in her Swahili grammar "…in a Bantu language function is more important than form, and one affix often has more than one function" (1944: 8).

The formal LFG analysis of pro-drop does not actually involve dropping or deleting a pronoun. There is no phonologically null pronoun present in the phrase structure. There is also no movement involved: the pronominal information is not assumed to have moved into the verbal position in order to be incorporated into the verb.

The separation of constituent structure (c-structure) and functional structure (f-structure) is key to understanding how LFG models pro-drop. C-structure and f-structure concern different aspects of syntactic structure. C-structure is typically modeled using phrase structure trees and displays information about syntactic category (e.g., noun, verb), word order and constituency. F-structure is modeled as feature structures (attribute-value matrices, AVMs) that contain information about formal features such as tense and case. Importantly, LFG also models syntactic functions (e.g., SUBJECT, ADJUNCT) using f-structures.

The basic LFG analysis of pro-drop is described in Haug 2023 [this volume] and will also be illustrated here with the help of example (3) from Finnish (Finno-Ugric):[2]

(3) Finnish

Join	kahvia.
drink.PAST.1SG	coffee.PART

'I drank coffee.'

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[1] Alternative analyses of pro-drop have been proposed within LFG; see Alsina (2020) for a recent example.

[2] The examples given here are from standard Finnish, which is the variety used in formal settings and in writing. Pro-drop is in fact less common in informal Finnish. Moreover, the discussion here only covers first and second person pronouns; third person pro-drop in Finnish is more constrained (Holmberg forthcoming).

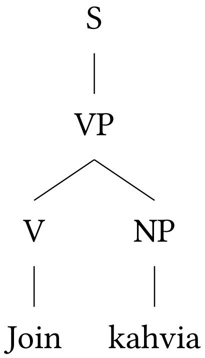
Finnish verbs inflect for three persons and two numbers. The full past tense paradigm for *juoda* 'to drink' is given in (4):

(4) *juoda* 'to drink' (Finnish)

SG	1	*join*
	2	*joit*
	3	*joi*
PL	1	*joimme*
	2	*joitte*
	3	*joivat*

The verb forms provide information about the subject's person and number. In an example like (3), there is no syntactically independent subject. A standard LFG analysis would postulate that the morphological information concerning the subject on the verb *is* the subject. The c-structure and f-structure of (3) are given in (5):

(5) C-structure and f-structure for (3)



$$\left[\begin{array}{ll} \text{PRED} & \text{`DRINK}\langle\text{SUBJ, OBJ}\rangle\text{'} \\ \text{TENSE} & \text{PAST} \\ \text{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{`COFFEE'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \\ \text{CASE} & \text{PARTITIVE} \end{array}\right] \\ \text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{`PRO'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 1 \end{array}\right] \end{array}\right]$$

The verb *join* in (3) is not formed in c-structure or f-structure; it is fully formed in the lexicon.[3] The c-structure does not have access to the internal structure of *join*: the terminal nodes in the phrase structure are morphologically complete words.

The mapping between c-structure and f-structure is not necessarily one-to-one; it allows for mismatches. Several f-structures can therefore receive featural information from the same word. In a sentence such as (3), the main f-structure of the sentence (the outer f-structure) and the subject f-structure both receive information from the verb *join*:

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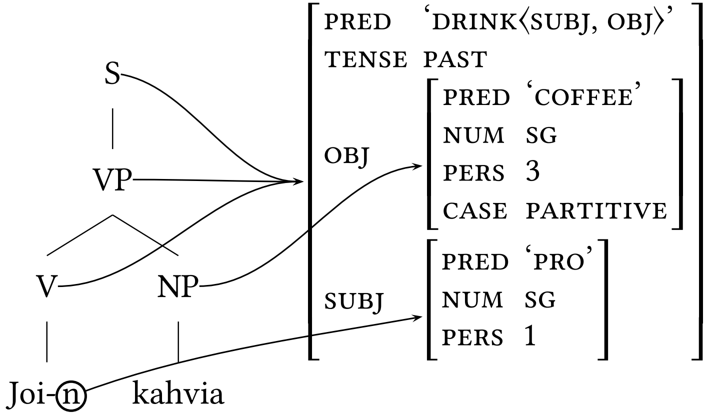
[3] The modular architecture of LFG is compatible with different theories of morphology (Dalrymple 2015, Dalrymple et al. 2019: Chapter 12; Bond 2016).

(6) Mapping between c-structure and f-structure, example (3)

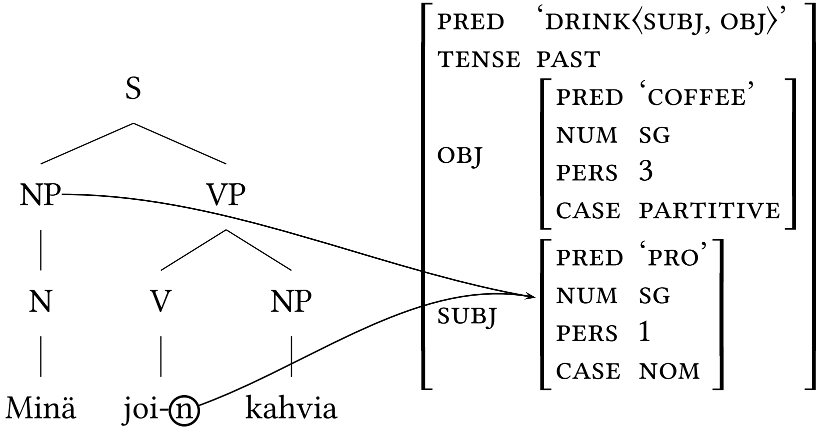


Information from several different words can also map onto the same f-structure. For example, in the Finnish sentence (7), information about the subject comes from both the pronoun *minä* and the agreement morphology on the verb.

(7) Finnish
Minä join kahvia.
I.NOM drink.PAST.1SG coffee.PART
'I drank coffee.'

The c-structure and f-structure for (7) are provided in (8):

(8) Mapping between c-structure and f-structure, example (7)



In sum, in Finnish and other subject pro-drop languages, the pronominal subject information can be provided by the morphology on the verb alone (as in (3)) or from the subject and the verb jointly (as in (7)).

According to the LFG analysis outlined above, the first person singular ending *-n* has a different function in (3) than in (7). In (3), the ending is the pronoun, but in (7) it is a mere agreement marker. In pro-drop languages, the agreement morphology thus doubles as pronominal incorporation. Central to capturing this dual function formally is the PRED feature: pronouns have a PRED feature and agreement markers do not. The PRED feature value is a SEMANTIC FORM and is therefore of a different nature than other feature values:[4] it is an indicator of the semantics of the form and it also contains information about its possible argument structure (Bresnan et al. 2016: Chapter 4), although fuller treatment of these aspects is given at the independent grammatical levels of argument structure and semantic structure.[5] The PRED feature also differs from other features in that its value is unique and can therefore not unify with another PRED feature, even if it is identical. This characteristic is crucial for understanding pro-drop in LFG, as will be illustrated below.

The lexical entry for the Finnish first person singular ending *-n* is provided here:

(9) *-n* (↑ SUBJ NUM) = SG
(↑ SUBJ PERS) = 1
((↑ SUBJ PRED) = 'PRO')

The first two lines of the lexical entry indicate that the subject of the verb hosting the ending *-n* is singular and first person. The third line states that a PRED feature with the value 'pro' (a pronominal referential feature) is optionally contributed to the subject. The parentheses indicate the optionality. The optional feature in effect yields two very similar yet not identical lexical entries, one with a PRED feature and one without:

(10) (a) *-*n_1 (↑ SUBJ NUM) = SG
(↑ SUBJ PERS) = 1
(↑ SUBJ PRED) = 'pro'

(b) *-*n_2 (↑ SUBJ NUM)= SG
(↑ SUBJ PERS) = 1

The ending *-n* maps onto the SUBJ f-structure and cannot combine with an independent subject that is not first person singular, as that would violate the LFG principle of UNIQUENESS. Uniqueness states that every attribute has a unique value. Since LFG allows feature unification, the *-*n_2 ending in (10b) can combine its PERS and NUM values with those of the independent pronoun *minä* where

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[4] Formal syntactic features such as TENSE and NUM take symbols such as PAST and PLURAL as values. Features can also take feature structures as values. For example, the values of grammatical function attributes (e.g., SUBJ, OBJ) are feature structures. Different types of features are illustrated in the f-structures above.

[5] For more references and discussion of the PRED feature, see Dalrymple et al. (2019: Section 8.2).

there is no feature conflict, but not with those of the pronoun *te* 'you (plural)', for example. The lexical entries for *minä* and *te* are given in (11a) and (11b), respectively:

(11) a. *minä* $(\uparrow \text{PRED}) = \text{`PRO'}$
$(\uparrow \text{NUM}) = \text{SG}$
$(\uparrow \text{PERS}) = 1$
$(\uparrow \text{CASE}) = \text{NOM}$

b. *te* $(\uparrow \text{PRED}) = \text{`PRO'}$
$(\uparrow \text{NUM}) = \text{PL}$
$(\uparrow \text{PERS}) = 2$
$(\uparrow \text{CASE}) = \text{NOM}$

The second person plural pronoun *te* will not co-occur with the first person singular *-n* because of the mismatch in features. The first person singular *minä* does co-occur with *-n* (see (7), for example). There is no mismatch in PERS or NUM, and *minä* can occur with the agreement marking ending in (10b). However, as mentioned above, each PRED value is assumed to be unique, and the pronoun *minä* can therefore not map onto the same f-structure as the pronominal *-n* ending in (10a), which itself contributes a PRED feature. The PRED feature of *minä* would also be 'PRO', but since every PRED feature value is unique, the two cannot combine. The single quotes around the semantic form indicate that it is unique. The uniqueness is sometimes also indicated with a subscript notation.

Again, the agreement marker *-n*$_2$ in (10b) can co-occur with *minä*: *-n*$_2$ has no PRED feature that could clash with the PRED feature of *minä*, the PERS and NUM features match and can unify, and the CASE feature is contributed by *minä* alone. In fact, *-n*$_2$ would have to co-occur with some lexical entry in the string contributing a PRED feature, otherwise the f-structure of the sentence would end up containing a SUBJ feature without a PRED. This is only acceptable for syntactic arguments that are not semantic arguments (e.g., expletives). Each semantic argument needs a PRED feature, by the LFG principle of completeness. The following formulation of completeness is provided by Bresnan et al. (2016: 62):

(12) COMPLETENESS:
i. Every function designated by a PRED must be present in the f-structure by that PRED.
ii. If a designator $(\uparrow \text{GF})$ is associated with a semantic role by the PRED, the f-structure element satisfying the designator must itself contain a semantic feature [PRED v].

The features provided by *minä* will map onto the SUBJ function at f-structure by the regular mapping principles between c-structure and f-structure (Bresnan et al. 2016: Chapter 4), and so will the features provided by -n_1. In terms of feature content, the only difference between *minä* and -n_1 is that *minä* has a nominative CASE feature. The two entries are strikingly different in form: one is an independent word and the other a bound morpheme, and they also differ phonologically. However, the entries are nevertheless almost identical in terms of the feature content they contribute to f-structure. Since both *minä* and -n_1 have a PRED feature 'pro', they both function as pronouns, despite the differences in morphophonological realization. The LFG parallel architecture allows for the possibility that forms look different at c-structure but nevertheless have the same function at f-structure.

LFG also allows for mismatches in the other direction: same form, different function. This is illustrated by the ambiguity of the *-n* form. The optionality of the PRED feature has an important effect on the function of the *-n* morpheme: -n_1, with a PRED 'pro' feature, is a pronoun, and the ending -n_2, without a PRED feature, is an agreement marker.

The examples considered concern subjects. The pronominal possessors in standard Finnish also display pro-drop, as illustrated in (13). The possessive suffix (*-ni* for first person singular) is obligatory but the independent pronoun is optional:[6]

(13) Finnish

a. (Minun) auto-ni on vanha.
my car-1SG.Px is old
'My car is old.'

b. *Minun auto on vanha.
my car is old

Just like subject pro-drop, the analysis of possessor pro-drop relies on the PRED feature of the possessive suffix *-ni*. The suffix contributes a PRED 'pro' feature when it stands alone, and it lacks a PRED feature when it is doubled by the independent pronoun *minun*.

Examples of object pro-drop are also attested cross-linguistically. Object pro-drop is common across the Bantu languages, for example (Bresnan & Mchombo 1987, Hualde 1989, Barrett-Keach 1995, Riedel 2009, a.o.). The examples below,

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[6] However, there are varieties of Finnish where the example in (13b), without the suffix, is grammatical.

adapted from Hualde (1989), are from the Bantu language KiRimi (also known as Nyaturu):[7]

(14) KiRimi

a. N-a-kU-on-aa (veve).
1-TNS-OM-saw-FV you
'I saw you.'

b. *N-a-on-aa veve.

Parallel to the Finnish subject and possessor examples above, the object markers that agree with independent pronouns in KiRimi are obligatory, while the independent pronouns themselves are optional. The analysis presented above can be applied in this case as well: the prefix *-kU-* has an optional PRED 'pro' feature and contributes its PRED feature only when *veve* is absent.

3 Pronominal marking across languages

This section explores some of the different ways languages make use of morphology on the head to provide information about dependents. The previous section presented the standard LFG analysis of pro-drop, which rests on the insight that the morpheme on the head has a dual function as an agreement marker and an incorporated pronoun. Of course, this does not mean that agreement morphemes *must* be able to double as pronouns. The English third person singular marker on present tense verbs (*-s* in *Mia walks*) functions solely as an agreement marker, for example. Like English, French does not allow pro-drop, even though French verbs display more detailed subject agreement marking than English, especially in the written forms. The paradigm for the verb *finir* 'to end, to finish' in (15) serves as an illustration:

(15) *finir* 'to end, to finish' (French)

SG	1	*finis*
	2	*finis*
	3	*finit*
PL	1	*finissons*
	2	*finissez*
	3	*finissent*

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[7] FV in the gloss stands for "final vowel". This "final vowel" in Bantu has received some attention in the literature for reasons not relevant here.

In LFG terms, the subject endings on French and English verbs are mere agreement markers that do not have PRED features, not even optional ones. Rich agreement without pro-drop is cross-linguistically very rare (Siewierska 1999).

Conversely, an incorporated pronoun does not necessarily double as an agreement marker. For example, Bresnan & Mchombo (1987) argue that object markers in the Bantu language Chicheŵa are unambiguously incorporated pronouns.[8] Chicheŵa object markers are exemplified by the morpheme *chí* in (16) (Bresnan & Mchombo's example (12)):

(16) Chicheŵa
Fîsi anadyá chímanga. Á-tá-chí-dya, anapítá ku San Francîsco.
hyena ate corn(7) he-SERIAL-it(7)-eat he-went to San Francisco
'The hyena ate the corn. Having eaten it, he went to San Francisco.'

The object marker *chí* is specified as noun class seven,[9] and is naturally interpreted as referring back to 'corn' in (16). It is possible to also include a freestanding pronoun as in (17) (Bresnan & Mchombo's example (13)) below, but the pronoun is then not interpreted as referring back to the 'corn' object from the previous sentence:

(17) Chicheŵa
Fîsi anadyá chímanga. Á-tá-chí-dya icho, anapítá ku San Francîsco.
hyena ate corn(7) he-SERIAL-it(7)-eat it he-went to San Francisco
'The hyena ate the corn. Having eaten it (something other than corn), he went to San Francisco.'

The grammatical object in the second sentence of (17) is the object marker, and the independent pronoun *icho* is a topic anaphorically linked to the object. In Chicheŵa, independent pronouns are used only for introducing new topics or for contrast (Bresnan & Mchombo 1987: 748).

Object markers can also co-occur with NPs headed by non-pronominal nouns:

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[8] Bresnan & Mchombo (1987) use the term ANAPHORIC AGREEMENT for markers that have a pronominal function and GRAMMATICAL AGREEMENT for markers that have a mere agreement marking function and no referential properties.

[9] Bantu languages are well-known for their rich noun class (gender) system; see Katamba (2003) for an extensive overview. Chicheŵa has 18 noun classes that are listed in Bresnan & Mchombo (1987: Table 1). Agreement markers and pronouns reflect the class of the noun they agree with or refer to.

(18) Chicheŵa
Njâchi zi-ná-wá-lúm-a alenje.
bees SM-PAST-OM-bite-INDIC hunters
'The bees bit them, the hunters.'

In (18) (Bresnan & Mchombo's example (2)), *alenje* is a floating topic linked to the object marker *wá*, which is an incorporated pronoun. However, if the full NP is a regular object with no special discourse status, the object marker does not appear:

(19) Chicheŵa
Njâchi zi-ná-lúm-a alenje.
bees SM-PAST-bite-INDIC hunters
'The bees bit the hunters.'

The object marker cannot co-occur with a regular object as that would result in a 'PRED clash': they would both contribute a PRED feature value and thus violate the uniqueness principle.

Bresnan & Mchombo (1987) provide ample evidence based on word order, intonation, tonal marking and other phenomena showing that the Chicheŵa pronominal object markers differ from subject markers. Chicheŵa subjects display regular pro-drop. The subject markers are obligatory, unlike object markers. A subject marker can be an agreement marker as in (19) above or an incorporated pronoun as in (20):

(20) Chicheŵa
Zi-ná-lúm-a alenje.
SM(10)-PAST-bite-INDIC hunters
'They bit the hunters.'

The Chicheŵa data show that different classes of morphemes (subject markers and object markers) can display different pro-drop characteristics within a single language. While the object marker functions as an incorporated pronoun only, the subject marker has a dual function as an agreement marker and a pronoun.

Agreement marking often shows sensitivity to animacy. Specifically, nouns that refer to entities higher on the animacy scale are more likely to trigger agreement. This effect is observed in many Bantu languages (Riedel 2009), for example Swahili (Barrett-Keach 1995) and KiRimi (Hualde 1989). KiRimi object markers agree with animate but not inanimate objects (Hualde 1989).

KiRimi object pro-drop was illustrated in (14) in Section 2, and is further illustrated in (21). The KiRimi examples in (21–22) and (24) are from Hualde (1989).

(21) KiRimi

a. N-a-**mU**-on-aa Maria.
1-tns-om-saw-fv Maria
'I saw Maria.'

b. N-a-**mU**-on-aa.
1-tns-om-saw-fv
'I saw her.'

Like Chicheŵa subjects, the KiRimi animate object marker has a dual function as an agreement marker (21a) and a pronoun (21b). This is captured here with an optional pred 'pro' in the lexical entries for animate object markers. Inanimate object markers, on the other hand, cannot co-occur with independent objects:

(22) KiRimi

a. N-a-**ki**-on-aa.
1-tns-om-saw-fv

b. *N-a-**ki**-on-aa kItabu.
1-tns-om-saw-fv book
'I saw it.'

Inanimate object markers can function as pronouns (22a), but they cannot agree with an object (22b). KiRimi inanimate object markers thus have an obligatory pred feature, like the object markers in Chicheŵa. The lexical entry for the noun class 7 object marker *-ki-* is given in (23):

(23) *-ki-* (↑ obj pred) = 'pro'
(↑ obj animate) = −
(↑ obj pers) = 3
(↑ obj def) = +

The presence of an agreeing object marker further indicates a definite interpretation of the object. This is shown in (24a) and (24b), where the difference in interpretation is indicated by the translation:

(24) KiRimi

a. N-a-**mU**-on-aa mwalimu.
1-tns-om-saw-fv teacher
'I saw the teacher.'

b. N-a-on-aa mwalimu.
1-TNS-saw-FV teacher
'I saw a teacher.'

The object in example (24a) with the object marker receives a definite interpretation, whereas the object in (24b) without an object marker receives an indefinite interpretation. The lexical entry for the noun class 1 object marker *-mU-* is provided in (25):

(25) *-mU-* ((↑ OBJ PRED) = 'PRO')
(↑ OBJ DEF) = +
(↑ OBJ ANIMATE) = +
(↑ OBJ PERS) = 3

The PRED feature for animate *-mU-* is optional: the feature is present when the object marker is pronominal and absent when the object marker functions as an agreement marker. Both the pronoun and the agreement marker are definite: personal pronouns are in general definite, and the agreement marker ensures a definite interpretation of non-pronominal objects.

The generalizations that KiRimi object markers only double objects that are both definite and animate are captured here with simple lexical specifications and the LFG principle of uniquess. The analysis is straightforward, but it does not explain the fact that the KiRimi facts follow certain cross-linguistic generalizations: dependents that are definite and high in animacy are cross-linguistically more likely to trigger agreement on the head. We will return to this point in Section 4.[10]

Like KiRimi, Irish shows that there can be differences with respect to pronouns and agreement marking within a single paradigm. However, in Irish, the

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[10] An anonymous reviewer points out that there might be noun classes with both animates and inanimates. Hualde (1989) does not address this possibility, but the description of KiRimi noun classes in Olson (1964) indicates that noun classes 9–10 and possibly 12–13 (diminutives) include both animates and inanimates. This is corroborated by Beletskiy & Diyammi's (2010) notes on noun classes in the closely related dialect/language Isanzu. I have not found a discussion of what the agreement data are in these noun classes. Hualde makes the categorical claim that only definite animates trigger agreement. If this is correct, then each relevant prefix is best represented with two quite different lexical entries and are thus examples of LEXICAL SPLITS (discussed below in Section 5). However, Olson (1964: 171) provides a few examples where inanimate objects from class 9 ('gardens', 'beehive', 'meat') cooccur with an object marker. This would indicate that nouns referring to biological inanimates from class 9 carry a grammatical [+ANIMATE] feature. For other examples of misalignment between biological animacy and grammatical animacy, see Bayanati & Toivonen (2019) and references cited therein.

variation is not governed by definiteness or animacy, the pattern instead seems idiosyncratically determined by form. In Irish, some verb forms (synthetic forms) provide person-number information about the subject that other forms (analytic forms) do not. The following conditional paradigm from Ulster Irish is from McCloskey & Hale (1984):

(26) *cuir* 'to put' (Irish)

sg	1	*chuirfinn*
	2	*chuirfeá*
	3	*chuirfeadh sé* (masc), *chuirfeadh sí* (fem)
pl	1	*chuirfimis*
	2	*chuirfeadh sibh*
	3	*chuirfeadh siad*

The synthetic forms *chuirfinn, chuirfeá* and *chuirfimis* contain information about the pronominal subjects, but *chuirfeadh* does not. The analytic *chuirfeadh* allows the subject to be expressed independently as a pronoun (*sé, sí, sibh,* or *siadh* in (26)) or a full NP. The synthetic forms cannot co-occur with independent pronouns, as evidenced by the ungrammaticality of (27) from McCloskey & Hale (1984):

(27) Irish:
*Chuirfinn mé isteach ar an phost sin.
put.cond.1sg I in on that job
'I would apply for that job.' (intended)

The fact that independent subject pronouns are ruled out indicates that the pronominal pred features in the lexical entries of the synthetic forms *chuirfinn, chuirfeá* and *chuirfimis* are obligatory, unlike the optional subject pred 'pro' features in Finnish and Chicheŵa. The pred features contributed by the synthetic verb forms cannot unify with the pred features of independent pronouns. In second person plural and third person singular and plural, however, the verb form does not contain any information about the subject. This information is instead contributed by independent pronouns. For more examples and discussion of variation within Modern Irish, see McCloskey & Hale (1984). For detailed LFG analyses, see Andrews (1990) and Sulger (2010).

This brief overview provides a sample of the variety of patterns that pro-drop languages put on display cross-linguistically. The cross-linguistic differences are captured lexically in LFG: an incorporated pronoun has a pred 'pro' feature, an agreement marker has no pred feature, and morphemes that lead a double life as pronouns and agreement markers have an optional PRED feature. The data we have examined here illustrate that languages vary with respect to how they employ these possibilities. The data also illustrate that there can be differences within the same language between paradigms and, perhaps surprisingly, also within paradigms.

For more LFG analyses of pro-drop, drawn from a wide variety of languages and also a variety of types of pro-drop, see Dahlstrom (1991: Chapter 5) for Plains Cree subjects and objects, Sadler (1997) for Welsh subject and object clitics, Toivonen (2000, 2001) for Finnish infinitives, Strunk (2004, 2005) for nominal possessive constructions in Low Saxon, Rákosi & Laczkó (2011) for Hungarian spatial particles, Bayram (2013) for Turkish subjects and possessors, Laczkó (2017) for Hungarian possessors, and Dione (2019) for subjects in Wolof.

4 Grammaticalization

A stage where an affix is ambiguous between an agreement marker and a pronoun is unsurprising in light of the typical grammaticalization path of pronoun to agreement marker (Givón 1976, Mithun 1988, Hopper & Traugott 2003, van Gelderen 2011):

(28) independent pronoun > weak pronoun > clitic pronoun > agreement affix > fused agreement marker

The naturalness of pronoun/agreement ambiguities given the grammaticalization cline in (28) has been noted in many previous analyses of pro-drop, including Fassi Fehri (1984), Bresnan & Mchombo (1987), Austin & Bresnan (1996), Toivonen (2001), Morimoto (2002), Butt (2007), Coppock & Wechsler (2010), Barbu & Toivonen (2018) and Haug 2023 [this volume]. These authors and others have pointed out that when pronouns transition into agreement affixes, there can be a stage where the forms are not immediately reanalyzed as wholesale agreement, but instead are agreement markers when they double an NP and pronouns when they do not.

The grammaticalization cline in (28) conflates multiple linguistic dimensions. One such dimension regards the function: Does the marker have pronominal referential capacity or is it a mere agreement marker? This is modeled at f-structure in LFG. Other dimensions concern the morphophonological realization as an independent word, a clitic, a bound agglutinative morpheme, or a fused morpheme. This is modeled at c-structure, m-structure and p(rosodic)-structure in LFG. A lexical entry can in principle be ambiguous between a pronoun and an agreement marker regardless of its morphophonological realization.

The grammaticalization path in (28) therefore conflates common sequences of changes that are often but not always parallel. One sequence concerns c-structural realization:

(29) projecting word > non-projecting word > true clitic > affix > fused affix

A projecting word is a word that projects a phrase and a non-projecting word is a morphologically and phonologically independent word that does not project a phrase. A "true clitic" is here intended to refer to a form that does not project a phrase and is phonologically dependent on a host, but is not a bound morpheme. Projecting words can also be phonologically dependent on a host, which illustrates that prosody has in fact its own relevant dimension which could be separated from (29). Toivonen (2003: 45) provides examples of different types of projecting and non-projecting words and clitics. See also Lowe (2016) for a detailed treatment of clitics in LFG.

Another relevant scale concerns referential capacity:

(30) noun > pronoun > ambiguous pronoun/agreement marker > agreement marker > transitivity marker

The prosodic or phrase-structural realization in (29) is orthogonal to the scale in (30), which is a nominal scale of referential strength. This is modeled here to a large extent with the PRED feature. As seen in the sections above, nouns, pronouns and agreement markers differ in their PRED feature: nouns have a contentful nominal PRED feature, pronouns have the PRED feature 'pro', and agreement markers have no PRED feature at all. A transitivity marker is referentially very weak, as it simply indicates that there *is* an object and does not say anything about what the object refers to.

Changes along the cline in (29) tend to be closely tied to changes along (30). In Siewierska's (1999) survey of 272 languages, most pronouns (forms with obligatory PRED 'pro') are independent words; ambiguous forms (optional PRED) are small words, clitics or affixes; and pure agreement markers are affixes. However, the scales in (29) and (30) are not inherently connected. This disconnect is carefully argued for in van Rijn (2016), who draws on a sample of personal possessors from 39 different languages. She concludes that "loss of referentiality correlates with a loss in form, but in a relative rather than an absolute sense […] function and form evolve in the same direction, but need not evolve at the same pace" (2016: 233).

The insight that function and form can change independently of each other is not difficult to capture within LFG, since the framework models different types of linguistic information at distinct levels such as c-structure, p-structure and f-structure. The changes are also not difficult to formalize, and in fact the directionality of change seems natural within the framework. As explained in Bresnan & Mchombo (1987), the step from pronoun to optional agreement marker is modeled by the PRED feature changing from obligatory to optional. The step from ambiguous pronoun/agreement marker to pure agreement marker is modeled by the loss of the PRED feature. It is important to note, however, that even though this grammaticalization path is naturally modeled formally within LFG, the LFG framework does not dictate the directionality of the change. An explanation for this directionality needs to come from a substantive theory of language change. I will not provide such a theory here, but I will refer to a few insights from the previous literature.

As indicated by the hierarchies above, independent pronouns can be incorporated into the verb. Such a change does not necessarily occur, and it is not predictable exactly when it will occur. However, it is not surprising that such incorporation is common, given the fact that pronouns are typically unstressed and often positioned close to the verb. Pronouns are also often doubled by a full NP or a stressed pronoun, sometimes marked by some special morphology or intonation: *(As for) Carina, I really love her.* It is easy to see how such topic/focus NP + pronoun could come to be reanalyzed as argument NP + agreement marker. For example, recall that Chicheŵa object markers are incorporated pronouns that can double an object that is a discourse topic (Bresnan & Mchombo 1987). The string SUBJECT verb-*pronoun* TOPIC (where the TOPIC and the pronominal OBJECT are co-referential, e.g., (18)) could then in principle easily be reanalyzed as SUBJECT verb-*agreement* OBJECT. Bresnan & Mchombo (1987) indicate that this is precisely what has happened in some other Bantu languages, for example Makua. In light of this, it also makes sense that many agreement markers cross-linguistically agree exclusively with arguments that are high in topicality (Comrie 1981, Woolford 1999, Coppock & Wechsler 2010, Dalrymple & Nikolaeva 2011): it follows from the observation that the pronouns that were reanalyzed as agreement markers originally doubled topics. Since topics tend to be animate (Comrie 1981: 225; Arnold 2013, among others), it is also unsurprising that animates are more likely to agree than inanimates.

Other cross-linguistic observations follow from the very fact that agreement markers used to be pronouns. Agreement marking is often restricted to definite or specific arguments (see, e.g., the discussion of Romanian below). Personal pronouns are in general inherently definite and specific, so it is easy to see how such restrictions could remain when the markers lose their pronominal status.

Several cross-linguistic tendencies thus follow from an understanding of the history of agreement marking: agreement can be restricted to topics and to nominals with animate, definite or specific reference. It is important to note that although these generalizations can be readily captured with the LFG formalism, the formalism itself neither predicts nor dictates these tendencies. In LFG, it would be just as easy to formally specify that only indefinites agree in a given language, for example. However, given what research in historical linguistics and psycholinguistics has shown us, it would be unlikely for such a system to emerge.

One further important cross-linguistic generalization concerns the asymmetry between subjects and objects: object agreement marking is less common than subject agreement. In fact, Siewierska (1999) argues that there is no pure object agreement marking. According to Siewierska, apparent examples of object agreement are actually cases of ambiguous marking: the agreement morphemes double as pronouns. Siewierska (1999) offers some possible explanations for this asymmetry, but stresses that those explanations are tentative. In LFG, it is formally no harder to model object agreement than it is to model subject agreement. The forms would simply lack a PRED feature, like the English and French subject agreement markers mentioned in Section 3. The explanation for Siewierska's generalization thus does not come from the LFG formalism.

In general, I assume that insights about language use and change are largely independent of the formal tools that are used to model grammar. However, it is in principle possible to formulate a substantive theory of language change that is compatible with the LFG framework and that might shed light on attested cross-linguistic generalizations.

Up until now, we have mainly focused on the role of the PRED feature. However, other features are also involved and those features can change and erode as well. Coppock & Wechsler (2010) carefully detail the loss of PRED features alongside changes affecting other features such as PERS, NUM, TOPICALITY and DEFINITENESS in different ways in the Finno-Ugric languages Northern and Eastern Ostyak (Khanty) and Hungarian. Toivonen (2001) similarly traces the change of various features that lead to differences in the possessive systems of different dialects of Finnish and Saami. These works trace historical changes that target features other than PRED features, and such changes can lead to differences that reach beyond the PRED feature when a morpheme is at the ambiguous stage. The next section is devoted to examples where the pronominal morpheme is quite different from the agreement marker, even though they are identical in form.

5 Lexical splits

The LFG approach to pro-drop presented above relies on the insight that a form can have a dual function as an agreement marker and an incorporated pronoun. This duality opens the door to the possibility that the morphemes might grow further apart due to language change: since the morphological form corresponds to two similar but distinct lexical entries (one with and one without a PRED feature), the two entries might develop separately. This is in fact cross-linguistically common, and several examples will be given in this section.

One of the first languages for which the LFG theory of pro-drop was developed was Arabic. Abdelkader Fassi Fehri explored the subject agreement system in Modern Standard Arabic as well as local varieties of Arabic in several talks and papers. Fassi Fehri (1988) shows that some of the affixes are exclusively pronominal (this is the case for the first and second person affixes) and others are ambiguous between pronouns and agreement markers. He further argues that in some cases the pronominal affix is remarkably different from the agreement marking affix, which indicates that their lexical entries differ beyond the PRED feature.

Fassi Fehri's (1988) analysis of feminine subjects in MSA will be reviewed here. Fassi Fehri shows that the affix *-at* (also sometimes *-ati* in Fassi Fehri's examples) is ambiguous. In its pronominal use, it is a third person feminine singular. However, as an agreement marker, the same affix is less restricted. For example, *-at* (here *-ati*) agrees with a plural subject in (31):

(31) Modern Standard Arabic
ja:ʔ-ati l-bana:tu
came-FEM.SG the-girls
'The girls came.'

Fassi Fehri (1988) proposes the lexical entries in (32) for the *-at* affix, indicating that the agreeing affix is only constrained by gender.

(32)

Pronoun:			Agreement:		
(↑ SUBJ PRED)	=	'pro'			
(↑ SUBJ GEND)	=	FEM	(↑ SUBJ GEND)	=	FEM
(↑ SUBJ NUM)	=	SG			
(↑ SUBJ PERS)	=	3			

Fassi Fehri (1988) further proposes that strong forms of pronouns are never directly assigned subcategorized functions in Arabic. Instead, they are always assigned the FOCUS function, which is a grammaticalized discourse function. As such, emphatic pronouns in MSA do not co-occur with the agreement marking version of *-at* even when they are feminine. It would result in a coherence violation: neither the emphatic pronoun nor the agreement marker contributes a PRED feature to the SUBJ.

The *-at* ending can be contrasted with the third person feminine plural affix *-na*, which, unlike *-at*, is a pronoun only and cannot agree:

(33) Modern Standard Arabic

a. ji:ʔ-na
came-FEM.PL.HUM
'They came.'

b. *ji:ʔ-na l-bana:tu
came-FEM.PL.HUM the-girls

The feminine plural pronoun *-na* can only co-occur with independently expressed nouns when they are topics:

(34) Modern Standard Arabic
al-bana:tu ji:ʔ-na
the-girls came-FEM.PL.HUM
'As for the girls, they came.'

In (34), the pronominal affix *-na* is the true subject. The noun *al-bana:tu* is a topic, as evidenced in part by the word order: the unmarked word order in Standard Arabic is VSO. When *al-bana:tu* precedes the verb, *-at* is not felicitous:

(35) Modern Standard Arabic
*al-bana:tu ja:ʔ-at
the-girls came-FEM.SG
(intended) 'As for the girls, they came.'

The pronominal *-at* is singular and cannot refer to the plural *al-bana:tu*. The agreement marking *-at* does not contribute a PRED feature. As the TOPIC, the NP *al-bana:tu* also does not contribute a PRED feature to the SUBJ. The agreement marker cannot alone correspond to the SUBJ function, since the subject needs a PRED feature due to the LFG completeness condition, provided in (12) above. In these specific examples, the verb 'to come' requires a subject with a semantic role, and that subject needs a PRED. In (31), *l-bana:tu* is the subject, and provides the PRED feature. In (33) and (34), the pronominal affix *-na* contributes a pronominal pred feature to the subj f-strucure. In (35), *al-bana:tu* provides a pred feature to the topic function, not the subj function. The agreement marking affix on the verb does not provide a pred feature at all.

Fassi Fehri (1988) introduces further lexical entries and also specific rules to cover the complex pronominal and agreement system in Standard Arabic. Additional examples accompanied by discussions of computational implementations of Arabic agreement are provided by Hoyt (2004) and Attia (2008). Crucial to the point here is that already one of the first treatments of pro-drop in LFG pointed out that an agreement affix can diverge from a homophonous pronominal affix in features other than just the pred feature. The agreement marking *-at* differs from the pronominal version of the same form, and Fassi Fehri captures the differences straightforwardly with the lexical entries.

Next we consider so-called 'clitic doubling' in Romanian. In Romanian, objects can be 'doubled' by a morpheme that agrees in person, number and gender. This morpheme is typically referred to as a clitic, but its morphophonological status is controversial (Dobrovie-Sorin 1994, Monachesi 1998, Popescu 2000, Luís 2004). Romanian clitic doubling is exemplified in (36), where the object *pe băiat* is doubled by the clitic *l-*:

(36) Romanian:
L-am văzut pe băiat.
3sg.m.acc-have.1sg seen acc boy
'I saw the boy.'

In some dialects of Romanian, all definite objects are doubled (Tomić 2006: Chapter 4; Tomić 2008: 84; Hill 2013, Barbu & Toivonen 2018). This is the case in the Aromanian dialect (spoken in Albania, Macedonia, Romania, Bulgaria, Serbia and Croatia) and the Megleno-Romanian dialect (spoken in Greece and Macedonia). Since the relevant pronouns are inherently definite, these dialects can be analyzed in LFG with an optional pred feature in the lexical entry for the clitic, just like most of the pro-drop examples discussed above.

However, in other dialects of Romanian, including the standard variety, doubling is restricted to *pe*-marked, human, definite objects. For example, the nonhuman direct object 'snail' in (37) cannot be doubled by a clitic:

(37) Romanian:

a. Am văzut melcul.
have.1sg seen snail.def
'I saw the snail.'

b. *L-am văzut (pe) melc.
3SG.M-have.1SG seen ACC snail

The clitic can refer to non-humans when it stands alone. For example, the *l-* in (38) can refer back to *melcul*, the snail:

(38) Romanian:
L-am văzut.
3SG.M.ACC-have.1SG seen
'I saw it/him.'

The clitic in (38) could also refer to a human participant.

The restrictions on doubling in this variety of Romanian indicate that the agreement marking clitic and the pronominal clitic differ beyond the presence or absence of the PRED feature. Barbu & Toivonen (2018) spell out the details of such an analysis, and their account is summarized here. They follow the Romanian tradition of treating *pe* as an accusative case marker (e.g., Cornilescu 2000) that is specified for human animacy, and they posit the lexical entries in (39) for the pronominal and agreement-marking clitics.

(39)

Pronoun:			Agreement:		
(↑ PRED)	=	'pro'			
(↑ PERS)	=	α	(↑ PERS)	=	α
(↑ NUM)	=	β	(↑ NUM)	=	β
(↑ GEND)	=	γ	(↑ GEND)	=	γ
(↑ CASE)	=	ACC	(↑ CASE)	$=_c$	ACC
(↑ DEF)	=	+	(↑ DEF)	=	+

The variables α, β and γ simply stand for different PERS, NUM and GEND features that vary according to which form is used: *mă/m-* for first person singular, *te* for second person singular, *îl/l-* for third person singular masculine, etc.

The two entries in (39) only differ very slightly. The pronouns have a PRED 'pro' feature and the agreement markers do not, just like we have seen in several examples above. However, there is one small but important further difference: the *case* is specified as a defining equation for the pronoun and a constraining equation for the agreement marker. The regular defining equation of the pronoun directly contributes a [CASE ACC] feature to the object f-structure. The constraining equation requires a [CASE ACC] feature, but does not itself provide it. If the feature is not provided in some other way, the agreement marker is illicit. The marker *pe* provides the ACC feature that is needed. This explains why the clitic cannot occur without *pe*. When *pe* functions as a case marker (*pe* has an additional function as the preposition 'on'), it is also specified for human animacy, and this indirectly explains why only objects with human reference can be doubled.

Tigău (2010, 2014) reports that some speakers of Romanian allow clitic doubling with indefinites:

(40) Romanian:

Petru	(l-)a	vizitat	pe	un	prieten.
Peter	3SG.M-have.3SG	visited	ACC	a	friend

'Peter visited a friend.'

Even the speakers who allow doubling with indefinite objects allow it only sometimes. Tigău (2010, 2014) argues that doubled indefinite objects get a *specific* interpretation (see also Aoun 1981: Chapter 3).

The difference between the standard variety of Romanian (captured by (39)) and the indefinite-doubling dialect described by Tigău is captured by the lexical entries in (41):

(41)

Pronoun:			Agreement:		
(↑ PRED)	=	'pro'			
(↑ PERS)	=	α	(↑ PERS)	=	α
(↑ NUM)	=	β	(↑ NUM)	=	β
(↑ GEND)	=	γ	(↑ GEND)	=	γ
(↑ CASE)	=	ACC	(↑ CASE)	$=_c$	ACC
(↑ DEF)	=	+	(↑ SPECIFIC)	=	+

In this dialect, the pronoun is the same as in the standard dialect, but the agreement marker is marked for specificity instead of definiteness.

In two of the dialects of Romanian that have been considered here, the difference between the agreement marking clitic and the pronominal clitic goes beyond the PRED feature. Again, this kind of 'split' is not unexpected under the LFG account of pro-drop, since the optional PRED feature in effect means there are two lexical entries: one agreement marker and one pronoun.

Romanian is not the only Romance language in which the agreement marking clitic and pronominal clitic are markedly distinct. Varieties of Spanish display clitic systems very similar to that of Romanian (see, e.g., Mayer 2017). Andrews (1990) and Estigarribia (2013) analyze Rioplatense Spanish within an LFG framework, and they both propose entries for pronominal clitics that differ from the agreement clitics beyond the PRED feature. Estigarribia specifically proposes that the agreement marker has a specificity feature that the pronominal clitic lacks, which would indicate that Rioplatense Spanish clitics are very similar to the Romanian clitics represented in (41).

Finnish possessive suffixes provide yet another example of 'lexical splits'. Pronominal possessors in standard Finnish are marked by an independent pronoun and a suffix on the possessed noun or by a suffix alone (42):

(42) Finnish
Jukka näkee (minun) ystävä-ni.
Jukka sees my friend-1SG
'Jukka sees my friend.'

In first and second person, the independent pronoun is optional, and our basic LFG pro-drop analysis can be employed: first and second person possessive suffixes have an optional PRED 'PRO'.

The optionality of the PRED 'PRO' in Finnish possessive suffixes was already mentioned in Section 2. However, the third person suffix displays a more significant split. When a third person independent pronoun is omitted and possession is marked by just a third person suffix, the possessor is necessarily bound by a subject within the minimal finite clause:

(43) Finnish
Jukka$_i$ näkee ystävä-nsä$_{i/*j}$.
Jukka sees friend-3
'Jukka sees his (own) friend.'

Conversely, when an independent pronoun is present, the possessor *cannot* be bound by a subject:

(44) Finnish
Jukka$_i$ näkee hänen$_{*i/j}$ ystävä-nsä.
Jukka sees his/her friend-3
'Jukka sees his/her friend.'

In Toivonen's (2000) analysis, the suffix in (43) is an anaphoric pronoun with a PRED feature, and the suffix in (44) is an agreement marker without a PRED feature. The entries further differ in that the agreement suffix is restricted to agreement with human personal pronouns (45a–45d), even though the pronominal suffix can be bound by both nouns and pronouns with human or non-human referents (45e):

(45) Finnish

a. Jukka näkee Pekan ystävän.
Jukka sees Pekka's friend.ACC
'Jukka sees Pekka's friend.'

b. *Jukka näkee Pekan ystävä-nsä.
J. sees Pekka's friend-3Px

c. Jukka näkee sen hännän.
Jukka sees its tail.ACC
'Jukka sees its tail.'

d. *Jukka näkee sen häntää-nsä.
Jukka sees its tail-3Px

e. Se/koira$_i$ heiluttaa häntää-nsä$_i$.
It/dog wags tail.PART-3Px
'It/the dog is wagging its tail.'

The Finnish pronominal possession system thus provides a further example where pro-drop involves two homophonous but syntactically quite distinct lexical entries: one agreement marker and one pronoun. In the case of Finnish third person possessive suffixes, the pronoun is anaphorically bound and has no animacy restrictions. The agreement marker agrees only with personal, human pronouns that are not anaphorically bound. For a lexical formalization similar to the analyses of Arabic subject markers and Romanian object clitics outlined above, see Toivonen (1996, 2000). For a different analysis, and also more data and references as well as a critique of the LFG analysis, see Humarniemi & Brattico (2015).

The final language we will consider in this section is Pakin Lukunosh Mortlockese. The Mortlockese data and generalizations come from Odango (2014). Odango argues that the third person singular object marker in this Micronesian language shows a split between incorporated pronoun and transitivity marker. He further shows that other object suffixes (the first and second person suffixes and the third person plural suffix) do not involve a split; they function exclusively as incorporated object pronouns (Odango uses the term 'anaphoric agreement', following Bresnan & Mchombo 1987). Example (46) illustrates the second person singular object suffix, which cannot co-occur with an independent pronoun:

(46) Mortlockese
I=aa wor-o-k (*een).
1sg.sbj-realis see-th-2sg.obj 2sg
‘I see you.’

The third person singular marker is also an incorporated pronoun when there is no independent object:

(47) Mortlockese
anga-i-tou mwo
take-3sg.obj-downward please
‘Please take it down.’

The object marker is translated here as *it*, but it can also be translated as *him* or *her*. The pronominal third person singular marker has a pred feature ‘pro’.

Unlike the other object suffixes, the third person singular suffix can co-occur with an object. When it does, there are no number restrictions on the object. Odango argues that the suffix is a *general transitivity marker* when it co-occurs with an object. In (48), the suffix agrees with a third person plural object:

(48) Mortlockese
Ngaan i=sán mwo shuu-{nge-i/*nge-er}
1sg.emph 1sg.sbj=neg.pot yet meet-th-3sg.obj/th-3pl.obj
mwáán=kewe.
man=dist.pl
‘As for me, I have not yet met those men.’

Note that the third person plural marker is not admissible in (48), because it functions solely as a pronoun with a pred ‘pro’ and can therefore not co-occur with the object *mwáán=kewe*.

According to Odango, the transitivity marking suffix is generally limited to third person for many speakers, but some speakers also accept examples where the transitivity marker co-occurs with a first or second person independent pronoun.[11] He provides the following example, which is accepted by some younger speakers:

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[11] The independent pronouns only appear with borrowed verbs and a few verbs that cannot be inflected (Odango 2014).

(49) Mortlockese
R-aa wér-e-i kiish.
3pl.subj-realis see-th-3sg.obj 1pl.incl
'They see us (incl.).'

For most speakers, however, it seems that the transitivity marker is restricted to third person. Odango (2014) reports on one further restriction on the use of the transitivity marker: it seems to be restricted either for definiteness or specificity. Odango also points to interesting age and geographical variation regarding the exact use of the marker. The variation details are interesting, but they will nevertheless be set aside here.

The basic generalization that the third person singular object marker has split into a pronominal suffix and a transitivity marker is clear. Odango (2014) ties his discussion to Bresnan & Mchombo (1987), but he does not provide a formal analysis of Mortlockese. However, the generalizations he provides evidence for can be captured by the following lexical entries for the marker *-i*:

(50)

Pronoun:			Transitivity marker:		
(↑ obj pred)	=	'pro'	(↑ obj definite)	=	+
(↑ obj pers)	=	3	(↑ obj pers)	=	3
(↑ obj num)	=	sg			

The lexical entries in (50) are tentative but serve to illustrate the relevant lexical split. The pronominal version of the third person singular suffix is straightforward. Since it provides a pred feature, it cannot co-occur with an independent object. However, the transitivity marker version of the suffix *requires* an independent object. The presence of (↑ obj) features ensures the presence of an obj function in the f-structure corresponding to the verb that the ending is attached to. This object function needs a pred feature because of the completeness condition, and this feature is provided by an appropriate object in the c-structure. The lexical entry for the transitivity marker includes a third person object feature. However, for speakers that allow it to co-occur with first and second person pronouns (see (49)), the lexical entry will not include a pers feature. I assume here that the transitivity marker is specified for definiteness, but Odango hints that it is unclear whether the relevant feature is definiteness or specificity. It is possible that this point is also a matter of speaker variation. In any event, the transitivity marking entry can be modified to include a specificity feature instead of a definiteness feature.

Although the Pakin Lukunosh Mortlockese data involve variations and points to be further investigated, it is clear that the third person singular object marker involves a split. Odango argues that the split is between a pronoun and a transitivity marker. From a historical perspective, the emergence of this split is unsurprising: object markers often grammaticalize into transitivity markers, sometimes via object agreement marking (Lehmann 2002, Mayer 2017, Widmer 2018).

In sum, a pro-drop analysis where an incorporated morpheme is assumed to have a dual function and correspond to both an agreement marker and a pronoun leads to the prediction that the two versions of the morpheme can change independently and grow further apart. This section has considered multiple examples that indicate that such cases do, in fact, occur. The examples we have considered come from Standard Arabic subject marking, Romanian object clitic doubling, Finnish possessive marking, and Mortlockese object marking. In the first three cases, the pronominal version of a morpheme displays different characteristics than the corresponding agreement-marking morpheme. In the Mortlockese case, we adopted Odango's proposal that the non-pronominal version of the third person singular incorporated pronoun is a transitivity marker.

6 Pro-drop without agreement marking

The focus of this chapter has been on cases where information about the dropped arguments is encoded on the head as an incorporated pronoun. However, sometimes pronouns are omitted even though there is no corresponding morphology on the head. This is the case in DISCOURSE PRO-DROP. Some LFG work on this type of pro-drop will be briefly reviewed in this section, even though it does not involve morphological pronoun incorporation.

Chinese and Japanese lack morphological agreement marking but nevertheless allow argument omission. A Cantonese example, originally from Luke et al. (2001), is given in (51):

(51) Cantonese (Talking about dogs)

wui5-m4-wui5	beng6	gaa3
will-not-will	ill	PART

'Would (they = the dogs) get ill?'

This kind of pronoun omission is referred to as DISCOURSE PRO-DROP or RADICAL PRO-DROP. Discourse pro-drop is substantially different from pro-drop linked to agreement (Neeleman & Szendrői 2007, Sigurðsson 2011, Irgens 2017),[12] although

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[12] Discourse pro-drop has been argued to in fact resemble general nominal ellipsis more than pro-drop (Irgens 2017).

they occur under similar pragmatic conditions, which are also conditions under which omission of weak pronouns occur in the Germanic languages (Sigurðsson 2011, Rosén 1998: and references therein). Focussing on omitted subjects, Luke et al. (2001) analyze Cantonese discourse pro-drop in LFG. They propose specific discourse-pragmatic criteria to explain how empty subjects receive an interpretation. They also posit an empty subject node in the c-structure, which renders their analysis unusual from a mainstream LFG perspective, where empty c-structure material is avoided since it is deemed unnecessary and computationally costly.

Rosén (1998) develops a different LFG analysis for Vietnamese. Vietnamese allows the subject, object and second object (OBJ$_{\theta}$) to be dropped, even though there is no morphology on the head to indicate the characteristics of the omitted element. Two examples from Rosén (1998: 146) are given in (52):

(52) Vietnamese

a. Ăn ít cỏ lắm.
eat few grass very
'(It) eats very little grass.'

b. Ông Ba tặng một bó hoa hồng hôm nọ.
Mr. Ba give one bunch flower pink day other
'Mr. Ba gave (her) a bunch of roses the other day.'

In Rosén's analysis, the dropped pronouns (*it* and *her* in the examples above) are not represented in the c-structure. In the f-structure, they are represented as the relevant grammatical functions. The PRED 'pro' features are contributed by optional equations in the phrase structure rule for S for the SUBJ and the VP rule for OBJ and OBJ$_{\theta}$. The f-structures of Vietnamese examples with pro-drop will thus look quite similar to examples where the c-structure does contain expressed pronouns, and also similar to the f-structures of Italian-style pro-drop languages, where other morphology provides the pronominal information. A difference is that the f-structures for the pro-dropped grammatical functions in Vietnamese do not contain person and number information. The key to understanding how empty pronouns assign reference in Vietnamese lies in semantic structure (s-structure) and discourse structure (d-structure), according to Rosén. Like the f-structure information, the semantic schemata needed for the s-structure of the unpronounced pronoun are contributed by the c-structure rules. These schemata include basic semantic information, such as specifications regarding the argument-function mapping.

Rosén (1998) stresses that the interpretation of the dropped pronouns does not depend on guessing. According to Rosén (1998: Chapter 7), one condition for pronoun omission is referential givenness, meaning the existence of a presupposition of unique reference. Another important condition is relational givenness: the intended referent is clear with relation to the verb in context.[13] This is, for example, the case when the verb is the same as in an immediately preceding context. In this case, the participants of the event referred to by the verb remain the same and can be omitted. For example, if someone asks *Did Sarah cook the meat?* and the response repeats the verb *cooked*, no pronouns are included in Vietnamese as it is clear that the participants remain the same. Another example of relational givenness would be *Sarah bought some meat and (she) cooked (it)*, where in the Vietnamese equivalent both the subject and the object pronoun can be omitted. The use of empty pronouns signals that the speaker is sure that the propositional content makes clear which referents to supply for the arguments (Rosén 1998: 137).

Butt & King (1997) show that pro-drop in Hindi/Urdu is not necessarily tied to agreement, and like Rosén, they argue for a discourse-based account. They argue that pronouns can only be omitted if they are continuing topics or backgrounded information, and they model their analysis on the independent linguistic level of i(nformation)-structure.[14] Butt (2007) extends Butt & King's analysis to Punjabi. The analyses developed by Butt & King (2000), Luke et al. (2001) and Rosén (1998) differ significantly from each other, and this indicates that there is room for more (perhaps cross-linguistic) research on discourse pro-drop within LFG. In general, discourse structure has received less attention in LFG than other levels of linguistic representation, but see King & Zaenen (2004), Dalrymple et al. (2018), and references cited in those works for important proposals.

Yet another type of pronoun omission is topic drop, which is found in several Germanic languages and illustrated in the Swedish example in (53):

(53) Swedish
Kommer kanske att sakna det.
come perhaps to miss it
'[I/We/They...] will perhaps miss it.'

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[13] According to Rosén's formal analysis of the discourse conditions, empty pronouns must always be part of the tail value at d-structure, where the tail is understood as the s-structure of the sentence minus the value of the link and the focus.

[14] Rosén (1998) uses the label d(iscourse)-structure and Butt & King (1997) use i(nformation)-structure to formalize the same type of phenomena. Zaenen 2023 [this volume] provides a comprehensive overview of LFG research on i-s and d-s in LFG. She reserves the term i-s for sentence-internal information, and d-s for larger units of discourse.

Swedish verbs bear no agreement and the interpretation of the dropped elements is provided by the context. In these two respects, topic drop is similar to discourse pro drop. However, topic drop is more restricted and only elements in the left periphery of the sentence can be dropped (Neeleman & Szendrői 2007, Sigurðsson & Maling 2008, Sigurðsson 2011). Topic drop has not been treated extensively in LFG, but Berman (1996) provides an analysis of the phenomenon in German.

7 Summary

The focus of this chapter has been the LFG theory of pronominal incorporation and the interactions between nouns, independent pronouns, incorporated pronouns, and agreement markers. The analysis of regular pro-drop centers on the person, number and gender marking on the head, which is often ambiguous between an agreement marker and a pronoun. In other words, the marker is an incorporated pronoun, or else it simply agrees with an independent pronoun or noun.

Languages vary with respect to exactly how pronominal information is expressed morphosyntactically, and many different systems have been captured with LFG analyses that take the basic agreement marker-pronoun ambiguity as its starting point. The overview of the literature provided in this chapter illustrates how the typological diversity can be formally understood by appealing to features, feature unification and the mappings between independent linguistic levels.

The LFG theory of pronoun incorporation and pro-drop aligns well with the research on the grammaticalization of pronominal forms and agreement marking. In Section 4 it was argued that although LFG does not technically offer substantive historical explanations, the framework provides formal tools which are suitable for modelling the attested diachronic changes and trends.

Ambiguity between agreement marker and pronoun can give rise to changes that further differentiate between pronominal and agreement morphemes. Such drifts are not uncommon, as illustrated by the examples in Section 5. Many languages have agreement morphemes that differ in clear and significant ways from incorporated pronouns. For example, the Finnish third person possessive suffix is restricted to non-anaphoric human personal pronouns in its agreement use, but it has no animacy restrictions and must be anaphorically bound in its pronominal use.

Finally, Section 6 of this chapter briefly reviewed some LFG accounts of pro-drop that do not involve pronominal incorporation or any morphology indicating the person and number of the omitted discourse participant. These cases are interesting for many reasons. First, they illustrate the importance of discourse-pragmatic principles for pronominal interpretation. Second, these cases pose an interesting challenge for the theory of LFG f-structure. The principle of completeness dictates that a semantic argument needs a PRED feature, and it is not obvious where that feature comes from in cases of discourse pro-drop, where the participant does not have a phonological realization in the linguistic string.

In conclusion, the basic LFG theory of pronominal incorporation and agreement that was first formulated by Fassi Fehri (1984, 1988) and Bresnan & Mchombo (1987) is still adopted today. Over the past four decades, that theory has been used as a tool to gain insight about the details of pro-drop in a large number of languages.

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Chapter 14

Raising and control

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Raising and control are classic topics that have had a key role in theoretical debates since the early days of transformational grammar. In this chapter we examine these structural patterns, taking into account cross-linguistic variation and with a particular focus on the way the phenomena in question have been analysed within LFG and the differences between LFG and other theoretical frameworks.

1 The phenomena: raising, control and complementation

The terms RAISING, in reference to the examples in (1), and CONTROL, for those in (2), label different types of relation that may hold between a governing verb and its complement.

(1) a. The teacher seemed to like the students.
b. The students believed the teacher to like them.

(2) a. The teacher tried to help the students.
b. The students persuaded the teacher to help them.

On the surface these look very similar: a verb immediately followed by an infinitival complement in (1a) and (2a), and a verb followed by an NP and an infinitival in (1b) and (2b). However, a moment's inspection is enough to reveal fundamental differences. While (2b) does mean that the students persuaded the teacher, (1b) says nothing about whether the students believed the teacher. At the same time in both (1b) and (2b) the NP *the teacher* responds to standard diagnostics for objecthood such as replacement by the pronoun *her/him* and change of

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status to subject under passivization: *The teacher was believed to like the students* and *The teacher was persuaded to help the students.*

Considered from a semantic perspective, the essential difference here is that a raising verb like *seem* does not assign a theta-role to its external argument; rather the acceptability of a sentence with *seem* depends on the semantic compatibility of its external argument and the predicate expressed in the following infinitive. Thus, (1a) is good because *like* requires an animate, sentient being as subject and teacher fills that bill; hence by contrast the unacceptability or pragmatic strangeness of *?The blackboard seemed to like the students.* In this respect, items such as *seem* show similarities with an auxiliary or a copula like *be* or *become* and indeed they have sometimes been referred to as semi-auxiliaries or semi-copulas (Pustet 2003: 5–6). This intermediate status between a grammatical and a lexical item is often the product of historical change, a topic to which we will return in Section 13 below. By contrast, the external argument of a control (aka equi) verb such as *persuade* or *try* does identify the source of the persuasion or the effort.

Although, in common with much of the literature, we have referred above to *seem* as a raising verb, it would be more accurate to call it a raising predicate since, as has frequently been observed, a particular lexical item may give expression to more than one predicate, not all of which exhibit the same control/raising status. Thus, *appear* is sometimes synonymous with *seem*, as for instance in (3a) beside (1a), but can also occur in other contexts where *seem* is not an option, hence the contrast in grammaticality between (3b) and (3c) and the fact that (3d) is perfectly acceptable while (3e) is at best tautological:

(3) a. The teacher appeared to like the students.
b. The teacher appeared as if from nowhere.
c. * The teacher seemed as if from nowhere.
d. The teacher seemed to appear from nowhere.
e. ? The teacher appeared to seem to like the students.

In a similar vein, *wants* in (4a) is ambiguous between a reading in which Sally desires to be more diligent and one which expresses her teacher's opinion even if Sally herself has no such wish! The former is a control reading, the latter a raising reading. With a gerundial complement in (4b) only the raising option is available as also in the alternative version in (4c) attested in Scottish and some other varieties of English:

(4) a. Sally wants to work harder.
b. This shirt wants washing.
c. This shirt wants washed.

More generally, rather than a binary split between raising and control verbs, there appears to be a continuum from raising to control with different verbs in different languages ranged along it (Barron 2001: 75–79, who references an earlier discussion by Huddleston 1976). Such evidence in turn implies the importance of taking into consideration both the syntactic and semantic bases of these constructions as well as language-particular lexical idiosyncrasies. The latter, as we will see, also argue in favour of adopting a diachronic as well as a synchronic perspective.

The terms 'raising' and 'control' both go back to the early years of generative grammar and allude in an interestingly complementary way to the different perspectives that scholars have adopted in analysing examples such as those in (1) and (2). Raising implies a movement from a lower to a higher position within a syntactic representation and thus evokes the derivational type of account that LFG has turned its back on. Control by contrast refers to the relation between a dominant element and a subordinate item or position within a range of non-finite — and indeed, as we will see, some finite — contexts, but with no further implication as to how this relation is to be modelled. In other words, it is part of the more general phenomenon of coreference and identifies a relation which can hold both within complement structures, as above, and in broader syntactic contexts as in the examples in (5):

(5) a. Glad to be home again, Sally waved to her neighbours in the garden.
b. Bill called a plumber to fix the drain.
c. Sally came across Bill in the garden crying his eyes out.

In (5a) the argument that *glad* is predicated of can only be Sally and not her neighbours but the relation is determined by the clausal structure and not by any specific lexical item; in (5b) we have an optional purpose clause added to the main clause *Bill called a plumber*; in both (5b) and (5c) the modifying clauses *to fix the drain* and *crying his eyes out* are controlled by the object of the main clause. Cases such as these fall under the heading of adjunct control, a topic which we consider in more detail in Section 12 below.

The literature on these constructions, and possible analyses thereof, is vast (see Davies & Dubinsky 2004 and Landau 2013 for book-length treatments and Polinsky 2013 for a briefer but no less valuable survey), and there is now a very thorough and up-to-date account in LFG terms in Dalrymple et al. (2019: chapter 15). It is natural then to ask what more a chapter such as the present one can bring to the table. Rather than simply serving up yet another overview, we will concentrate instead on three themes, in each case seeking to show the advantages — and in some instances the problems — inherent in adopting an LFG perspective:

1. cross-linguistic and diachronic variation in control/raising structures;
2. proposals that post-date the surveys cited above, in particular the 'two-tier' model put forward in Landau (2015), the analysis of so-called restructuring verbs (Grano 2015), the treatment of partial control (Pearson 2016, Sheehan 2018a,b, Sevdali & Sheehan 2021), and the treatment of adjunct control (Donaldson 2021a,b, Landau 2021);
3. cross-theoretical comparison of LFG with other approaches, in particular on the one hand derivational accounts within versions of Minimalism and on the other the lexical semantic approach of Jackendoff & Culicover (2003) and Culicover & Jackendoff (2006).

That said, some foundations need to be laid. We begin therefore by reviewing a series of dichotomies and sub-types that have served to frame much of the literature to date (Section 2 through Section 5) before moving on to consider our chosen themes and their theoretical implications.

2 Functional vs anaphoric control

Differences of detail and interpretation aside, LFG analyses of these items and constructions all build on the classic distinction between functional and anaphoric control developed in Bresnan (1982a) and other early LFG work on the topic such as Mohanan (1983). Functional control involves identity between a controlling grammatical relation and an open function, xcomp in the case of control induced by lexical items and xadj for adjunct control. Crucially, on Bresnan's account functional control provides a means of modelling both verbs traditionally labelled as raising and equi, as can be seen in the f-structures for *seem* and *try* in (6):

(6) a. *seem* V (↑ pred) = 'seem⟨xcomp⟩subj'
(↑ subj) = (↑ xcomp subj)

b. *try* V (↑ pred) = 'try⟨subj,xcomp⟩'
(↑ subj) = (↑ xcomp subj)

These representations distinguish the raising verb *seem*, where the SUBJ is outside the brackets which enclose the semantically pertinent arguments, from the equi verb *try*, where all the arguments are inside. Otherwise put, *try* assigns a theta-role to its subject while *seem* does not.

The open XCOMP function has also been proposed as a way of modelling some copular and auxiliary constructions (Falk 1984). Thus in Maltese, where there is no copula in the present tense as in (7a) by contrast with the past (7b), one solution is to allow the PRED value ‘BE⟨XCOMP⟩SUBJ’ to be assigned either to the copula or, in its absence, to the predicate nominal. In effect, this treats these constructions as a type of raising.

(7) Maltese

a. Albert tabib
Albert doctor
‘Albert is a doctor.’

b. Albert kien tabib
Albert be.PST.M.SG doctor
‘Albert was a doctor.’

The alternative here, and one perhaps more consistent with traditional accounts of copulas as items that connect subjects and predicates of various grammatical kinds, would involve the closed function PREDLINK and a copula with the PRED value ‘BE⟨SUBJ,PREDLINK⟩’ (for more discussion of these options and the conclusion that no single account will cover all cross-linguistic copular patterns, see Dalrymple et al. (2019: 189–197)).

A further possibility, which we will not discuss here, is to permit control into some object and oblique structures, an account that involves postulating open variants XOBJ and XOBL of the standard closed functions OBJ and OBL (Falk 2005).

In contrast to these lexically determined structures, an example like (5a) requires a statement of the relational equivalence within the relevant PS rule rather than as part of the lexical entry:

(8)
$$\begin{array}{llcc} \text{IP} & \longrightarrow & \text{AP} & \text{IP} \\ & & (\uparrow \text{XADJ})=\downarrow & \uparrow=\downarrow \\ & & (\uparrow \text{SUBJ})=(\downarrow \text{SUBJ}) & \end{array}$$

In this way an adjunct phrase (AP) such as *glad to be home again* is marked as serving the XADJ role within the f-structure of the higher IP and the open subject of the XADJ will be determined at the level of the clause rather than by a specific lexical entry.

The common property in both the XCOMP and XADJ constructions is identity between the controlling and the controlled function, which means not only that the items in question must be coreferential but that they must share all grammatical and semantic features such as case, gender, number and person. They also have in common that in some contexts they may alternate with closed functions. Thus, the examples (9a) and (9b) illustrate a closed COMP *that*-clause subcategorised by verbs like *believe* and *promise*, while in (10a) and (10b) we have instances of closed ADJ as the function to be associated with the constituents *everyone having gone home* and *with Sally away*:

(9) a. The doctor promised Sally that the medicine would work.
b. Sally believed that the doctor was right.

(10) a. Everyone having gone home, Bill could finally relax.
b. With Sally away, the house seemed very quiet.

Examples such as those in (9) and (10) are closed functions with independently defined subjects. However, it is also possible for a closed COMP to have a controlled subject, as in (11) and (12).

(11) a. Losing the race upset Bill.
b. Bill and Sally discussed complaining to the teacher.

(12) a. Bill prefers to leave now.
b. Bill wishes to leave tomorrow

In such a circumstance, in order to establish a link between a controller and a controlled item within a closed function we need anaphoric control. As the name implies, this involves an element, labelled PRO, which behaves like a pronoun in its ability to establish a referential link to an item outside the constituent that it is part of, but, like overt anaphors such as reflexives and unlike pronouns, it does not have the ability to refer independently. Formally, what this involves is the rule in (13) (= (35) in Bresnan 1982a: 326), where G identifies the universal set of semantically unrestricted functions and Δ allows for particular limitations on the available function in any given language:

(13) For all lexical entries L, for all G $\in \Delta$, assign the optional pair of equations $\{((\uparrow \text{G PRED}) = \text{‘PRO’}), (\uparrow \text{FIN}) =_c \alpha\}$ to L.

This general principle allows the PRO-valued function to be assigned to lexical entries while respecting language-particular constraints as to what may constitute the function G and what set of forms it can apply to. Thus, in English G can only be SUBJ and the forms in question must be non-finite but, as we shall see, other languages may vary. This rule is applicable both for predicates with no overt subject such as *losing the race* in (11a) or *complaining to the teacher* in (11b) and for the complements of some verbs, particularly those of wishing and wanting, as in (12). We return to the special issues engendered by the analysis of these verbs in Section 4 below.

The difference between verbs that take functional control and those that take anaphoric control is very clear in Icelandic (Andrews 1982, 1990), a language in which some items display subject properties such as determination of reflexives but where the case marking is not the usual nominative. Thus, in the simple sentence (14a) the subject of *gengur vel* 'do well' is marked with the dative case. When this predicate is embedded under a functional control verb as in (14b) the dative case is maintained but with an anaphoric control verb as in (14c), for many speakers, it is the latter item that determines the nominative case on the subject (examples from Andrews 1990: (39) and (43)):

(14) Icelandic

a. Drengnum gengur vel við vinnuna
boy.DEF.DAT go.PRS.3SG well at work
'The boy is doing well at work.'

b. Drengnum virðist ganga vel við vinnuna
boy.DEF.DAT seem.PRS.3SG go.INF well at work
'The boy seems to be doing well at work.'

c. Drengurinn vonast til að ganga vel við vinnuna
boy.DEF.NOM hope.PRS.3SG C INFL go.INF well at work
'The boy hopes to do well at work.'

To model (14c) requires a lexical entry for *vona* 'hope' as in (15):

(15) *vona* V (↑ PRED) = 'VONA⟨SUBJ,COMP⟩'
(↑ COMP SUBJ PRED) = 'PRO'

Where the presence of PRO is determined by the lexical entry, as here, we have an instance of obligatory anaphoric control. By contrast in (16) we have so-called arbitrary control where the antecedent for PRO depends not on the requirements of the matrix verb but on the broader context.

(16) a. Bill gestured but nobody noticed it.
b. Bill gestured to leave.
c. Bill gestured for everyone to leave.
d. Sally said everyone thought Bill should have gestured (for them/her) to leave.

A verb like *gesture* does not require a complement, as (16a) demonstrates. However, if it is linked to an infinitive, then the external argument of the infinitival verb can either be implicit and dependent on the discourse situation, as in (16b), or be made explicit, as in (16c). Moreover, if there is an overt antecedent it may be two or more clauses earlier as in (16d).

It is important to underscore that while, as we have already said, labels like raising and control verb or construction are commonly used to classify empirical phenomena, the distinction between functional and anaphoric control is a theoretical construct designed to model such data. It is eminently possible, therefore, that within LFG as within other frameworks, there could be different analyses for the same dataset. Thus, for the verb *try* Bresnan's lexical entry in (6b) implies an analysis in terms of functional control, endorsed in Mohanan (1983: 644) and repeated in Börjars et al. (2019: 103). Similarly, Falk (2001: 141–144) argues for a distinction between *try* with functional control and verbs like *agree* with anaphoric control. By contrast, Dalrymple et al. (2019: 561–566), and already Dalrymple (2001: §4.2), prefer to analyse *try* as also requiring obligatory anaphoric control and hence with the PRED value in (17) akin to the one for Icelandic *vona* in (15):

(17) *try* V (↑ PRED) = 'TRY⟨SUBJ,COMP⟩'
(↑ COMP SUBJ PRED) = 'PRO'

This has the benefit of allowing a much closer alignment between the traditional classes and the different analyses, with raising coming under functional control and equi verbs under anaphoric control. It has consequences, too, when we come to consider the semantics of control/raising since a COMP translates naturally into a proposition whereas the obvious semantic correlate of an XCOMP is a property. Moreover, it serves to undermine one of the criticisms of LFG made by Landau (2013: 61–62) following Davies (1988), namely that functional control is not relevant for phenomena which traditionally fall under the heading of control. But this depends on the analysis not the framework. Landau rightly goes on to observe, as others have done, that in this respect the LFG account exhibits parallels with the movement theory of control advanced by Hornstein and colleagues

(Hornstein 1999, Hornstein & Polinsky 2010): they move everything, Bresnan moves nothing! But once again this is a matter for debate within the frameworks in question not one for *a priori* prescription. What is clear is that more than one analytic device is required to encompass the full range of empirical phenomena both within and across languages.

It should also be emphasised that within LFG neither functional nor anaphoric control requires the postulation of anything more than a VP at the level of c-structure in stark contrast to the FinPs, ForcePs, TPs, vPs and the like which populate the syntactic trees assigned to these constructions within derivational/configurational analyses, regardless of the finiteness of the complement.

We return to the question of the relation between finiteness and control/raising in Section 6 and to issues concerning the appropriate semantic analysis in Section 10.

3 Obligatory vs non-obligatory control

The distinction between obligatory (OC) and non-obligatory control (NOC) goes back to Williams (1980); since then there has been considerable discussion about where and how to draw the boundary between them. The crucial differences, as set out by Williams (1980: 208–209), are that in cases of OC the PRO cannot be replaced by an overt lexical item and must have a grammatically determined antecedent. Hence the general agreement that raising constructions fall within the territory defined as OC while the PROs in examples such as those in (18) require NOC.

(18) a. It is not possible [PRO to open the window].
     b. [PRO forgetting his own birthday] is typical of Bill.

Where other types of control are to be placed and how they are to be modelled are by contrast still matters for debate. There is, for example, a close match between Williams's (1980) dichotomy and the distinction between functional and anaphoric control as originally formulated in Bresnan (1982a), although even then the two are not equivalent (*pace* for example Landau 2013: 241). Since that time, however, there has been general agreement that anaphoric control for desiderative verbs for example must fall within OC. In order to get the discussion going, therefore, we need criteria to delimit these empirical domains, and to that end we will adopt what Landau (2013: 29) calls the OC 'signature' and which he defines as in (19) (= his (74)):

(19) In a control construction [... X_i... [$_S$ PRO$_i$...]...], where X controls the PRO subject of the clause S:

  a. The controller(s) X must be (a) co-dependent(s) of S

  b. PRO or part of it must be interpreted as a bound variable.

NOC is then defined as anything which does not meet these criteria. Alternatively, and more positively, NOC covers control into subject and adjoined or extraposed clauses (Landau 2013: 38, (96)) and, if we follow Landau (2020), also for some classes of lexical predicates. We return to the issue of NOC in Section 11 when we discuss Landau's two-tier model.

4 Exhaustive vs partial control

Within the broader domain of OC there is a sub-type that has generated special interest, namely the phenomenon that has come to be called partial control (PC). We have already observed that in one reading of an example like (4a) — repeated here as (20a) — the subject of *want* can be in a control relation to the unexpressed subject of its infinitival complement: Sally is both the source of the desire and the one who will work.

(20) a. Sally wants to work harder.

  b. The chair wanted to meet without me.

  c. Morten wants to leave the European Union.

In (20b), on the other hand, the subject of the infinitive includes, but is not simply coreferential with, the subject of *want*. Rather, the embedded verb *meet* requires a semantically plural subject, as is clear from the ungrammaticality of (21a) but nonetheless can occur as the complement of *want* even when the subject of *want* is singular. Similarly, while (20c) is fine as an expression of Morten's political ambition for the country he belongs to, (21b) describes an odd state of affairs since membership of an organization like the EU is not a matter for individual decisions or efforts.

(21) a. * The chair met.

  b. # Morten tried to leave the European Union.

At the same time, the semantic plurality of the implicit subject does not trigger morphosyntactic plurality for all speakers. Thus, (22a) is fine while the uncontrolled (22b) fails. (22c) is unproblematic because both *Sally* and *herself* are singular whereas American English speakers do not readily accept the plural *by* *themselves*, as in (22d), unless the infinitival clause contains a plural subject as in (22e) (Landau 2013: 161).

(22) a. Sally wanted to work together.
b. * Sally worked together
c. Sally wanted to work by herself.
d. ? Sally wanted to work by themselves.
e. Sally wanted her and Bill to work by themselves.

Given the way the PC effects depend on the choice of governing verb, it follows from the principle in (19) that partial control must be a sub-type of OC. This conclusion is accepted by Asudeh (2005), who proposes an analysis combining f-structure and glue semantics as in (23) for the exhaustive control *try* and (24) for the partial control *want*:

(23) $\lambda x.\lambda P.try(x, P(x)) : (\uparrow \textsc{subj})_\sigma \multimap [(\uparrow \textsc{xcomp subj})_\sigma \multimap (\uparrow \textsc{xcomp})_\sigma] \multimap {\uparrow_\sigma}$

(24) $\lambda x.\lambda P.\exists y.want(x, P(y)) \wedge x \sqsubseteq y) :$
$(\uparrow \textsc{subj})_\sigma \multimap [(\uparrow \textsc{xcomp subj})_\sigma \multimap (\uparrow \textsc{xcomp})_\sigma] \multimap {\uparrow_\sigma}$

Here is not the place to go into the technical details of the glue analysis. The crucial difference is that while the analysis of *try* in (23) maps directly onto the f-structure representation in (6b), the analysis of *want* introduces an additional variable y, which can either be equivalent to x or identify a superset of which x is necessarily a member. In other respects (24) is a straightforward instance of functional control. However, as Haug (2013) notes, this gives the wrong result with quantified examples like (25) (= Haug's (29)):

(25) Everybody wanted to have lunch together.

The most natural reading of this is the collective one in which *everybody* and *together* refer to the same set of individuals, whereas the representation in (24) implies a distributive reading in which for each member of the set identified by *everybody* there is a different, not necessarily overlapping, group of people (s)he wants to lunch with.

In consequence, Haug proposes an alternative analysis involving what he calls 'quasi-obligatory anaphoric control'. Such items are distinguished from contexts of arbitrary control by virtue of a locality constraint imposed by the controlling predicate but, unlike with obligatory control verbs, the constraint is semantic and not syntactic. We will not go here into the formal details of his analysis (for which see also Haug 2014), but note simply that if these proposals are adopted, we end up with a typology of control that allows the four options set out in Table 1. Crucially, such a typology creates a de facto continuum from syntax through to discourse-determined structures rather than reducing all patterns to syntactic configurations.

Similar in spirit, though structurally more wide-ranging, is the LFG-based typology of control proposed in Szűcs (2018b) as in Table 2. The new data that is here incorporated into the typology is what Szűcs calls ‘prolepsis’ as exemplified in Hungarian examples such as (26) (= his 1b):

(26) Hungarian
Janós(-t) mondtad hogy jön a partira
John(-ACC) say.PST.2SG C come.PRS.3SG the party.onto
‘(Of) John, you said that he is coming to the party.’

The fronted argument *Janós* is optionally marked with accusative case. Szűcs takes this as evidence that it is an optional argument of the verb *mond* ‘say’ which therefore has a possible PRED value ⟨(SUBJ)(OBJ)(COMP)⟩. He draws a parallel here with English examples like *I read of Carol that she was awfully shy*, a type of structure that has received little or no attention in the literature to date. The relation of prolepsis to control has been taken up more recently by Landau (2021: §14.4.5) though without any reference to Szűcs’ contribution.

A different strategy for subsuming raising, but not control, within a broader set of constructions is the concept of structure-sharing developed by Alsina (2008, 2010). On this view, what raising shares with long distance dependencies (topics and wh-questions) and parasitic gap constructions is a governing and thematically unrestricted function which is shared with the embedded argument slot. There is not space here to go into the full details of Alsina’s proposals but the overall logic is similar to that of Szűcs, namely that there are shared properties of argument and pronominal constructions that need to be captured in an appropriate formal way, building on functional rather than categorial structure.

Noteworthy, too, is the fact that in a model such as Simpler Syntax, which goes further than LFG in the direction of reducing syntactic operations and structures to a minimum, one area where functions rather than configurations play a key role is precisely raising and control (Culicover & Jackendoff 2019: §3.3).

It is instructive to compare these approaches to syntax-centred ones such as those advanced in recent derivational work. Thus, Sheehan (2014) argues for the presence of a non-overt comitative argument in order to account for the extra participant(s) implicit in examples such as (20b), an analytic strategy akin to

Table 1: Typology of control (Haug 2013: 61)

	f-control	obligatory a-control	quasi-obligatory a-control	arbitrary a-control
locality	syntactic	syntactic	semantic	discourse
identity	+	–	–	–

Table 2: An LFG typology of control (Szűcs 2018b: 359)

CONTROL-TYPE			Example
Thematicity of controller	Nature of identification	Finiteness	
Equi (thematic)	anaphoric identification	finite complement	prolepsis
		non-finite complement	canonical control ("*agree*-type")
	functional identification	finite complement	Turkish object control (?)[a]
		non-finite complement	canonical control ("*try*-type")
Raising (non-thematic)	anaphoric identification	finite complement	not expected
		non-finite complement	not expected
	functional identification	finite complement	copy raising/ hyper-raising[b]
		non-finite complement	canonical raising

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[a] Turkish is here cited as a further example of control into finite clauses of the kind discussed with reference to a number of other languages in Section 6 below.

[b] The term 'hyper-raising' is taken from Carstens & Diercks (2013) and refers to structures that are in all relevant respects parallel to copy raising (on which see Section 9 below) but where the embedded finite clause has a covert rather than an expletive subject. See Zyman (2023) for further discussion and assessment of analyses within the framework of Minimalism.

that proposed by Asudeh (2005) but with the added variable inserted in the syntax rather than the semantics. This, however, is open to the same objections as raised by Haug and is challenged on its own theoretical terms by Landau (2016). Alternatively, as argued in Sheehan (2018b) and Sevdali & Sheehan (2021), the differences between exhaustive and partial control can be attributed to the syntactic constructs Agree and Case, neither of which are available — or indeed needed — within the theoretically more economical framework of LFG.

5 Split and implicit control

Partial control needs to be distinguished from two further subtypes, namely split control as exemplified in (27) and implicit control as in (28):

(27) John$_i$ discussed with Mary$_j$ [which club PRO$_{i+j}$ to become members of].

(28) a. It was fun to visit the new museum.
b. It was not permitted to cross the track.

In the former the antecedents are divided between the arguments of the verb, so that *members* in (27) must refer back jointly and exhaustively to John and Mary. As Landau notes, this phenomenon does not fall readily under any of the existing approaches and he concludes that at the time of writing 'there is no satisfactory theory for the syntax of split control constructions' (Landau 2013: 174). This may of course be because the pattern is not inherently syntactic but falls within the semantic/discourse domain of Haug's typology. Such a conclusion is reinforced by the fact that it is particularly attested in Japanese and Korean in the context of exhortative marking as in the Korean example (29) (= Landau's 328b):

(29) Korean
Chelsu$_i$-ka Hwun$_j$-eykey [PRO$_{i+j}$ ilbon umsik-ul mek-ca-ko
Chelswu-NOM Hwun-DAT Japan food-ACC eat-EXH-C
mal-ha-yess-ta]
tell-do-PST-DECL
Lit. 'Chelswu said to Hwun to eat Japanese food together.'

This reports a suggestion ('let's eat together') though it is not direct speech but the presence of the exhortative marker *-ca* on the verb licenses the split control. Similarly, the Japanese minimal pair in (30) (adapted from example (38) in Fujii 2010) shows that when the exhortative particle *-(y)oo-* is present there can be split control while with the imperative particle *-e-* the examples are ungrammatical:

(30) Japanese

a. * Taro-wa Hiroshi-ni [PRO otagai-o sonkeesi-a-e-to]
Taro-TOP Hiroshi-DAT each.other-ACC respect-RECP-IMP-C
itta/meireisita
say/order.PST
'Taro said to/ordered Hiroshi that they should respect-IMP each other.'

b. Taro-wa Hiroshi-ni [PRO otagai-o sonkeesi-a-oo-to]
Taro-TOP Hiroshi-DAT each.other-ACC respect-RECP-EXH-C
it-ta/teiansita
say/propose.PST
'Taro said/proposed to Hiroshi that they should respect-EXH each other.'

In other words, it is the nature of the speech act rather than the syntactic configuration that licenses the split control effect.

Implicit control, as in (28), is in a way the direct opposite since there is no overt antecedent for the infinitival complements. In the literature, and following Bresnan (1982a), this has been linked to the so-called Visser's generalization (VG) which states that subject control verbs cannot be passivized and which is claimed to explain the ungrammaticality of examples like (31a,31c) (= 86c,e from Bresnan 1982a):[1]

(31) a. * She was failed (by Max) as a husband.
b. Max failed her as a husband.
c. * Frank was promised to leave (by Mary).
d. Mary promised Frank to leave.

Examples such as these led Bresnan to propose as a general principle that controllers must be overt and occupy a semantically unrestricted grammatical function such as SUBJ or OBJ. However, while this may be true for English, it does not necessarily hold cross-linguistically as the grammaticality of the following Dutch (32) and German (33) examples and the ungrammaticality of their literal English translations — taken from the discussion in Wurmbrand (2021) — attest:[2]

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[1] In the literature VG is often accompanied by something labelled Bach's generalization (BG) — see for example Dalrymple et al. (2019: 586) — but as Landau (2013: 179–179) notes the empirical basis for BG has been challenged and we will not discuss it further here.

[2] Here and elsewhere in the glosses, to avoid confusion, we use C to label the category complementizer as opposed to the function COMP, although in the general literature and as recommended in the Leipzig conventions COMP is regularly used as a gloss for complementizer.

(32) Dutch
Er werd mij beloofd/aangeboden om me op de hoogte te
There be.pst I.dat promise/offer.pst.ptcp c I.dat on the height to
houden
keep.inf
‘It was promised/offered to keep me informed.’

(33) German
Mir wurde versprochen mir noch heute den Link für das
I.dat become.pst promise.pst.ptcp I.dat still today the link for the
Update zu schicken
update to send.inf
‘It was promised to me to send me the link for the update today.’

In the light of such data, van Urk (2013) proposes what has come to be called (Landau 2013: 182) the restricted VG as in (34):

(34) Implicit subjects cannot control if T agrees with a referential DP.

More recent cross-linguistic investigation of the phenomenon is reported in Pitteroff & Schäfer (2019) and Wurmbrand (2021) offers a formal account within a Minimalist framework. Within LFG, data of this kind can be handled within the framework developed by Haug (2014), as noted by Reed (2020: 13–16) in her discussion of Landau’s two-tier approach, although she herself offers yet another Minimalist account.

6 Control and finiteness

Much, if not most, of the literature dealing with the theory of control has focussed on English but, as we have already seen on more than one occasion, contrasting patterns from other languages shed new light on the phenomena and the way that they can be modelled. The English data that was at the heart of early debates focuses almost exclusively on infinitival constructions, but, as Haspelmath (2013) demonstrates, English is unusual in admitting infinitival clauses both with and without subjects co-referential to the subject of the controlling predicate as in the minimal pair *I want to leave* vs *I want Bill to leave*. In this section we review some of the typological diversity focussing in particular on finite vs non-finite splits (Italian, Danish, Hungarian), control into finite clauses (as in Greek, Romanian, Chinese and Japanese), and the special case of inflected infinitives (as in Portuguese and Sardinian).

We begin then with the finite/non-finite alternation seen in the following Italian examples:

(35) Italian

a. Giorgio vuole partire domani
Giorgio want.PRS.3SG leave.INF tomorrow
'George wants to leave tomorrow.'

b. Giorgio vuole che Paolo parta domani
Giorgio want.PRS.3SG C Paolo leave.PRS.SBJV.3SG tomorrow
'George wants Paul to leave tomorrow.'

The pattern here is clear: infinitival clause when there is co-reference between the subject of the governing verb and the embedded predicate, finite (and subjunctive) clause when the subjects differ. In LFG terms the functional structure of the 'want' verb is constant — 'VOLERE⟨SUBJ,COMP⟩' — but the syntactic realizations differ. Since it is the f-structure that feeds into the semantics there is no need to create parallel c-structures as would be required in frameworks where the configurational syntax drives the semantics.

The Danish examples in (36) work in similar fashion but with an extra dimension of complexity:

(36) Danish

a. Georg vil gerne tage af sted i morgen
Georg want.PRS with-pleasure go.INF from place in morning
'George wants to leave tomorrow.'

b. Georg vil gerne *(have) at Paul tager af sted i morgen
Georg want.PRS with-pleasure have.INF C Paul go.PRS from place in morning
'George wants Paul to leave tomorrow.'

c. Georg vil gerne *(have) æg til morgenmad
Georg want.PRS with-pleasure have.INF egg.PL for breakfast
'George wants eggs for breakfast.'

The translation of 'want' is *vil gerne*, literally 'will with pleasure', and in (36a), parallel to both the Italian (35a) and the English translation, in the coreferential construction it governs an infinitive. In (36b), on the other hand, when there are distinct subjects, the embedded clause is finite but there is an intervening infinitive of the verb *have* ‘have’. This same additional ingredient is required when the ‘want’ verb takes a nominal object as in (36c); both these examples are ungrammatical if *have* is omitted, whereas (36a) is ungrammatical if *have* is inserted.

At first sight the Danish data would appear to support the analysis of the syntax of ‘want’ verbs proposed in Grano (2015: 83), according to which the structures which underlie the various uses of English *want* are as in (37):

(37)
a. John wants [$\varnothing_{have}$ an apple].
b. John wants [$_{\text{VP}}$ to stay].
c. John wants [$_{\text{VP}}$ $\varnothing_{have}$ [$_{\text{vP}}$ Mary to stay].
d. John wants [$_{\text{VP}}$ $\varnothing_{have}$ [$_{\text{vP}}$ PRO to stay].

The key part of this analysis, building on Cinque (2004), is that English *want* is not treated as a full-fledged independent lexical item but rather as an item which occupies a functional head in the modal domain. When it appears to be transitive, as in (37a), it is because it is accompanied by a silent transitive HAVE which licenses the direct object. The same would hold for the equivalent Italian *Giovanni vuole una mela*. Danish then differs from English and Italian simply in virtue of the HAVE item being overt.

It follows, too, that if *want* sits in a functional position, an example like (37b) is monoclausal. This is supported by Italian examples like (38) where the clitic object can either attach to the modal ‘want’ or to the main verb:

(38) Italian
a. Giovanni vuole mangiar=la
Giovanni want.PRS.3SG eat.INF=it
b. Giovanni la=vuole mangiare
Giovanni it=want.PRS.3SG eat.INF
‘Giovanni wants to eat it.’

Strikingly, this so-called clitic climbing, standardly taken as evidence of restructuring from a bi- to a mono-clausal configuration, is for many speakers not permitted in PC contexts like (39):[3]

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[3] Native speaker judgements here are mixed with some speakers accepting both and some neither! However, for the majority (39a) is acceptable while for (39b) even those who accept it prefer a rephrasing with a finite clause *che ci incontrassimo* ‘that we should meet each other’.

(39) Italian

a. Giovanni vuole incontrar=si domani
Giovanni want.prs.3sg meet.inf=recp tomorrow

b. *? Giovanni si=vuole incontrare domani
Giovanni recp=want.prs.3sg meet.inf tomorrow
'Giovanni wants to meet tomorrow.'

In short, exhaustive control is monoclausal and partial control is biclausal, but with the biclausality in the latter licensed not by the *want* verb but by the silent have, in a structure parallel to that postulated for the English (37d). There are, however, two problems with this analysis. First, precisely in the partial control context Danish does not permit *have*, and second in no other context in English, Danish, Italian and many other languages do *have* verbs license finite clausal complements. Grano seeks to avoid this latter charge by analysing the complement of the silent have as a *v*P rather than the CP that Cinque had proposed but, given that the Italian item *che* in (35b) and the Danish *at* in (36b) are the default complementizers used in a wide range of embedded clauses types, this way out of the dilemma lacks conviction. The best alternative, therefore, would appear to involve a syntax or c-structure based on whatever overt categories are attested in the different languages linked to a more cross-linguistically robust f-structure and a syntax-semantics constructional hierarchy of exactly the kind set out in Table 1 above.

A more radical LFG alternative on the f-structure side, though one still consistent with the Haug hierarchy, would be to collapse comp and obj as proposed for Hungarian *akar* 'want' by Szűcs (2018a):

(40) Hungarian

a. Kati ételt akar
Kati food.acc want.prs.3sg
'Kati wants food.'

b. Kati enni akar
Kati eat.inf want.prs.3sg
'Kati wants to eat.'

c. Kati akarja hogy együnk
Kati want.prs.def.3sg c eat.sbjv.1pl
'Kati wants us to eat, lit. that we eat.'

d. Kati ételt és azzal jóllakni akar
Kati food.ACC and it.with satisfied.become.INF want.PRS.3SG
'Kati wants food and to be satisfied with it.'

This verb displays the same patterns of simple transitivity and an alternation of finite and infinitival complements as Italian and Danish. Given that the nominal and clausal arguments may be co-ordinated as in (40d), Szűcs argues that the most economical account involves a single lexical predicate structure, namely ⟨(SUBJ)(OBJ)⟩. He does not consider the PC option, but there is no reason to believe that this would undermine or alter his argument.

A different type of pattern is found in various languages belonging to the so-called Balkan *Sprachbund* such as Greek and Romanian, in some southern Italian dialects and in Japanese and Korean, where the complements can be finite regardless of whether there is coreference or not. Thus in Greek we have:

(41) Greek
a. thelo na liso to provlima
want.PRS.1SG PRT solve.PRS.1SG the problem
'I want to solve the problem.'
b. O Kostas theli na odhiji
the Kostas want.PRS.3SG PRT drive.PRS.3SG
'Kostas wants (her/him) to drive.'

In (41a) both the controlling verb and the embedded verb are finite first person singular despite the fact that they refer to the same subject. It follows that if both verbs are third person singular as in (41b), they can either co-refer (Kostas wants to be the driver) or have different referents (Kostas wants someone else to drive). A similar ambiguity can be seen in the Korean example (42) (Lee 2009: 112):

(42) Korean
Mina-ke hakkyo-ey ka-nun kes-ul para-yess-ta Wujin-to
M.-NOM school-LOC go-ADN thing-ACC want-PST-DECL W.-also
kuli-ha-yess-ta
SO-do-PST-DECL
'Mina wanted to go to school and so did Wujin.'

This can mean either that Mina wanted to go to school and Wujin also wanted to go to school himself or that Wujin also wanted Mina to go to school.

In all these languages there are restrictions on the tense or mood of the embedded predicate which space prevents us from going into here. However, the general principle is clear: the overt syntax does not map one-to-one onto the semantic ingredients so that either the syntax has to be rendered more semantically transparent via the use of functional and null heads and syntactic movement, or the configurational syntax is held constant and the burden is shifted to other levels. The use of f-structure and s-structure clearly goes down this latter route; see Sells (2007) and Polinsky (2013) for general discussion.

Another difference across languages concerns the realization of the pro item. While this is standardly taken to be a silent category, Satik (2021) argues that in the Anlo dialect of the Niger-Congo language Ewe the pronoun *yè* in the examples in (43) (= his (5a)) exhibits the properties of an overt pro (pot in his gloss stands for 'potential'):

(43) Ewe (Anlo dialect)

Agbei	dzagbagba/ŋlobe/dzina/vɔvɔm/wosusu/dzi/susum	be	yèi-a	dzo
A	try/forget/want/afraid/decide/like/intend	c	yè-pot	leave

'Agbei tried/forgot/wanted/is afraid/decided/likes/intends pro$_i$ to leave.'

Satik goes on to develop a Minimalist-inspired analysis of the Anlo data which we will not discuss in the present context. It suffices for our purposes to note that, as he also argues, the existence of languages with overt pro serves to disconfirm the movement analysis of control alluded to at the end of Section 2, since movement would always leave an empty and not an overt trace. This conclusion is reinforced by languages where the item in the expected pro slot is a full NP, as in the Zapotec example in (44) cited by Polinsky & Potsdam (2006) as an instance of what they call copy control (= their (22a)):

(44) Zapotec

rcààa'z	Gye'eihlly	g-auh	(Gye'eihlly)	bxaady
hab-want	Mike	irr-eat	(Mike)	grasshopper

'Mike wants to eat grasshopper.'

They further note that while the full NP is optional, a pronominal subject in the controlling clause would obligatorily determine an overt matching pronoun in the controlled clause, akin therefore to the Anlo example in (43).

Yet another type of alternation is to be seen in the contrast between bare and inflected infinitives in Portuguese and several other Romance varieties. Thus, consider the examples in (45):[4]

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[4] It is important to note that the examples in this section are drawn from European Portuguese (EP) since Brazilian and other varieties exhibit significant differences in relation to these constructions (Madeira & Fiéis 2020). There are similar patterns to EP in the closely related Galician (Sheehan et al. 2020).

(45) European Portuguese

a. Serà dificil (eles) aprovar-em a proposta
be.FUT.3SG difficult (they) approve-INF.3PL the proposal
'It will be difficult for them to approve the proposal.'

b. Eu lamento (eles) terem trabalhado pouco
I regret.PRS.1SG (they) have.INF.3PL work.PST.PTCP little
'I regret that they have worked very little; lit. them to have worked.'

In (45a) the embedded infinitival complement *aprovarem* bears the third person plural suffix, as does the perfect auxiliary *terem* in (45b). This same suffix occurs on the finite form *parecem* 'they seem' in the raising context of (46b) but in that context cannot be added to the embedded infinitive, hence the ungrammaticality of (46c).

(46) European Portuguese

a. parece que os organizadores adiaram o congresso
seem.PRS.3SG C the organizer.PL postpone.PST.3PL the conference
'It seems that the organizers have postponed the conference.'

b. Os organizadores parecem ter adiado o
the organizer.PL seem.PRS.3PL have.INF postpone.PST.PTCP the
congresso
conference
'The organizers seem to have postponed the conference.'

c. *Os organizadores parecem terem adiado o
the organizer.PL seem.PRS.3PL have.INF.3PL postpone.PST.PTCP the
congress
conference

With control verbs we find a significant difference between exhaustive and partial control (examples from Madeira & Fiéis 2020: 429):

(47) European Portuguese

a. Prefer-ias chegar(*es) a tempo
prefer-IND.IPFV.2SG arrive.INF (*2SG) on time
'You would prefer to arrive on time.'

b. O João prefer-ia reunir(%em)-se mais tarde
the J. prefer-IND.IPFV.3SG meet(%3PL)-RECP more late
'João would prefer to meet later.'

In the exhaustive control example (47a) the inflection on the infinitive is not permitted just as with raising in (46c). In (47b) on the other hand the notation % implies significant percentage differences in the judgements of native speakers, a conclusion confirmed by the more detailed statistical evidence presented in Sheehan (2018a,b). In this respect they parallel the cross-speaker discrepancies noted with respect to clitic climbing in the Italian PC example (39b). Such a degree of socio-pragmatic variation in turn would seem to support Haug's concept of a control scale moving from pure syntax through to discourse rather than attempts to motivate the differences in terms of core syntactic concepts such as Case and Agree.

All the languages we have considered in this section so far share the property of having morphological realizations of finiteness and the related categories of tense, mood and person. Mandarin Chinese, and Sinitic languages more generally, however do not exhibit such morphology and therefore call into question the relevance of the finiteness criterion in a different way (see Grano 2015: chapter 6 for discussion and a convenient summary of the relevant literature). In his LFG-based discussion of this and related issues, Lam (2022) bases his analysis on the contrast between the f-structure for *shefa* 'try' with xcomp as opposed to comp for the partial control verb *dasuan* 'intend' and with a VP complement for the former beside an IP complement for the latter.

7 Backwards control/raising and subsumption

As we have seen, the treatment of control and raising constructions in LFG relies on f-structure statements of the form (↑ subj) = (↑ xcomp subj), which imply equality between the content of the functional roles but asymmetry in the dominance relations since the thematic argument will of necessity occur in the higher clause. This is the case even if the linear order differs, as in the Hungarian examples (40b) and (40d) where *akar* 'want' follows rather than precedes its infinitival complement. However, an example like (48) from the North Caucasian language Adyghe evidences a different pattern, in which the thematic argument can be situated in the embedded clause (Potsdam & Polinsky 2012: (1), (2)), where the strikethrough items indicate deletion in their notation):

(48) Adyghe

a.

~~axe-r~~	[axe-me	se	saš'e-new]	∅-feže-ʁ-ex
3pl-abs	3pl-erg	1sg.abs	lead-inf	3abs-begin-pst-3pl.abs

b. axe-r [~~axe-me~~ se saš’e-new] ∅-feže-ʁ-ex
3PL-ABS 3PL-ERG 1SG.ABS lead-INF 3ABS-begin-PST-3PL.ABS
‘They began to lead me.’

While (48b) has an overt absolutive subject of the verb *feže* ‘begin’, accompanied by an unrealized subject of the embedded infinitive *saš’enew* ‘lead’, in (48a) the overt item is *axe-me* with the ergative suffix appropriate for the subject of ‘lead’.

The examples in (48) demonstrate a free alternation between forward and backward raising. At the same time, as Perlmutter (1970) demonstrated in a classic paper, verbs meaning ‘begin’ can vary between raising and control uses. An instance of backward control with ‘begin’ can be seen in the Malagasy example (49a). The difference here is both in the theta role — Rabe is the active beginner and the active driver — and in the fact that in Malagasy the forward version (49b) is ungrammatical.

(49) Malagasy
a. m-an-omboka [m-i-tondra ny fiara Rabe]
PRS-ACT-begin PRS-ACT-drive the car Rabe
‘Rabe is beginning to drive the car.’
b. *m-an-omboka Rabe [m-i-tondra ny fiara]
PRS-ACT-begin Rabe PRS-ACT-drive the car

Here only the backward control option is possible, a property which Sells (2006) proposes can be modelled by introducing the subsumption relation, annotated as ⊑, which implies a directionality in the flow of information from controller to controllee but involves no expectation of hierarchy. The difference between the ‘begin’ verbs in Adyghe and Malagasy can then be represented as in (50):

(50) a. Adyghe: *feže* (↑ SUBJ) ⊑ (↑ XCOMP SUBJ)
(↑ XCOMP SUBJ) ⊑ (↑ SUBJ)
b. Malagasy: *omboka* (↑ XCOMP SUBJ) ⊑ (↑ SUBJ)

This kind of cross-linguistic difference is part of a larger typological distribution. Table 3, adapted from Polinsky & Potsdam (2002: 278), shows the various patterns which have been attested to date for verbs meaning ‘begin’, which fall within the larger class of verbs with an aspectual meaning, something which seems to be a key factor here.

The concept of subsumption and its relation to backward control and raising goes back to Zaenen & Kaplan (2002), who propose as a general principle that

Table 3: Typology of backward control with 'begin'

Language	Backward control	Aspectual	Raising/control ambiguity
Tsez (Nakh-Daghestanian)	yes	yes	yes
Malagasy (Austronesian)	yes	yes	no
Tsaxur (Nakh-Daghestanian)	yes	yes	no
English	no	yes	yes

raising verbs involve the equality relation (↑ subj) = (↑ xcomp subj) while control/equi verbs have the subsumption relation (↑ subj) ⊑ (↑ xcomp subj). Sells (2006) goes a step further and proposes to replace equality with subsumption across the board. The debate, however, has not been settled in part because, as we have seen, there are arguments in favour of control as involving comp rather than xcomp and in part because others, notably within LFG (Arka 2014), have argued that both mechanisms can be at work in the same language.

Polinsky & Potsdam (2006) and again Polinsky (2013) argue that backward raising/control supports a movement account, and in particular a copy-and-delete version, with the difference cross-linguistically depending on whether it is the original or the moved copy that is deleted, but as noted above this analysis faces problems when it comes to copy control constructions. At the same time, Polinsky (2013) raises two queries vis-à-vis Sells and subsumption: a) is there a risk of over-generation? and b) how does it connect with other properties such as word order and headedness?

On this last point, Haug (2011, 2017) extends the discussion of backward control to include adjunct clauses as in the Ancient Greek (51) (= example (15) from Haug 2011):

(51) Ancient Greek
[egertheis de Iôsêph apo tou hupnou]
wake.pfv.ptcp.nom but Joseph.nom from def.gen dream.gen
epoiêsen…
do.pst.pfv.3sg
'When he woke up from the dream, Joseph did…'

Here, the subject of the *epoiêsen* 'did' is realised in the adjunct participial clause, which linearly precedes but is structurally subordinate to the main clause. For this reason, as Haug notes, it might be better to refer to ‘upward’ control but either way we have something that is parallel to the kind of pattern we have seen in our earlier examples of backward complement control. However, as he goes on to show, the appropriate analysis here involves functional equivalence and linear precedence rather than subsumption, a conclusion which suggests that subsumption as an operation, if required at all, should be restricted to contexts of complement control and raising, where, as examples like (48) and (49) demonstrate, linearization cannot be the answer.

8 Nominal control and raising

Another logical possibility is that the controlling item is nominal rather than verbal. This is particularly evident in the structure which, following Tsunoda (2020), we will call the Mermaid Construction (MC), as seen in the Japanese examples (52) and (53):

(52) Japanese
Hanako=ga Igirisu=ni ik-u ki=da
Hanako=NOM UK=DAT go-NPST.ADN feeling=COP.NPST.DECL
‘Hanako intends to go to the UK.’ (lit. ‘Hanako is the feeling to go to the UK’ or ‘It is the feeling where Hanako goes to the UK’)

(53) Japanese
Hanako=ga Igirisu=ni ik-u yotei=da
Hanako=NOM UK=DAT go-NPST.ADN plan=COP.NPST.DECL
‘Hanako is going to the UK.’ (lit. ‘Hanako is the plan that goes to the UK’ or ‘It is the plan where Hanako goes to the UK’)

The mermaid label reflects the fact that these are mixed constructions involving a full noun, *ki* ‘feeling’ and *yotei* ‘plan’, and an associated clitic copula *da* ‘be’ which taken together govern a dependent nominalized verb *ik-* ‘go’ and which translate as modal or aspectual markers. Tsunoda (2020) analyses these examples as monoclausal with the sequences *iku kida* and *iku yotei* being treated as complex predicates. Taguchi (2022), however, argues that the structures in question are bi-clausal and hence allow independent negation and adverbials for both predicates:

(54) Japanese
Kinoo Hanako=ga [asita Igirisu=ni ik-u]
yesterday Hanako=nom tomorrow UK=dat go-npst.adn
yotei=datta
plan=cop.pst.decl
'Yesterday Hanako planned to go to the UK tomorrow.'

(55) Japanese
Hanako=ga [Igirisu=ni ik-anai] yotei=dewanai
Hanako=nom UK=dat go-neg.npst.adn plan=neg.cop.pst.decl
'Hanako did not plan not to go to the UK.'

He therefore proposes the following lexical entries, where *ki* involves anaphoric control while *yotei* is treated as a raising verb with functional control:

(56) a. *ki* N (↑ pred) = 'ki⟨subj,comp⟩'
(↑ comp subj pred) = 'pro'

b. *yotei* N (↑ pred) = 'yotei⟨xcomp⟩subj'
(↑ subj) = (↑ xcomp subj)

Examples of the MC are found across a wide range of languages — twenty-six in Asia and one in Africa according to Tsunoda (2020: 1), to which Taguchi adds parallel examples from Scots Gaelic, Tatar and Russian. Here is not the place to compare these in detail and it may well be that, even if Taguchi is right and the monoclausal analysis does not hold for Japanese, this is the correct account for the construction in other languages. What more generally, therefore, this data demonstrates is the fuzzy border between raising/control constructions and complex predicates, and the likelihood that over time the former may develop into the latter (see Butt 2014, Booth & Butt 2023 [this volume] and the discussion in Section 13 below).

9 Copy raising, control and resumption

In addition to the widely discussed examples with an infinitival complement, the English verb *seem* also allows the pattern to be seen in (57) in which the subject of *be sick* appears to have been raised and replaced by the pronoun *he* in the complement clause.

(57) Alfred seems like/as if he's sick.

Structures of this kind have been labelled ‘copy raising’ with the pronoun being treated as ‘resumptive’ (Asudeh & Toivonen 2007, 2012; Asudeh 2012). The last-mentioned work in particular shows how this construction can be naturally accounted for by invoking resource logic and glue semantics, as well as demonstrating the cross-linguistic evidence for similar structures. As Asudeh (2012: chapter 12) shows, the availability of copy raising is lexically determined; it is attested with *seem* and *appear* but not for example with *tend*:

(58) *Alfred tends like he won.

The items in question will therefore have a lexical specification via a local copy name as in (59) together with the usual open function to link the main clause subject and the subject of the embedded predicate *like*:

(59) *seem* V $(\uparrow \textsc{subj})_\sigma$=$(\%\textsc{copy}_\sigma\ \textsc{antecedent})$
$(\uparrow \textsc{subj}) = (\uparrow \textsc{xcomp}\ \textsc{subj})$

(60) *like* P $(\uparrow \textsc{pred})$ = ‘like⟨comp⟩’

The f-structure for *like* needs to include the comp function in order to cope with the fact that the clause following *like* is finite. What has been more open to contention is its categorial status, with some arguing for it as a complementizer but with Asudeh opting for the more traditional assumption that it is a preposition. The latter is more plausible given that it can also take a simple NP as in *Alfred looks like his sister*. This solution would also allow for a transparent analysis of the *as if* alternant in (55) with *as* being a P parallel to *like* and with *if* as the c head of the embedded comp.[5] The prepositional account finds support in the analysis advanced by Camilleri (2018), also within the framework of LFG, of the parallel constructions in Maltese, as in (61) (= her example (32)):

(61) Maltese

qis-ha	bħal(likieku)	ta-w-ha	xebgħa
as.though-3f.sg.acc	as.if	give.3pfv-pl-3f.sg.acc	smacking

‘She’s as though they gave her a smacking.’

We see here a copy raising construction with a null copula (compare the Maltese data in (7) above) and where the optional element *likieku* is indeed a counterfactual complementizer but crucially can only occur in this construction as the complement of the preposition *bħal* ‘like’.

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[5] Gisborne (2010: chapter 7) also argues for treating *like* as a preposition albeit in the context of a different Word Grammar analysis of the construction as a whole. Landau (2011) by contrast opts for a derivation-based account in which *like* is treated as a complementizer.

Although space here has only allowed us to look at some core examples of this construction, this has sufficed to demonstrate the importance of such data for the analysis of the relation between semantics, syntax and lexis. Further issues concern the relation between these examples and the ones in (62):

(62) a. Alfred seems like Thora hurt him.
b. Alfred seems like Thora's hurt.
c. Alfred sounds/looks like he enjoyed the party.

In (62a) the co-referential argument is an object not a subject and in (62b) there is no overt co-referent but simply a context-derivable assumption that Alfred and Thora are somehow connected. Such an assumption makes clear the route by which the speaker has reached their conclusion, hence the label 'perceptual resemblance verb' (PRV) that has been applied to such items. (Compare too in this connection example (67b) in Section 12 below.) While Asudeh (2012: 351–356) demonstrates how examples like (62) and the dialect variation associated with them can be captured, Toivonen (2021) is an exploration of PRVs and the way they vary between English and Swedish.

This construction with raising verbs has its counterpart in the domain of control verbs as we saw in connection with the so-called 'copy control' construction exemplified in (44), where it is the thematic controller which recurs as a pronoun in the embedded finite clause.

10 The semantics of raising and control

While much of the literature both within and outside LFG seeks to account for control and raising effects in syntactic (i.e. f-structure and/or c-structure) terms, there is an important strand of work which argues that the phenomenon is at heart semantic (for English see Jackendoff & Culicover 2003, Culicover & Jackendoff 2006 and references there, Duffley 2014, and compare Akuzawa & Kubota 2020 for Japanese). In the words of Culicover & Jackendoff (2006: 152): 'Control should be taken out of the hands of the syntax and turned over to the semantics.'

In fact, these debates can be broken down into two separate, though not unconnected, issues. The first concerns the semantics of the governing predicates, which can be divided into a series of lexical sub-classes defined in terms of their semantic content of their predicates and hence their associated thematic roles. Thus, for example, in their treatment of control in Japanese, Akuzawa & Kubota (2020) distinguish the following classes:

(63) Attitudinal, e.g. *try*, *decide*
Commissive, e.g. *declare*
Directive, e.g. *order*
Implicative, e.g. *succeed*
Factive, e.g. *regret*

Such a list is clearly not exhaustive but it goes a good way towards predicting the types of structures and arguments that will be found with the items in the different classes. It is very much in line with the Culicover & Jackendoff way of thinking and with the recent work by Landau discussed below. That said, the fact remains that raising and control exhibit overt syntactic patterns that need to be accounted for. It is striking that the model deployed by Culicover & Jackendoff under the name 'Simpler Syntax' makes crucial use of grammatical relations (GR in their notation) rather than categorial structure in a way that is strikingly similar to the role of f-structure. By contrast a model like Role and Reference Grammar treats raising and control directly in terms of thematic roles without intervening recourse to grammatical functions (see Bentley & Vincent 2023 [this volume]). Within LFG, the role of meaning, and more precisely the relation between a-structure and f-structure, is handled by lexical mapping theory — see the chapter by Findlay et al. 2023 [this volume] — and semantically defined templates (Dalrymple et al. 2019: 230–237).

A separate issue concerns the semantic category to be assigned to the complement: is it to be treated as a proposition, as in Dalrymple (2001) or a predicate, as suggested by Asudeh (2005)? The proposition/predicate debate is one which arises in other frameworks. Thus, Pearson (2016) argues for the property interpretation contra Landau and the use of the contrast in relation to adjunct control in Landau (2021). We return to this issue in Section 11 and Section 12.

11 Predication vs logophoric anchoring

In a substantial contribution to the debate Landau (2015) proposes what he calls a 'two-tiered' theory of control, more precisely a binary division of OC; NOC remains outside this picture. On the one hand, there is logophoric anchoring where the controlling predicate is labelled 'attitudinal'.[6] This contrasts with predicative

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[6] The concept of logophoricity goes back to Hagège (1974) with specific reference to languages which distinguish between two sets of pronouns according to whether the antecedent is the speaker or not. Sells (1987) offers an early formalization in terms of Kamp's discourse representation structures. Landau's use of the term is rather more general but shares the key idea of reference back to the speaker.

anchoring, which applies to non-attitudinal verbs. The two classes can be further divided into sub-classes:

(64) a. attitudinal: desiderative, propositional, interrogative, factive, e.g. *want, refuse, agree, ask, pretend, plan, imagine*, etc.
  b. non-attitudinal: modal, aspectual, evaluative, implicative, e.g. *dare, see, remember*, etc.

Building on this distinction Landau (2015: 20) states the following generalization:

(65) Nonattitude complements force EC, attitude complements allow PC.

This in turn is worked out in terms of a semantic distinction between what he calls a 'property-denoting projection', which defines predicative control, and a 'propositional projection', which defines logophoric control. Propositional projections involve an extra layer of syntactic structure above the layer containing the property projection and hence they are 'two-tiered'. He sets out the properties of the two types of control in Table 4, and he sums up the resulting empirical contrasts between the two in Table 5.

Table 4: Properties of control constructions (Landau 2015: 83)

	Predicative control	Logophoric control
Semantic type of complement	<d,<e, <s,t>>>	<<e,<κ,e>>,<κ,t>>
Head of complement	transitive $\text{Fin}_{[u\text{D}]}$	transitive $\text{C}_{[u\text{D}]}$
Control and agreement are established via:	predication	predication + variable binding

The diagram from Landau (2015: 85) reproduced in Figure 1 shows his conception of the relations between the two types of control. Two questions then arise: do we need this distinction? And if not, how can the issues it is designed to address be accommodated within a framework like LFG? The answer to the first question is probably not and to the second, they already have been! Thus, as we have noted, Reed (2020) discusses objections to the two-tier account contrasting it with a single-tier approach and citing in this connection Haug (2014). She goes on to develop her own category-based syntactic account but once again we see that elaborating syntactic configurations is an alternative, and less economical, analytical strategy compared to the functional definitions that lie at the heart of LFG, especially once they are combined with a semantics of the Glue type.

Table 5: Empirical diagnostics of control constructions (Landau 2015: 65)

	Predicative control	Logophoric control
Inflected complement	✓	*
[– Human] PRO	✓	*
Implicit control	*	✓
Control shift	*	✓
Partial control	*	✓
Split control	*	✓

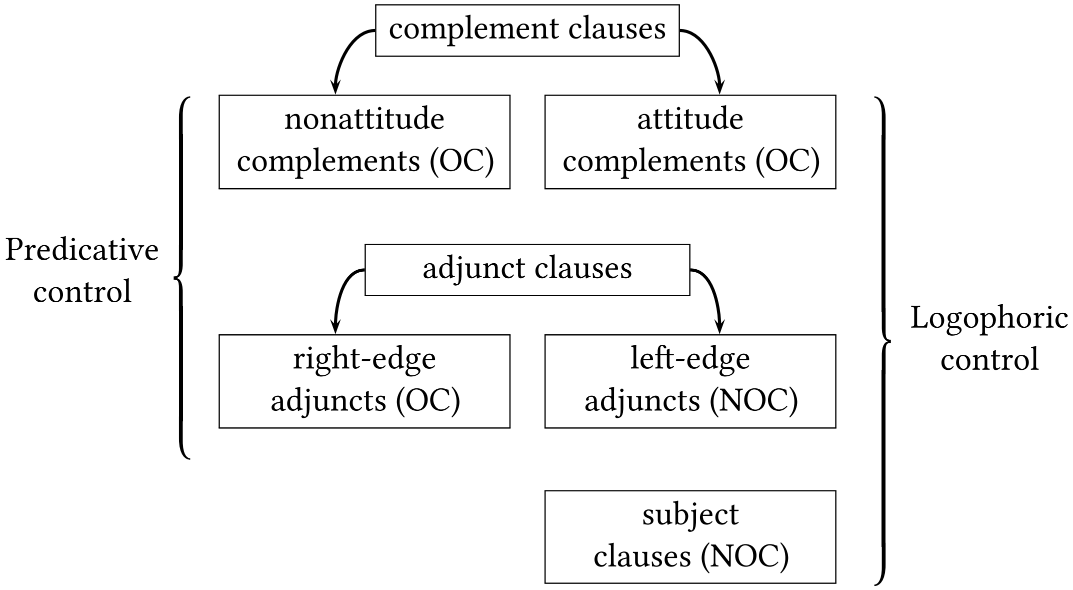

Figure 1: Landau's (2015) two types of control (his Figure 6.1)

12 Adjunct control

In the standard literature, adjunct control, as exemplified in (5) — repeated here in (66) for convenience — has received relatively little attention by comparison with other types of control:

(66) a. Glad to be home again, Sally waved to her neighbours in the garden.
b. Bill called a plumber to fix the drain.
c. Sally came across Bill in the garden crying his eyes out.

Recently, however, there have been some significant contributions which provide interesting contrasts in the way the phenomenon can be modelled. Thus, Green (2019) extends the movement account and challenges an early version of the approach now developed in Landau (2021), where he builds on the two-tier model discussed in the previous section. The LFG account developed in Donaldson (2021a) adopts a similar line of argument, but this is revised in Donaldson (2021b).

Consider the pair of examples cited at the beginning of Donaldson (2021b):

(67) a. Watching him, Thrasher realized that something in his appearance didn't ring true. (Green 1956: *The Last Angry Man*)

b. Watching him, it seemed as if a fibre, very thin but pure, of the enormous energy of the world had been thrust into his frail and diminutive body. (Woolf 1942: *The Death of the Moth*)

In (67a) the missing subject of *watching him* is supplied by the subject of the main clause. By contrast, *his* in *his appearance* is interpreted pragmatically as referring to the same individual as referenced by *him*. If *appearance* was replaced by *memory*, the natural antecedent of *his* would be *Thrasher*. Similarly, it is the context in (67b) which leads the reader to link *him* and *his body*. However, it is also the context that determines the missing subject of *watching him* since there is no argument in the main clause which can fill that role. In short, there is no debate over the fact that structures like (67b) require an extrasentential interpretation of the missing argument, in other words arbitrary anaphoric control and hence in the rightmost box of Haug's Table 1 above.

When it comes to examples like (67a), however, different accounts have been proposed. Donaldson (2021a) follows a line of analysis within LFG going back to Mohanan (1983) and argues that the strict link in interpretation between the missing argument and the subject of the main clause is best treated as an instance of functional control providing the link to the open XADJ clause. However, Donaldson (2021b) notes that a functional control analysis will not generalise to examples like (68) where there is an embedded gerund, but nonetheless the two types of structure pattern similarly in other respects as can be seen in (69).

(68) After a year of complaining, Bill finally left his job.

(69) a. After three days of preparing himself/*herself, Bill spoke to Sue.

b. While preparing himself/*herself, Bill helped Sue.

He therefore proposes an obligatory anaphoric control analysis for both. How then do we distinguish between obligatory and arbitrary anaphoric control in adjuncts?

Adjunct control cross-cuts the opposition between OC and NOC, leading Landau (2021: 21) to propose the following criteria:

(70) a. Locality: an OC controller must be an argument of the clause immediately dominating the adjunct.
  b. Humanness: PRO in NOC, but not in OC, must be [+ human]

A different issue concerns the location of the adjunct clause. As is clear from Figure 1, Landau consider his two-tier theory to apply to both and draws a distinction between right edge adjuncts, which involve OC and are predicative, and left edge adjuncts, which involve NOC and are logophoric (compare already Williams 1992 on logophoricity and adjunct control). Hence by the principle in (70b) left edge adjuncts will be interpreted as holding of a human argument. This conclusion appears to be supported by the examples in (71) cited by Donaldson (2021b):

(71) a. Being made of stainless steel, rust won't be an issue. (after Davies 2018)
  b. * Rust won't be an issue, being made of stainless steel.
  c. The knife resists rusting, being made of stainless steel.

(71a) is acceptable even though the extrasentential controller is necessarily inanimate, while (71b) fails because the adjunct is now left edge and therefore is required to be human unless it can be interpreted as an instance of OC as in (71c).

An alternative account of the difference between OC and NOC adjuncts is advanced by Fischer & Høyem (in preparation, 2022). Instead of a reference to right and left they distinguish the levels of emebedding and hence syntactic scope as the determining factor. OC is limited to arguments within the verbal domain, while proposition modifying adjuncts, which display NOC properties, are interpreted on the basis of pragmatic factors. The common property of all of these accounts is that they involve a scale moving from syntax (whether relationally or categorially defined) through semantics to pragmatics, a scale which we have now seen more than once is best defined in the terms of Haug (2013, 2014) rather than always being reduced to a syntactic configuration. An interesting additional dimension introduced by Donaldson is that of processing, who adduces the psycholinguistically based principle that, in his words, 'language users guess at a controller as soon as it becomes apparent that one is required' (Donaldson 2021b:

100), and hence with differential consequences for initial, medial and final adjuncts. There are also parallels here with the linearization effects noted by Haug (2017) in connection with examples like (51) above.

13 The diachrony of raising and control

Most of the literature on raising and control constructions is synchronic in orientation but there has been some work on the way these patterns may change over time. In this section we will briefly consider some case studies and the contribution made by an LFG-based approach to modelling them.

Our first examples come from the work of Barron (1997, 2001) on the historical development of 'seem' verbs from verbs of perception. One such is Latin *videri*, formally the passive of the verb *videre* 'see' but commonly used in the sense of 'seem' as in (72) contrasted with its literal meaning in (73):

(72) Latin

… ill-orum	beata	mors	vid-et-ur
they-GEN.PL	blessed.NOM.F.SG	death.NOM.F.SG	see-PRS.3SG-PASS

'… their death seems blessed' (Cicero *De amicitia* 23,7)

(73) Latin

ubi	sol	etiam	sex	mensibus	continuis	non
where	sun.NOM.SG	even	six	month.ABL.PL	continual.ABL.PL	NEG
vid-et-ur						
see-PRS.3SG-PASS						

'where the sun is not seen for six months in a row' (Varro *Res rusticae* 1,2,4)

What (72) and (73) share is that the perceiver argument has been suppressed and in consequence the object of perception comes to fill the SUBJ function in virtue of the Subject Condition. However, the verb's inflectional morphology and the syntactic configuration of the clause remain unchanged. In Latin both uses are attested over a long time span, but following the general principle of grammaticalization that concrete meanings develop into abstract ones rather than vice versa, it is reasonable to suppose that the 'be seen' meaning is older than the 'seem' meaning.

The diachronic sequence is not in doubt in Barron's second example, namely the development of French *sembler* and Italian *sembrare*, both meaning only 'seem', from the Latin *simulare* 'pretend'. At the level of function and argument structure the change is parallel. In this case, the ‘pretender’, that is to say the causer of the perception has been lost with the result that the object that has been made to appear takes over the subject role.

While the above examples involve the historical shift into a raising function of items that were already etymologically verbs, our next examples, drawn from Camilleri & Sadler (2019), show how the same verbal function may develop from items that belong to other categories, specifically here a noun *šakl* ‘shape, form’ and a preposition *zēy* ‘like’. Example (74) shows the ‘shape’ word in its nominal use together with a dependent genitive and a predicative adjective that can agree either with the masculine head *šakl* or its possessive feminine dependent *dærah* ‘circle’. (Note here that there is no copula since this is present tense, as with the Maltese example (7a) above.)

(74) Egyptian
šakl id-dærah mdawwar/mdawwar-ah
shape.m.sg def-circle.f.sg round.m.sg/round-f.sg
‘The shape of the circle is round.’

In (75) by contrast *šakl* serves as a raising predicate taking the perfective *rigiʕ* ‘return’ as its complement:

(75) Egyptian
Morsi šakl-u rigiʕ
M. shape-3m.sg.gen return.pfv.3m.sg
‘Morsi seems to have come back.’

In LFG terms the diachronic development here involves a shift from the predicate ‘šakl⟨poss⟩’ to ‘šakl⟨xcomp⟩subj’.

Camilleri & Sadler’s (2019) second case can be seen in the difference between the examples (76) and (77) from two different varieties of Algerian Arabic drawn from studies conducted at different time periods:

(76) Saïda Algerian Arabic, 1908
lābes zēy el-mɣāṛba
wear.act.ptcp.m.sg like def-moroccan.pl
‘He was wearing (i.e. dressed) like Moroccans.’

(77) Djidjelli Algerian Arabic, 1954
zēyu nsā-na
like.m.sg.gen forget.pfv.3m.sg-1pl.acc
‘He seems to have forgotten us.’

In this instance the source is prepositional but the outcome once again is a raising predicate: ‘ZĒY⟨XCOMP⟩SUBJ’. Semantic parallels for this development are to be seen in the use of English like in the copy-raising constructions reviewed in Section 9 and in the origin of Latin *simulare* ‘pretend’ discussed above as a causative built on the same stem as *similis* ‘similar’.

What all these examples taken together demonstrate is that it not the categorial status of the etymon — verb, noun, adposition respectively — that unites them but a common semantic core plus a the transition to the functional structure ⟨XCOMP⟩SUBJ, a shared development that a framework like LFG is ideally equipped to model.

We move now to the development of a control predicate, namely WILL verbs in Germanic. These can all be traced back to the Proto-Indo-European root **wel-*, and are cognate with Latin *velle* ‘want’ which in turn is the source of French *vouloir* and Italian *volere* discussed in Section 6. As Börjars & Vincent (2019) show in detail, comparing items across the family reveals a sequential development from the original ‘want’ meaning through to the future and intentional meanings of modern English. The most conservative languages are Swedish and Icelandic where in the modern languages the verb *vilja* has only ‘want’ meanings and in that respect resembles the Danish pattern set out in (36) above. Modern English *will*, by contrast, has lost these uses though they are attested in Old and Middle English. Danish stands in between in the sense that it has retained the ‘want’ meanings but has also developed the intention and future meanings. Hence an example like (78) is ambiguous:

(78) Danish
Peter vil hjælpe dig
Peter will.PRS help.INF you.ACC
‘Peter will help you.’ OR ‘Peter wants to help you.’

Within grammaticalization studies developments of this kind are typically modelled in terms of informal scales or semantic maps (Bybee et al. 1994, Narrog & van der Auwera 2011) such as the one proposed in Börjars & Vincent (2019: 301):

(79) DESIRE > INTENTION > PREDICTION

We can now offer a more refined version of this development; in effect a diachronic instantiation of Haug’s scale:

(80) QUASI-OBLIGATORY AC > AC > FC > PREDLINK

What we see here, then, is the development from an independent lexical item to control verb to raising verb and ultimately to simple of marker of tense and/or aspect, as is consistent with the cross-linguistic diversity in the etymology of control and raising verbs (Barron 2001, Vincent 2019). One may compare too the diachronic development from control verb to complex predicate discussed in Butt (2014) and in Booth & Butt 2023 [this volume].

14 Conclusion

The general conclusion that emerges from this chapter, in line with the view expressed by Landau (2013: 257–258), is that control and raising do not constitute a unitary phenomenon. Rather such pre-theoretical labels subsume a variety of structural possibilities that vary across languages and which may change over time. However, contrary to Landau (2013, 2015), we argue that these patterns not only can be captured within a framework like LFG but also that a parallel correspondence model of this kind, which does not make all generalizations hinge on syntactic configurationality, has the potential to offer richer insights in both the synchronic and diachronic domains.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

ACT	active	HAB	habitual
ADN	adnominalizer	INFL	head of IP
C	complementizer	POT	potential
EXH	exhortative	PRT	particle

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Part III

Grammatical modules and interfaces

Chapter 15

Glue semantics

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Glue Semantics is a general framework for semantic composition and the syntax–semantics interface. It assumes an autonomous syntax and therefore needs to be paired with some syntactic theory. Here the focus is on LFG as the syntactic theory. The Glue logic, a fragment of linear logic, is presented first. This highlights the resource sensitivity of semantic composition in Glue. Second, Glue is presented without reference to LFG or any other syntactic theory. This highlights Glue's property of flexible composition. Third, the syntax–semantics interface is considered. This highlights Glue's autonomy of syntax and serves as a way to compare and constrast Glue with well-known alternatives. Fourth, Glue is paired with LFG (LFG+Glue), which highlights another important property of the theory, syntax/semantics non-isomorphism. Lastly, a number of particular phenomena are briefly reviewed and their analyses sketched: quantifier scope, modification, tense, events, argument structure, multiword expressions, and anaphora.

1 Introduction

The fundamental principle of compositional semantics is the following:

(1) *Principle of Compositionality (PoC)*
The meaning of a whole is a function of the meanings of the parts.
(Partee 1995)

According to the PoC, the meaning of an expression depends on its parts, but also on its syntax. The aspects of syntax that are relevant are standard features like NUM, PERS, TENSE, etc., as well as syntactic predicate-argument relations and local and non-local syntactic dependencies. These are all represented in f(unctional)-structure in LFG, so the relevant syntactic representation for compositional semantics in LFG is f-structure.

Ash Asudeh. 2023. Glue semantics. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 651–697. Berlin: Language Science Press. DOI: 10.5281/zenodo.10185964

But how are compositionally relevant features and relations obtained from f-structure? This is really a question about the mapping between syntax and semantics, or the nature of the *syntax–semantics interface*.[1] There are two fundamental ways in which different levels in LFG's Correspondence Architecture (Kaplan 1987, 1995) can be related: *description by analysis* and *co-description*. Both methods have been applied to the syntax–semantics interface in LFG.

Halvorsen (1983) developed the initial semantics for LFG, in which an f-structure is analyzed for features, including grammatical functions and other relational dependencies, to obtain a description of the compositional semantics. This is an example of *description by analysis* (Halvorsen & Kaplan 1988, Kaplan 1995) and is similar in spirit to Logical Form (LF) semantics (Heim & Kratzer 1998), even though the input syntactic structures are formally quite different. The description-by-analysis approach to LFG semantics effectively makes the same assumption as LF semantics: the semantic interpretation function applies to an entire syntactic structure — a standard non-tangled tree in LF semantics or an f-structure in description-by-analyses semantics for LFG.

Halvorsen & Kaplan (1988) offered a co-description alternative. According to co-description, a lexical item specifies its c-structural category, which captures its syntactic distribution, and also simultaneously specifies its contributions to f-structure, s(emantic)-structure, and any other grammatical modules. The contribution to f-structure, s-structure, etc., is accomplished through a set of constraints and equalities whose solutions determine the lexical item's non-c-structural contributions.[2] Thus, a syntactic formative on this view simultaneously *co-describes* its contributions to compositional semantics.

Glue Semantics (Glue) further develops and logically systematizes the co-description idea of Halvorsen & Kaplan (1988).[3] In contrast to description by analysis, co-descriptive LFG semantics is in the spirit of the syntax–semantics interface tradition that developed out of the *rule-by-rule* approach of Montague (1973), to use the terminology of Bach (1976). This tradition is standardly exemplified by Categorial Grammar (CG; for a basic overview and foundational references, see

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[1] Unfortunately, this term has been somewhat bleached of meaning through overuse in syntactic theory, where the mapping is often not specified in sufficient detail.

[2] See Asudeh (2012: ch. 3) for a basic introduction to one version of the Correspondence Architecture.

[3] The implementation of Glue that was developed for the Xerox Linguistic Environment (XLE) implementation of LFG (Crouch et al. 2011) used description-by-analysis, but out of necessity rather than by design. The co-descriptive version of Glue would have required changes to the underlying XLE implementation, whereas description-by-analysis Glue did not. Also see Andrews (2008) for a consideration of description-by-analysis versus co-description approaches to Glue.

Wood 1993). In fact, Dalrymple, Gupta, et al. (1999) discuss how Glue is strongly related to Categorial Grammar in the type-logical tradition (for overviews and further references, see e.g., Carpenter 1997, Morrill 1994, 2011, Moortgat 1997).

However, Glue Semantics and Categorial Grammar make distinct assumptions about the relation between the syntax of word order and the syntax of compositional semantics (for discussion and further references on this aspect of CG, see Steedman 2014). LFG's claims about Universal Grammar (Bresnan et al. 2016: ch. 4) serve to highlight the distinction. C-structure, which represents word order, is highly variable cross-linguistically, whereas f-structure, which represents syntactic features and dependencies, is largely invariant cross-linguistically. This is reflected in the fact that although embedding is significant at f-structure, order among features in the same f-structure is not, as shown in (2) and (3):

(2)
$$\begin{bmatrix}\textsc{att1} & \begin{bmatrix}\textsc{att2} & \textsc{val}\end{bmatrix}\end{bmatrix}$$
$$\neq \begin{bmatrix}\textsc{att2} & \textsc{val}\end{bmatrix}$$

(3)
$$\begin{bmatrix}\textsc{att1} & \textsc{val1}\\ \textsc{att2} & \textsc{val2}\end{bmatrix}$$
$$= \begin{bmatrix}\textsc{att2} & \textsc{val2}\\ \textsc{att1} & \textsc{val1}\end{bmatrix}$$

A language with relatively free word order (e.g., Warlpiri) has quite different c-structures from a language with relatively fixed word order (e.g., English). However, the two languages have similar f-structures, which predicts that they are similar with respect to syntactic features and dependencies (Bresnan et al. 2016: ch. 1). It would be antithetical to the theory for compositional semantics to be computed from c-structure, since the cross-linguistically relevant information for semantics is captured in the unordered f-structure. So Glue Semantics uses a commutative logic for composition, which turns out to yield insights beyond those which originally motivated Glue.[4] This will be explored more carefully below, from a higher level perspective.

The first papers in the Glue Semantics (Glue) framework were published in the mid-nineties (Dalrymple et al. 1993, Dalrymple, Lamping, Pereira, et al. 1995, Dalrymple, Gupta, et al. 1997, Dalrymple, Lamping, Pereira, et al. 1997). The initial major publications on Glue, including revised versions of most of these papers, appeared in Dalrymple (1999). These publications all assumed some version of

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[4] Note that the term *logic* here is intended not merely in the sense of a representational language for meaning, but rather a deductive system for deriving formulae from other formulae, i.e., proving conclusions from premises and previously proven conclusions.

LFG syntax. It should be borne in mind, however, that Glue Semantics (Glue) is a general framework for semantic composition and the syntax–semantics interface and is in that sense independent from LFG per se. The key syntactic assumption that Glue makes is headedness, which is universal across formal syntactic theories, even if specifics vary. Glue thus offers a highly flexible and adaptable approach to semantic composition and the syntax–semantics interface. In addition to LFG, Glue Semantics has been defined for a number of syntactic frameworks, including Lexicalized Tree-Adjoining Grammar (Frank & van Genabith 2001), HPSG (Asudeh & Crouch 2002b), Minimalism (Gotham 2018), and Universal Dependencies (Gotham & Haug 2018).

Asudeh (2022: 324) highlights the following high-level properties of Glue Semantics:[5]

1. *Resource-sensitive composition*
   The logic of composition in Glue is *resource-sensitive*: The underlying logic of composition itself requires that all and only the resources/premises instantiated from the syntax are used in semantic composition.
2. *Flexible composition*
   The logic of composition in Glue is *commutative*. Semantic composition is systematically related to and constrained by syntax, but is not determined by syntactic word order. Semantic composition is tightly restricted by resource-sensitive composition.
3. *Autonomy of syntax*
   The logical assumptions of Glue yield a truly autonomous syntax, as a corollary of flexible composition. Semantic composition is commutative, but syntax is not: Syntax is subject to word order constraints that do not apply to semantic composition.
4. *Syntax/semantics non-isomorphism*
   Grammatical formatives, e.g. lexical items, may contribute multiple Glue terms that are all contributed to the semantic proof or no Glue terms at all, as a corollary of autonomy of syntax. There is no requirement that a formative must make exactly one contribution to interpretation.

In Asudeh (2022), I used these properties as organizing themes for a big-picture discussion that mostly backgrounded the combination of LFG in particular with

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[5] My thanks to an anonymous reviewer of Asudeh (2022) for suggesting the term *syntax/semantics non-isomorphism.*

Glue (often called LFG+Glue). Here I wish instead to foreground LFG+Glue, but it is nevertheless useful to have these properties in one place, as they will occasionally be referred to below.

I also want to emphasize that these properties are not fully independent, at least as given. The degree of resource sensitivity flows from the particular fragment of *linear logic* (Girard 1987) that one chooses for the Glue logic, but the implicative fragment with universal instantiation is commonly used and this fragment is highly resource sensitive, as explained in the next section. From resource sensitivity flow some automatic constraints on flexible composition such that it's not just 'anything goes.' Flexible composition in turn permits true autonomy of syntax, which fits naturally within LFG's general ethos of allowing mismatches between distinct linguistic modules in the Correspondence Architecture (Kaplan 1987, 1995, Asudeh 2006). Lastly, since syntax is autonomous from semantics, given flexible composition, it does not follow that a compositional analysis is only possible if each formative contributes exactly one meaning to semantic composition. Formatives may contribute nothing to meaning, e.g. expletive subjects or *do*-support *do*, or contribute multiple meanings to semantic composition.

2 The Glue logic: Resource-sensitive composition

The Glue logic is a fragment of *linear logic* (Girard 1987, Crouch & van Genabith 2000). Linear logic can be thought of as a logic of resources: Each premise in a linear logic proof must be used exactly once.[6] This can be usefully understood from the perspective of *substructural logics.* Substructural logics "focus on the behaviour and presence — or more suggestively, the *absence* — of *structural rules.* These are particular rules in a logic which govern the behaviour of collections of information." (Restall 2000: 1–2; emphasis in original). The basic intuition is that the choice of structural rules allows a precise logical characterization of some system of information. Language can be construed as information. For example,

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[6] Girard (1987) defines two modal operators for linear logic, ! (*Of course!*) and ? (*Why not?*). These operators prefix particular premises (e.g., $!A$ or $?A$). This allows resource accounting to be turned off for the premise. Some early work in Glue used the ! modal in the analysis of coordination (Kehler et al. 1995, 1999). However, Asudeh (2004, 2005a) argued for a stricter notion of resource sensitivity that results from a simpler modality-free fragment of linear logic. Asudeh & Crouch (2002a) present a polymorphic Glue analysis of coordination (Steedman 1985, Emms 1990, 1992). The Asudeh & Crouch (2002a) approach does not require the modality; also see Dalrymple et al. (2019: ch. 16).

Chomsky (1986, 1995) can be understood as characterizing language as information from a cognitive perspective. Another example is the characterization of language as information from a logical perspective, as in van Benthem (1991).

Three structural rules that are particularly relevant to substructural logics for linguistics are *weakening*, *contraction*, and *commutativity*:[7]

(4) *Weakening* Intuition: A premise can be *freely added*

$$\frac{\Gamma \vdash B}{\Gamma, A \vdash B}$$

(5) *Contraction* Intuition: Any additional occurrence of a premise can be *freely discarded*

$$\frac{\Gamma, A, A \vdash B}{\Gamma, A \vdash B}$$

(6) *Commutativity* Intuition: Premises can be *freely reordered*

$$\frac{\Gamma, A, B \vdash C}{\Gamma, B, A \vdash C}$$

If a logic *lacks* the rules of weakening and contraction, then premises in the logic cannot be added or discarded and the logic is therefore a *resource logic*.

However, we can also distinguish logics based on commutativity: A resource logic can be commutative or non-commutative. Linear logic is a commutative resource logic. In contrast, the Lambek logic L (Lambek 1958) is a non-commutative resource logic. L is the fundamental logic of the Lambek calculus, the basis for the type-logical approach to Categorial Grammar (see, e.g., van Benthem 1991, Moortgat 1997). The diagram in Figure 1 shows linear logic in a space of related substructural logics.[8]

The appropriate resource logic for semantics alone is a commutative resource logic. Semantic composition is resource-sensitive but does not show evidence of order-sensitivity in its own right (Asudeh 2012: ch. 5). Consider the general case

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[7] The notation in these structural rules is understood as follows. Γ denotes a set of terms in the logic, whereas A, B denote particular terms in the logic. The single turnstile denotes a valid derivation/proof from the lefthand side to the righthand side; e.g., $\Gamma \vdash B$ means that B can be proven from Γ. The horizontal line separating the top and bottom of the rule means that the bottom can be derived from the top by the rule in question (i.e., the top *sequent* can be replaced by the bottom one). For example, the weakening rule states that, given $\Gamma \vdash B$, one can conclude $\Gamma, A \vdash B$; i.e., every instance of $\Gamma \vdash B$ can be replaced by $\Gamma, A \vdash B$, given the rule.

[8] Note that the relation between intuitionistic logic and classical logic is characterized by the addition of the law of the excluded middle. However, this law is not strictly a structural rule, hence the dashed rather than solid line in Figure 1.

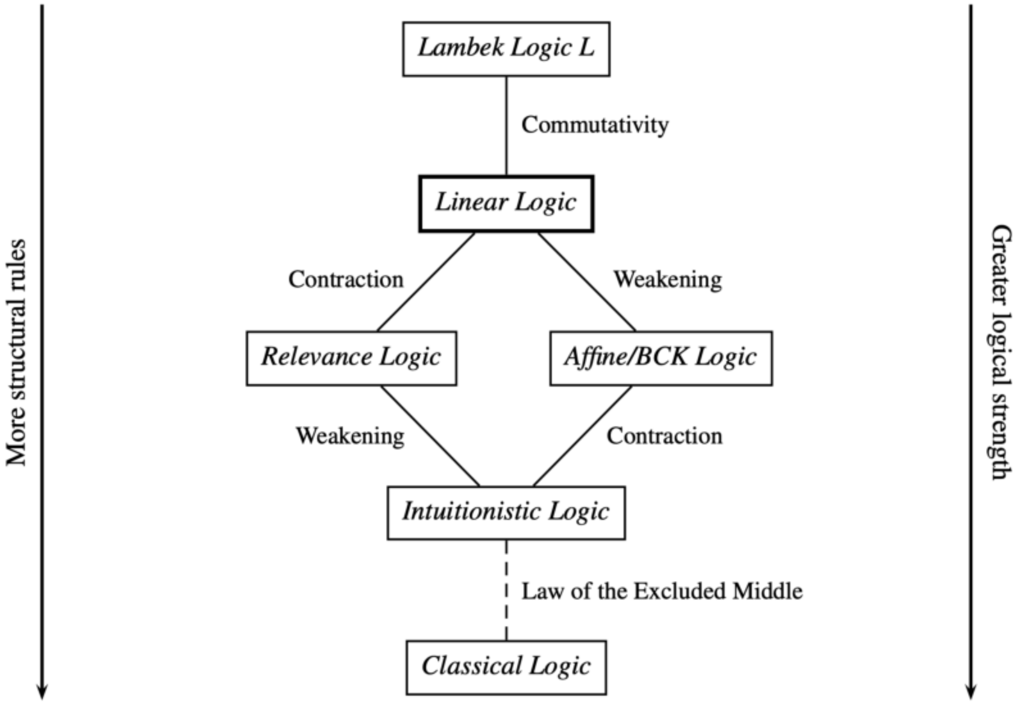
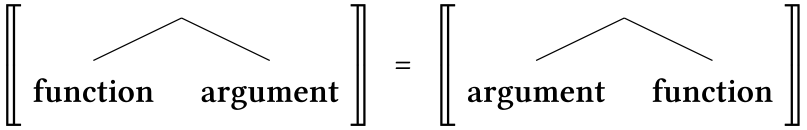


Figure 1: Hierarchy of logics related by structural rules (Asudeh 2012: 103; used with permission)

of some binary structure that is to be interpreted. If one branch denotes a function and the other denotes an argument, the function applies to the argument, whether the function is on the left or right:

(7)



For example, in English basic word order, the function that is the denotation of a transitive verb takes its argument to the right, but the resulting function that is the denotation of the VP takes its argument to the left.

It is not the *order* of the function and argument that determines their composition, but rather their semantic types (Klein & Sag 1985). This is saliently exemplified by the rule of functional application in the widely familiar system of Heim & Kratzer (1998: 44, 95). It is also exemplified by the equivalent interpretations of the forward and backward slash rules of Combinatory Categorial Grammar (see, e.g., Steedman 1987: 406 or Steedman & Baldridge 2011: 186).

But how is semantics resource-sensitive? The following quote from Klein & Sag (1985: 172) illustrates:

> Translation rules in Montague semantics have the property that the translation of each component of a complex expression occurs exactly once in the translation of the whole. … That is to say, we do not want the set S [of semantic interpretations of a phrase] to contain all meaningful expressions of IL [Intensional Logic] which can be built up from the elements of S, but only those which use each element exactly once.

In other words, Montague's (1973) translation rules are resource-sensitive. However, this is merely coincidental as far as his translation process is concerned. In their generalization of Montague's system, Klein & Sag (1985: 174) need to define an operation of *bounded closure*. This operation ensures that the meaning of each element of semantic composition is indeed used "exactly once."

We can obtain this result in a more general way, if we adopt a resource logic for semantic composition. This rests on the absence of the structural rules of contraction and weakening. The lack of contraction means that the number of occurrences of a premise matters, so a set of linear logic premises is a *multiset* (sometimes called a *bag*). The lack of weakening means that the bag must be emptied in constructing a valid proof. In other words, it follows directly from the absence of contraction and weakening that "each element" must be used "exactly once". Klein & Sag's (1985) bounded closure is effectively an attempt to capture the logical resource sensitivity of linear logic or L (Asudeh 2012: 110–111).

Logical resource sensitivity in turn forms the basis for linguistic resource sensitivity (Asudeh 2012: ch. 4). This is achieved by placing a linguistically motivated goal condition on the Glue logic proof; for example, we can require that the proof of a sentence terminates in a single meaning constructor of type t (Dalrymple, Gupta, et al. 1999). Asudeh (2012: 110–123) argues that resource-sensitive composition not only directly captures bounded closure, it arguably also captures a diverse set of principles across a variety of frameworks. These include Completeness and Coherence (Kaplan & Bresnan 1982), the Theta Criterion (Chomsky 1981), the Projection Principle (Chomsky 1981, 1982, 1986), No Vacuous Quantification (Chomsky 1982, 1995, Kratzer 1995, Kennedy 1997, Heim & Kratzer 1998, Fox 2000), the Principle of Full Interpretation (Chomsky 1986, 1995), and the Inclusiveness Condition (Chomsky 1995).

In addition, it seems that phonology and syntax can equally be considered resource-sensitive, i.e. lack weakening and contraction from a logical perspective, as outlined in Asudeh (2012: 98–99). This allows a deeper generalization about natural language as computation (Steedman 2007), namely that *natural language is resource-sensitive*. The claim is set out in the *Resource Sensitivity Hypothesis* (Asudeh 2012: 95). Where phonology and syntax contrast with semantics is not with respect to weakening and contraction, but rather with respect to commutativity. Phonology is strictly non-commutative, whereas syntax shows commutativity in some circumstances of free word order. This leaves two options. The partial commutativity of syntax can be captured by separating the syntax of structure from the syntax of composition, treating the syntactic module(s) autonomously, as in Glue Semantics. Alternatively, partial commutativity can be captured by not separating structural and compositional syntax and instead introducing a mechanism to the syntax–semantics interface that relaxes commutativity in what is otherwise a non-commutative system. An example of such a mechanism is the categorial modalities of Baldridge (2002).

3 Glue without LFG: Flexible composition

Linguistic meanings in Glue are encoded in *meaning constructors*. Meaning constructors are pairs of terms from two logics. These terms can be represented as $\mathcal{M}$ and G (where $\mathcal{M}$ is mnemonic for *meaning language* and G is mnemonic for *Glue logic*). These could be written in any conventional way for writing pairs, such as $\langle \mathcal{M}, G \rangle$, but most Glue work of the past couple of decades has written the pair using an uninterpreted colon as a pairing symbol, as in (8):

(8) $\mathcal{M} : G$

The meaning language can be anything that supports the lambda calculus, such as the simply typed lambda calculus that is often used in linguistic semantics. However, more specialized lambda languages can be used, as in van Genabith & Crouch (1999), Bary & Haug (2011), and Lowe (2015), which all use Muskens's (1996) Compositional Discourse Representation Theory (CDRT) or Dalrymple et al. (2019: ch. 14), which uses Haug's (2014) partialized version, Partial Compositional DRT (PCDRT). The glue logic is a fragment of *linear logic* (Girard 1987). The glue logic specifies semantic composition based on a syntactic parse that instantiates the general terms in G to a specific syntactic structure. The meaning constructors thus serve as *premises* in a linear logic *proof* of the compositional semantics.

The linear logic implication connective, $\multimap$,[9] is the basis for the fundamental compositional rule of functional application. Functional application corresponds to linear implication elimination in natural deduction style:

(9) Functional application:
Implication elimination modus ponens

$$\frac{\beta : A \multimap B \qquad \alpha : A}{\beta(\alpha) : B} \multimap_{\mathcal{E}}$$

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[9] This is the *multimap* symbol, but it is often referred to in Glue discourse as the *lollipop*.

The implication elimination rule is standard modus ponens. The rule is read as follows: given $\beta : A \multimap B$ and given $\alpha : A$, it is valid to conclude $\beta(\alpha) : B$.

The Curry-Howard Isomorphism (CHI; Curry & Feys 1958, Howard 1980) determines the correspondence between the term to the left of the colon — a term from $\mathcal{M}$ — and the term to right of the colon — a term from G. The CHI puts logical formulas in correspondence with computational types. Here linear logic formulas are in correspondence with types in the lambda calculus.[10] The terms A, B in (9) are schematic for possibly complex formulas; α, β may similarly be complex terms.

The rule for linear implication introduction corresponds to functional abstraction.

(10) Functional abstraction:
Implication introduction — hypothetical reasoning

$$\begin{array}{c} [\alpha : A]^{1} \\ \vdots \\ \beta : B \\ \hline \lambda\alpha.\beta : A \multimap B \end{array} \multimap_{\mathcal{I},1}$$

In this schema, a hypothesis is uniquely flagged with a numerical index. The fact that it is a hypothesis — i.e. not a premise encoded by a meaning constructor — is indicated by square brackets. If a conclusion can be derived through some series of proof steps (indicated by the vertical ellipsis), given the hypothesis, then we know that the hypothesis implies the conclusion: the hypothesis is discharged (as the antecedent of an implication with the conclusion as the consequent) and its flag is withdrawn. In the meaning language, this corresponds to abstraction over the variable introduced on the meaning language side of the hypothesis.

Let’s turn to a simple linguistic example:

(11) Blake called Alex.

---

[10] Some early papers in Glue (Dalrymple et al. 1993, Dalrymple, Lamping, Pereira, et al. 1995, 1997, Crouch & van Genabith 1999, van Genabith & Crouch 1999, Fry 1999a, Kehler et al. 1999) used a more ad-hoc method of relating the meaning terms to the Glue logic, but Dalrymple, Gupta, et al. (1997, 1999) introduced the Curry-Howard approach to Glue, which is now standard. Kokkonidis (2008) introduced an alternant called *First-Order Glue* which has also proven influential in subsequent Glue literature (e.g., Bary & Haug 2011, Lowe 2014, Gotham 2018, Gotham & Haug 2018, Findlay 2019; see also Andrews 2010 for a related proposal).

Let us assume the following meaning constructor for the verb *called*, leaving tense aside:[11]

(12) $\lambda y.\lambda x.call(y)(x) : a \multimap b \multimap c$

On the Glue side, *c* is mnemonic for *called*, *a* for *Alex*, and *b* for *Blake*. This meaning constructor would in fact be specified in some general form but instantiated relative to a particular syntactic structure. For now, let us just assume that some instantiation has given us the meaning constructor in (12). In Section 5 below, we'll see how to specify meaning constructors in general terms given LFG's usual f-description language.

Assuming that the lexical entries for *Alex* and *Blake* contribute meaning constructors that are instantiated to $alex : a$ and $blake : b$, we can construct the following proof, given (12); note that $\Rightarrow_\beta$ indicates β-reduction of a lambda term.

(13)
$$\frac{blake : b \qquad \dfrac{\lambda y.\lambda x.call(y)(x) : a \multimap b \multimap c \qquad alex : a}{\lambda x.call(alex)(x) : b \multimap c}\,{\multimap_{\mathcal{E}}, \Rightarrow_\beta}}{call(alex)(blake) : c}\,{\multimap_{\mathcal{E}}, \Rightarrow_\beta}$$

The meaning term in the conclusion is equivalent to $call(blake, alex)$ in the commonly used relational notation (Montague 1973).

Note that proofs are abstract mathematical objects that can be written down in various ways. This is quite apart from whatever convention or notation we choose for writing them down. For example, even holding constant our natural deduction notation, what is shown in (13) is just one of four ways to write down the single abstract normal form proof (Prawitz 1965). Writing the proof down imposes an order,[12] but since the Glue logic is commutative (see Section 2 for further details), all four written representations of the proof are equivalent.

Given the commutativity of the Glue logic, the arguments of the function can be freely reordered (re-curried), as in (14) below, but still yield the appropriate meaning:

(14) $\lambda x.\lambda y.call(y)(x) : b \multimap a \multimap l$

Example (15) below is a schematic demonstration of how this argument reordering works in a proof; the example abstracts away from the particular *call* function. The example also shows the implication introduction rule in action.

---

[11] Note that the lambda term $\lambda y.\lambda x.call(y)(x)$ is equivalent to the function *call* by η-equivalence in the lambda calculus. However, it is useful for the exposition below to present it in non η-reduced form.

[12] The *Alex* meaning constructor/premise must be written either to the right or left of the functional (verb) meaning constructor and similarly for the *Blake* meaning constructor/premise.

(15)
$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\lambda y.\lambda x.f(y)(x) \,:\, a \multimap b \multimap c \qquad [v \,:\, a]^1}{\lambda x.f(v)(x) \,:\, b \multimap c}\multimap_{\mathcal{E}} \qquad [u \,:\, b]^2}{f(v)(u) \,:\, c}\multimap_{\mathcal{E}}}{\lambda v.f(v)(u) \,:\, a \multimap c}\multimap_{\mathcal{I},1}}{\lambda u.\lambda v.f(v)(u) \,:\, b \multimap a \multimap c}\multimap_{\mathcal{I},2}}{\lambda x.\lambda y.f(y)(x) \,:\, b \multimap a \multimap c}\Rightarrow_{\alpha}, \Rightarrow_{\alpha}$$

The result is a reordered form of the original term but without any change in meaning, because the CHI ensures that the function's arguments in the meaning terms are also appropriately reordered. The α-equivalences, in which variables are renamed, are not strictly necessary, but have been added for full transparency. In general, given n arguments in the order $a_1 \ldots a_n$, a reverse order $a_n \ldots a_1$ can be obtained by a series of hypotheses on the arguments that are discharged in the order they were made. More generally, the arguments can be reordered in any order by mixing the order of hypothesis assumption and discharge.

4 The syntax–semantics interface: Autonomy of syntax

Glue rests on two general assumptions about the syntax–semantics interface:

1. The *logical syntax* of semantic composition (Fenstad et al. 1987) is distinct from the *structural syntax*. The syntax of linear logic proofs captures the logical syntax in Glue. Some separate syntactic framework, such as LFG, captures the structural syntax of categorially determined distribution, constituency, features, and local and non-local dependencies (i.e, *syntax* in the standard sense).

2. Logical syntax and structural syntax are systematically related through the instantiation of Glue meaning constructors.

These assumptions distinguish Glue from both *interpretive theories* of semantic composition and *parallel theories* of semantic composition. A well-known example of interpretive theories is Logical Form semantics (e.g., Heim & Kratzer 1998). The *description-by-analysis* semantics for LFG of Halvorsen (1983) is another example of an interpretive theory. Two well-known examples of parallel theories are Combinatory Categorial Grammar (e.g., Steedman & Baldridge 2011) and Type-Logical Categorial Grammar (e.g., Carpenter 1997).[13]

With respect to LF semantics, Glue's assumption of a separate level of structural syntax is similar. However, in its standard co-descriptive guise, Glue is distinct from LF semantics, because Glue does not assume that the syntactic structure in its entirety is the input to semantic interpretation. With respect to Categorial Grammar, we also see similarity and divergence. We see similarity in Glue's assumption of the pairing of functional application (the fundamental compositional operation) with terms that define complex categories implicationally.[14] However, Glue is also distinct from Categorial Grammar, because Glue does not assume that implicational categories are responsible for word order (hence their lack of directionality), but rather that there is a separate syntactic representation. In sum, Glue is a compositional semantic theory of a third kind. From a big picture perspective, Glue synthesizes certain aspects of LF semantics and Categorial Grammar, yet remains distinct from both these theories.

The assumptions, in 1 and 2 above, that began this section derive a strong notion of syntactic autonomy. Categorial Grammar makes the very strong assumption that syntax and semantics are isomorphic. This assumption entails that any semantic distinction must be the reflection of a syntactic distinction. LF semantics similarly assumes that any interpretive/semantic distinction must be due to an underlying syntactic distinction. In an interpretive semantic theory such as LF semantics, the needs of semantics dictate what's in the syntax, even if the things in question are syntactically questionable. The predicate abstraction/numerical nodes in Heim & Kratzer (1998: 186) are an example, since they require the addition of lambda operators to the syntactic tree. This is surprising from the perspective of semantic theory, since this means that *object* languages, i.e. the natural languages undergoing analysis, must in fact contain these logical operators, for which there is no compelling evidence (such as lexicalization in some language or other).

---

[13] Parallel theories are often discussed under the rubric of "rule-by-rule composition" (Bach 1976), but the *rule-by-rule* term is no longer accurate. The term originates in the paired syntactic/semantic rules of Montague (1973), which is now deprecated. This kind of theory is also sometimes referred to as "direct compositionality" (Barker & Jacobson 2007, Jacobson 2014), but this raises a number of issues (Asudeh 2006), so I do not favour that term.

[14] Categorial Grammar's slashes are directed implications. For example, X/Y states that one can conclude a category X conditional on there being a category Y to the right; in other words, X/Y means that Y → X yields X so long as Y is on the right of X.

Quantifier scope ambiguity offers perhaps the most straightforward demonstration of the distinction between Glue on the one hand, and LF semantics and Categorial Grammar, on the other. Consider the following standard example:

(16) Everybody loves somebody.

The Glue logic computes two readings for this sentence, but *without* imputing a syntactic ambiguity, which seems structurally under-motivated; see s 6.1 for further details. This contrasts with both LF semantics and Categorial Grammar; these theories both require the two readings to be syntactically distinguished.

In the next section, I pair Glue with LFG as the syntactic framework in order to render these general points more specific. Although LFG is the natural syntactic framework to choose, given the present venue and the fact that most Glue work has assumed an LFG syntax, see Section 1 above for a list of other syntactic frameworks that have been paired with Glue.

5 Glue with LFG: Syntax/semantics non-isomorphism

Consider the example in Figure 2, which shows the c-structures and f-structure for the sentence *I drank water* in Finnish and English.[15] The distinct c-structures capture the variation in syntactic realization between the two languages. In particular, they capture the fact that Finnish allows null subjects, unlike English. The f-structure shows that these distinct c-structures encode identical syntactic features and dependencies. Figure 3 shows the same structures with the arrows resolved. One way to solve the equations is to label all c-structure nodes that bear a down arrow with an f-structure variable. Instantiation of the metavariables ↑ and ↓ is arbitrary, barring accidental identity, and resolves the equalities (Bresnan et al. 2016: 54–58).

In both the Finnish and English c-structures, the mapping to OBJECT is contributed structurally by the annotation (↑ OBJ) = ↓ on the NP daughter of V′. In the English c-structure, the mapping to SUBJECT is also contributed structurally, by the annotation (↑ SUBJ) = ↓ on the DP in SpecIP. In contrast, the SUBJECT information is contributed morphologically in the Finnish c-structure. This distinction is reflected in the lexical entries in Table 1. Notice that the f-descriptions in these lexical entries not only describe their lexical contributions to f-structure, but also have appropriate Glue meaning constructors that define the mappings

---

[15] I assume LFG's theory of *extended heads*, which allows the Finnish verb to be generated in I (Bresnan et al. 2016: ch. 6–7).

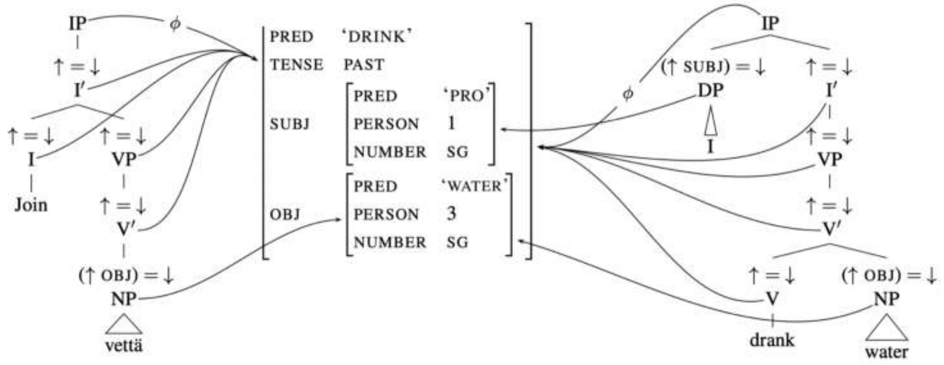

Figure 2: C-structures and f-structure for *I drank water* in Finnish and English (adapted from Asudeh & Toivonen 2015: 27; used with permission)

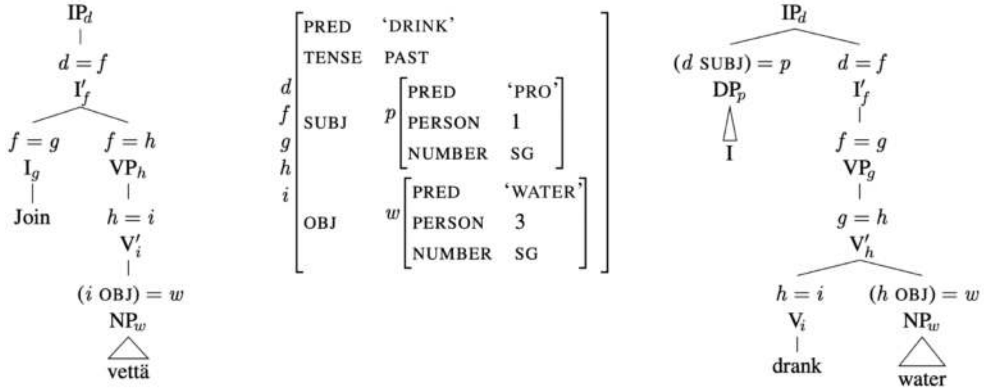

Figure 3: Finnish and English structures with ↑ and ↓ metavariables resolved (Asudeh 2022: 330; used with permission)

to s(emantic)-structure and encode the composition of the head and its dependents as linear implications.[16] I have set tense aside in the semantics, but return to it in Section 6.3 below. The annotation σ on the arrows in the Glue meaning constructors indicates that these are the s-structure correspondents of the relevant f-structures. The σ correspondence function maps from f-structure to s-structure.

The up arrows in Table 1 are instantiated to the f-structure of the relevant pre-terminal node: g (Finnish *join*), w (Finnish *vettä*), p (English *I*), i (English *drank*), and w (English *water*).[17] However, we know from Figure 3 that $g = i = d$.

---

[16] The asterisk in the term for *vettä*/*water* is the cumulativity operator of Link (1983). It states that *water* is a mass term, although this is not important for our present purposes.

[17] In the case of the abbreviated (triangle) structures, there would be intervening nodes. But there would be a chain of ↑=↓ annotations between the word and the phrase it heads, so this is a harmless simplification.

Table 1: Lexicons for *I drank water* in Finnish and English

Finnish			English		
join	I	$(\uparrow \textsc{pred}) = \text{‘}\textsc{drink}\text{’}$ $(\uparrow \textsc{tense}) = \textsc{past}$ $(\uparrow \textsc{subj pred}) = \text{‘}\textsc{pro}\text{’}$ $(\uparrow \textsc{subj pers}) = 1$ $(\uparrow \textsc{subj num}) = \textsc{sg}$ $\mathit{speaker} : (\uparrow \textsc{subj})_\sigma$ $\mathit{drink} :$ $(\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap {\uparrow_\sigma}$	*I*	D	$(\uparrow \textsc{pred}) = \text{‘}\textsc{pro}\text{’}$ $(\uparrow \textsc{pers}) = 1$ $(\uparrow \textsc{num}) = \textsc{sg}$ $\mathit{speaker} : {\uparrow_\sigma}$
vettä	N	$(\uparrow \textsc{pred}) = \text{‘}\textsc{water}\text{’}$ $(\uparrow \textsc{pers}) = 3$ $(\uparrow \textsc{num}) = \textsc{sg}$ ${}^{*}\mathit{water} : {\uparrow_\sigma}$	*drank*	V	$(\uparrow \textsc{pred}) = \text{‘}\textsc{drink}\text{’}$ $(\uparrow \textsc{tense}) = \textsc{past}$ $\mathit{drink} :$ $(\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap {\uparrow_\sigma}$
			water	N	$(\uparrow \textsc{pred}) = \text{‘}\textsc{water}\text{’}$ $(\uparrow \textsc{pers}) = 3$ $(\uparrow \textsc{num}) = \textsc{sg}$ ${}^{*}\mathit{water} : {\uparrow_\sigma}$

So we can just use the mnemonic label d in all relevant cases. We can also take advantage of the equality $(d\ \textsc{subj}) = p$. We obtain the following collection of identical instantiated meaning constructors for each language:

(17) $\{\mathit{speaker} : p_\sigma, \mathit{drink} : w_\sigma \multimap p_\sigma \multimap d_\sigma, {}^{*}\mathit{water} : w_\sigma\}$

This yields a single normal form proof (i.e., minimal proof; Prawitz 1965) for the corresponding Finnish and English sentences, which can be presented in natural deduction format as follows (recall that order of premises on a proof line does not matter, since the Glue logic is commutative):

(18)

$$\dfrac{\mathit{speaker} : p_\sigma \qquad \dfrac{\mathit{drink} : w_\sigma \multimap p_\sigma \multimap d_\sigma \qquad {}^{*}\mathit{water} : w_\sigma}{\mathit{drink}({}^{*}\mathit{water}) : p_\sigma \multimap d_\sigma}\multimap_{\mathcal{E}}}{\mathit{drink}({}^{*}\mathit{water})(\mathit{speaker}) : d_\sigma}\multimap_{\mathcal{E}}$$

6 Some applications of glue semantics

6.1 Quantifier scope

Let us return to the quantifier scope example in (16) above, repeated here as (19).

(19) Everybody loves somebody.

Glue's properties of autonomy of syntax and flexible composition allow (19) to be treated as *syntactically unambiguous* but *semantically ambiguous.*

I will not show the c-structure here, as the relevant syntactic representation is the single f-structure for (19) shown here, with mnemonic labels as usual:

(20)
$$
{}_{l}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{love}\text{’} \\
\textsc{tense} & \textsc{pres} \\
\textsc{subj} & {}_{e}\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{everybody}\text{’} \\ \textsc{person} & 3 \\ \textsc{number} & \textsc{sg} \end{array}\right] \\
\textsc{obj} & {}_{s}\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{somebody}\text{’} \\ \textsc{person} & 3 \\ \textsc{number} & \textsc{sg} \end{array}\right]
\end{array}\right]
$$

The Glue meaning constructors in the lexical entries are shown in (21). Tense has again been set aside and it is again most transparent for expository purposes to show the meaning term for *loves* in non-η-reduced form (see footnote 11 on η-reduction).

(21) *everybody* D $\lambda Q.every(person, Q) : \forall S.(\uparrow_{\sigma} \multimap S) \multimap S$
somebody D $\lambda Q.some(person, Q) : \forall S.(\uparrow_{\sigma} \multimap S) \multimap S$
loves V $\lambda y.\lambda x.love(y)(x) : (\uparrow \textsc{obj})_{\sigma} \multimap (\uparrow \textsc{subj})_{\sigma} \multimap \uparrow_{\sigma}$

When we instantiate the meaning constructors in (21) relative to the f-structure in (20), we get:

(22)
$$
\begin{aligned}
\Gamma = \{\, & \lambda y.\lambda x.love(y)(x) : s \multimap e \multimap l, \\
& \lambda Q.every(person, Q) : \forall S.(e \multimap S) \multimap S, \\
& \lambda Q.some(person, Q) : \forall S.(s \multimap S) \multimap S \,\}
\end{aligned}
$$

The functions *every* and *some* are standard quantificational determiners from generalized quantifier theory (Montague 1973, Barwise & Cooper 1981, Keenan & Faltz 1985), with type $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$. The function *every* is defined as $\lambda P.\lambda Q.P \subseteq Q$. The function *some* is defined as $\lambda P.\lambda Q.P \cap Q \neq \emptyset$. In these formulas, P is the set of entities that is the determiner's restriction and Q is the set of entities that is its scope. The quantifier $\lambda Q.every(person, Q)$ thus returns true if the set of people is a subset of its scope set. Similarly, the quantifier $\lambda Q.some(person, Q)$ returns true if the intersection of the set of people and its scope set is non-empty.

A comment is in order about the universal quantification symbol $\forall$ in the Glue terms for the quantifiers. This universal ranges over variables in the Glue logic. It allows the quantifier scope over *any* Glue logic dependency on the semantic correspondent of the quantifier. Asudeh (2005b: 393–394) discusses the interpretation of ∀ in linear logic. The key insight is that, given the resource sensitivity of linear logic, the universal means “any one”, not “all”. The function of the linear universal is to define *scope points* and its interpretation is not related to the quantificational force in the meaning language. Observe that *every* and *some* alike are associated with these linear universal scope terms, even though *some* has existential force.

The meaning constructors in (22) yield exactly two normal form/minimal proofs. These can be represented as in Figure 4 and Figure 5.[18] In other theories, quantifier scope ambiguity requires either a syntactic operation such as Quantifier Raising (QR) in Logical Form semantics (May 1977, 1985, Heim & Kratzer 1998) or a type shifting operation and corresponding categorial modification of some kind, as in Combinatory or Type-Logical Categorial Grammar semantics (Partee & Rooth 1983, Hendriks 1993). Thus, interpretive and parallel theories of composition alike impute a syntactic ambiguity to handle quantifier scope ambiguity.[19]

This contrasts with Glue Semantics. The fact that Glue assumes an independent level of syntax (autonomy of syntax) allows composition to be flexible (flexible composition), which in turn allows the theory to derive the two distinct scope readings without positing a syntactic ambiguity or type shift.

$$
\dfrac{\begin{array}{l}\lambda Q.\mathit{every}(\mathit{person}, Q) :\\ \forall S.(e \multimap S) \multimap S\end{array}
\quad
\dfrac{\dfrac{\begin{array}{l}\lambda Q.\mathit{some}(\mathit{person}, Q) :\\ \forall S.(s \multimap S) \multimap S\end{array}
\quad
\dfrac{\dfrac{\dfrac{\begin{array}{l}\lambda y.\lambda x.\mathit{love}(y)(x) :\\ s \multimap e \multimap l\end{array} \quad [v : s]^1}{\begin{array}{l}\lambda x.\mathit{love}(v)(x) :\\ e \multimap l\end{array}}\multimap_{\mathcal{E}}, \Rightarrow_{\beta} \quad [u : e]^2}{\mathit{love}(v)(u) : l}\multimap_{\mathcal{E}}, \Rightarrow_{\beta}}{\begin{array}{l}\lambda y.\mathit{love}(y)(u) :\\ s \multimap l\end{array}}\multimap_{\mathcal{I},1}, \Rightarrow_{\alpha}}{\mathit{some}(\mathit{person}, \lambda y.\mathit{love}(y)(u)) : l}\multimap_{\mathcal{E}}, \forall_{\mathcal{E}}[l/S], \Rightarrow_{\beta}}{\begin{array}{l}\lambda x.\mathit{some}(\mathit{person}, \lambda y.\mathit{love}(y)(x)) :\\ e \multimap l\end{array}}\multimap_{\mathcal{I},2}, \Rightarrow_{\alpha}}{\mathit{every}(\mathit{person}, \lambda x.\mathit{some}(\mathit{person}, \lambda y.\mathit{love}(y)(x))) : l}\multimap_{\mathcal{E}}, \forall_{\mathcal{E}}[l/S], \Rightarrow_{\beta}
$$

Figure 4: Surface scope interpretation of *Everybody loves somebody*

---

[18] The universal linear instantiation step is trivial, as in classical/intuitionistic logic. I have therefore not shown it explicitly. See Asudeh (2012: 396) for the rule.

[19] Jacobson (2014: ch. 14) offers a textbook comparison of the LF and CG approaches.

$$\dfrac{\begin{array}{c}\lambda Q.\mathit{some}(\mathit{person}, Q) :\\ \forall S.(s \multimap S) \multimap S\end{array} \qquad \dfrac{\dfrac{\begin{array}{c}\lambda Q.\mathit{every}(\mathit{person}, Q) :\\ \forall S.(e \multimap S) \multimap S\end{array} \qquad \dfrac{\begin{array}{c}\lambda y.\lambda x.\mathit{love}(y)(x) :\\ s \multimap e \multimap l\end{array} \qquad [v : s]^1}{\begin{array}{c}\lambda x.\mathit{love}(v)(x) :\\ e \multimap l\end{array}} {\multimap_{\mathcal{E}}, \Rightarrow_{\beta}}}{\mathit{every}(\mathit{person}, \lambda x.\mathit{love}(v)(x)) : l} {\multimap_{\mathcal{E}}, \forall_{\mathcal{E}}[l/S], \Rightarrow_{\beta}}}{\begin{array}{c}\lambda y.\mathit{every}(\mathit{person}, \lambda x.\mathit{love}(y)(x)) :\\ s \multimap l\end{array}} {\multimap_{\mathcal{I},1}, \Rightarrow_{\alpha}}}{\mathit{some}(\mathit{person}, \lambda y.\mathit{every}(\mathit{person}, \lambda x.\mathit{love}(y)(x))) : l} {\multimap_{\mathcal{E}}, \forall_{\mathcal{E}}[l/S], \Rightarrow_{\beta}}$$

Figure 5: Inverse scope interpretation of *Everybody loves somebody*

6.2 Modification

Glue is similar to Categorial Grammar in offering an analysis of semantic *modification* such that modifiers are easily identifiable by their formal shape. For example, the nominal modification category in (23) has its Glue logic analog in (24) (leaving the meaning language aside):

(23) N/N

(24) $A_{\langle e,t\rangle} \multimap A_{\langle e,t\rangle}$

A nominal modifier is a functional category/type that takes a nominal category/type as an input and returns the same category/type as an output. The modificational semantics is captured on the meaning language side.

For example, a Glue meaning constructor for the attributive adjective *Finnish* would look like (25).

(25) $\lambda P \lambda x.P(x) \wedge \mathit{finnish}(x) : (a_e \multimap b_t) \multimap (a_e \multimap b_t)$

Continuing the example, the common noun *city* would provide the ⟨*e,t*⟩ input to the main implication in (25), such that *Finnish city* would correspond to the following (composed) result:

(26) $\lambda x.\mathit{city}(x) \wedge \mathit{finnish}(x) : (a_e \multimap b_t)$

More generally, a modifier of any type corresponds to a meaning constructor with the following form:

(27) $\lambda f.\mathit{mod}(f) : X \multimap X$

The function *mod* is a placeholder for whatever the semantic effect of the modifier is.

The property of syntax-semantics non-isomorphism, which allows a lexical item to contribute multiple meaning constructors, allows a natural and elegant analysis of so-called *recursive modification* (Kasper 1997). In a nominal like the following, the result we want is that it is apparently the case that the city in question is Finnish:

(28) apparently Finnish city

In other words, we somehow want to maintain a consistent semantics for *apparently* as a modifier, while nevertheless allowing it to fulfill this modificational role inside a nominal. This is despite the type clash between the modifier, which expects a proposition-forming type as input, and the adjective *Finnish*, which does not have this type. The adjective instead has the type of a modifier, i.e. a function on the type that the interpretation of *apparently* expects.

The solution in Glue is to associate predicative and attributive adjectives with the property denotation for the adjective, shown in the first line of (29), and to further add a general nominal modification meaning constructor to the lexical entry for the attributive adjective, as in the second line of (29).

(29) *Finnish* $\lambda x.\mathit{finnish}(x) : v \multimap f$
$(\lambda Q \lambda P \lambda x.Q(x) \wedge P(x) : (v \multimap f) \multimap (a \multimap b) \multimap (a \multimap b))$

The reader can verify that the combination of these two meaning constructors yields the meaning constructor in (25) above (with types omitted). The second meaning constructor is treated as optional to ensure that predicative uses of the adjective work as expected. Resource-sensitive composition ensures that a predicative occurrence of the adjective cannot use the second meaning constructor whereas an attributive occurence must use it.

The revised analysis allows recursive modification by a modifier like *apparently*, assuming that we have a meaning constructor like the following associated with *apparently*, suitably instantiated to an f-structure where *apparently* is in the ADJ set of *finnish*:

(30) *apparently* $\lambda P \lambda x.\mathit{apparently}(P(x)) : (v \multimap f) \multimap (v \multimap f)$

The combination of this meaning constructor for *apparently* and the first meaning constructor in (29) then yields the following:

(31) $\lambda x.\mathit{apparently}(\mathit{finnish}(x)) : v \multimap f$

This is sufficient for a predicative occurrence, as in *Marimekko is apparently Finnish.*

For attributive occurrences, (31) then combines with the second meaning constructor in (29), which yields the desired result:

(32) $\lambda P \lambda x.\mathit{apparently}(\mathit{finnish}(x)) \land P(x) \,:\, (a \multimap b) \multimap (a \multimap b)$

This would then combine with the interpretation of *city* to yield the correct interpretation for, e.g., *The apparently Finnish city is nice.*

I leave aside here the natural extension that is necessary to fully capture recursive modification in examples like the following:

(33) apparently obviously Finnish

The extension just involves having two separate meaning constructors for the adverbial modifier *obviously* (and *apparently*, etc.), in order to make the system fully general, much as we have for the adjective *Finnish* in (29).

The first proposal for the extended modificational semantics presented here was in Dalrymple (2001: 255–274), to my knowledge. The most recent version of the LFG+Glue approach to modification, including recursive modification, is the subject matter of Dalrymple et al. (2019: ch. 13).

6.3 Tense

The basic approach to modification that was sketched at the beginning of Section 6.2 supports a simple account of tense as a modifier on a basic verb meaning, provided that we add a tense coordinate to verb meanings (for a review of approaches to tense in compositional semantics, see Grønn & von Stechow 2016).

Let us assume that a basic meaning constructor for a verb now looks like this:

(34) *sigh* $\lambda x \lambda t.\mathit{sigh}(t, x) \,:\, \mathit{subj} \multimap \mathit{tense} \multimap \mathit{verb}$

Let's also assume, following Haug 2008, that u stands for utterance time (what Grønn & von Stechow 2016 denote as s^*, for speech time). Then we can capture simple present, past and future tense as follows, with the Glue logic instantiated suitably per the terms in (34):[20]

(35) a. PAST $\lambda P \lambda t.P(t) \land t \prec u \,:\, (\mathit{tense} \multimap \mathit{verb}) \multimap (\mathit{tense} \multimap \mathit{verb})$
b. PRESENT $\lambda P \lambda t.P(t) \land t = u \,:\, (\mathit{tense} \multimap \mathit{verb}) \multimap (\mathit{tense} \multimap \mathit{verb})$
c. FUTURE $\lambda P \lambda t.P(t) \land u \prec t \,:\, (\mathit{tense} \multimap \mathit{verb}) \multimap (\mathit{tense} \multimap \mathit{verb})$

This sort of account is obviously too simple, but it illustrates tense as a modifier. Note that I've presented the tenses "on their own" for maximal perspicuity, but

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[20] These sorts of meanings assume a model of time as consisting of points, but it may well be preferable to think of time as consisting of intervals (Dowty 1979). An interval-based semantics poses no problem for tense in Glue Semantics per se, but I've chosen to keep things simple here.

in a lexicalist framework such as LFG, one would normally assume that tense-inflected forms are inserted in the syntax as words, formed morpholexically. That would just mean that, for example, the inflected form *sighed* would contribute both the meaning constructor in (34) and the one in (35a). Note also that I assume some kind of suitable eventual existential closure of the temporal variable.

One could also incorporate grammatical (as opposed to lexical) aspect in a similar, modificational manner. For analyses of tense and grammatical aspect in Glue Semantics, see Haug (2008), Bary & Haug (2011), and Lowe (2014, 2015).[21]

6.4 Events

The first Glue analysis to incorporate event semantics (Davidson 1967, Parsons 1990, Champollion 2017) was never published (Fry 1999b, 2005). To my knowledge, the first major publications to use event semantics were Asudeh & Toivonen (2012) and Asudeh et al. (2013). Much like the analysis of tense sketched above, event semantics for Glue involves adding a dependency on an event variable. Moreover, work in event semantics in Glue has generally taken the Neo-Davidsonian approach of Parsons (1990), in which verbs (and other predicates that take event-arguments) denote functions from events to truth values, such that the arguments of the verb are actually modifiers of the event variable. For example, the sentences in (36) would receive an interpretation like (37), whereas the sentence in (38) would receive an interpretation like (39).[22]

(36) a. Sam hugged Max.
  b. Max was hugged by Sam.

(37) $\exists e.hug(e) \wedge agent(e) = sam \wedge patient(e) = max$

(38) Max was hugged.

(39) $\exists e \exists x.hug(e) \wedge agent(e) = x \wedge patient(e) = max$

It can be observed from (37) and (39) that the event variable is eventually existentially closed. This is a standard assumption in event semantics.

Event semantics is a natural meaning language for Glue Semantics, because the event variable permits a highly factorized semantics, using LFG's *template* language (Dalrymple et al. 2004), which is designed to allow generalizations to be

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[21] Some of this work assumes some version of event semantics (sketched in Section 6.4). However, event semantics is not necessary for a basic treatment of tense, as I've illustrated here.

[22] It is also possible to treat verbs as generalized quantifiers over events (Champollion 2017, Coppock & Champollion 2020), but I'm not aware of any Glue work thus far that has taken this tack and it wouldn't make a difference to the sorts of simple cases sketched here.

captured across grammatical elements, including meaning constructors. This in turn maximizes the analytic leverage offered by flexible composition and syntax/semantics non-isomorphism.

For example, the lexical entry for the verb *hugged* (again leaving tense aside) can capture its underlying semantic bivalence by encoding a dependency on a SUBJECT and OBJECT (as well as the event variable):[23]

(40) *hugged* $\lambda y \lambda x \lambda e.hug(e) \wedge agent(e) = x \wedge patient(e) = y \;:\; obj \multimap subj \multimap event \multimap verb$

We can take advantage of pervasive syncretism in the English passive participle here and assume that the meaning constructor in (40) is associated with the past tense and passive participle alike.

We can then treat the passive voice as contributing a modificational meaning constructor that remaps the arguments, as in (41). I again associate this with an abstract formative to gloss over details of lexicalization (for a related proposal, see Findlay 2019: 185–186).[24]

(41) PASSIVE $\lambda P \lambda x \lambda y.P(x)(y) \;:\; (obj \multimap subj \multimap verb) \multimap subj \multimap obl \multimap verb$

Note that this entry requires implication elimination on the *event* term in the verb's meaning constructor and then reintroduction of the term (for eventual existential binding of the corresponding variable) after the passive modifier has composed with the verb's meaning constructor. We will shortly add a second meaning constructor to the entry for PASSIVE, but this one suffices to capture the truth-conditional equivalence of (36a–b) (which is not to say that they are information-structurally equivalent).

The result of combining the meaning constructor in (41) with the one in (40) is passive *hugged*:

(42) *hugged*+PASSIVE $\lambda x \lambda y \lambda e.hug(e) \wedge agent(e) = y \wedge patient(e) = x \;:\; subj \multimap obl \multimap event \multimap verb$

In other words, the passive voice modifies the meaning of *hugged* such that the passive subject corresponds to the logical object (the patient in this case) and

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[23] It has been common in Glue work on event semantics to use e, e', e'', etc., as variables over events, but a common convention in event semantics more generally is to use v, v', v'', etc. (e.g., Champollion 2017, Coppock & Champollion 2020).

[24] Note that the treatment sketched here uses mnemonics for f-structure grammatical functions, like *subj*, in the Glue terms. However, actual Glue work in this vein uses Glue terms defined with respect to argument structure, as sketched in the next section. See Asudeh & Giorgolo (2012: 75–76) and Asudeh et al. (2014: 77ff.) for further details.

passive *by*-phrase corresponds to the logical subject (the agent in this case).[25] Figure 6 shows the proof for (36b). The reader can verify that the result is the same interpretation as that of (36a). The interpretation for (36a,b) is shown in (37) above.

But what of the short passive in (38)? Here we can leverage optionality and the properties of resource-sensitive composition and syntax/semantics non-isomorphism to naturally extend the analysis. We simply add an optional meaning constructor to (41), such that the revised lexical entry is as follows:

(43) PASSIVE $\lambda P \lambda y \lambda x.P(x)(y) : (obj \multimap subj \multimap verb) \multimap subj \multimap obl \multimap verb)$
$(\lambda P \exists x.P(x) : (obl \multimap verb) \multimap verb)$

The optional entry allows the passive to also contribute a second meaning constructor that existentially binds the subject argument. If there is an actual subject resource, though, as in the long passive in (36b), resource sensitivity ensures that the optional meaning constructor cannot be used, because then the actual subject resource would go unused. Figure 7 shows the proof for (36b). The reader can verify that the result is the same interpretation as that of (38), shown in (39) above.

The use of event semantics in LFG+Glue has become especially common in a thread of work on argument structure, the topic that we turn to next.

6.5 Argument structure

There is a prominent strand of work in Glue Semantics on argument structure and mapping theory (i.e., the realization of underlying arguments in the syntax). Representative work in this vein includes Arnold & Sadler (2013), Asudeh & Giorgolo (2012), Asudeh et al. (2014), Asudeh (2021), Findlay (2014, 2016, 2020), Lowe (2016, 2019), Lowe & Birahimani (2019), Przepiórkowski (2017), and Lovestrand (2020).

However, before turning to the Glue approach to argument structure, it is worth presenting some of the background that led to it, because it highlights another issue in Glue Semantics that has concerned some researchers. The substance of the worry can be straightforwardly summarized: What are the identity conditions for empty semantic structures? In other words, if a semantic structure is an attribute value matrix of some kind, as assumed from quite early on

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[25] I have implicitly assumed in my choice of mnemonic, *obl*, that the *by*-phrase is an OBLIQUE, but nothing hinges on this. The same term works if it is treated as an ADJUNCT, although its mnemonic function is obscured.

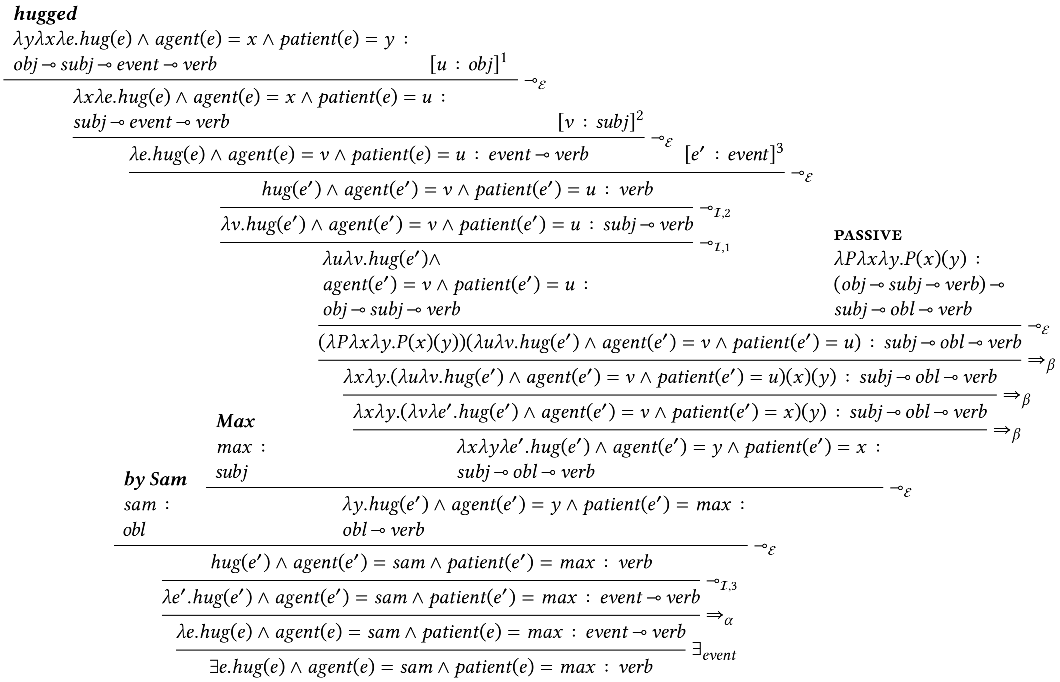


Figure 6: Proof for passive (36b), *Max was hugged by Sam*

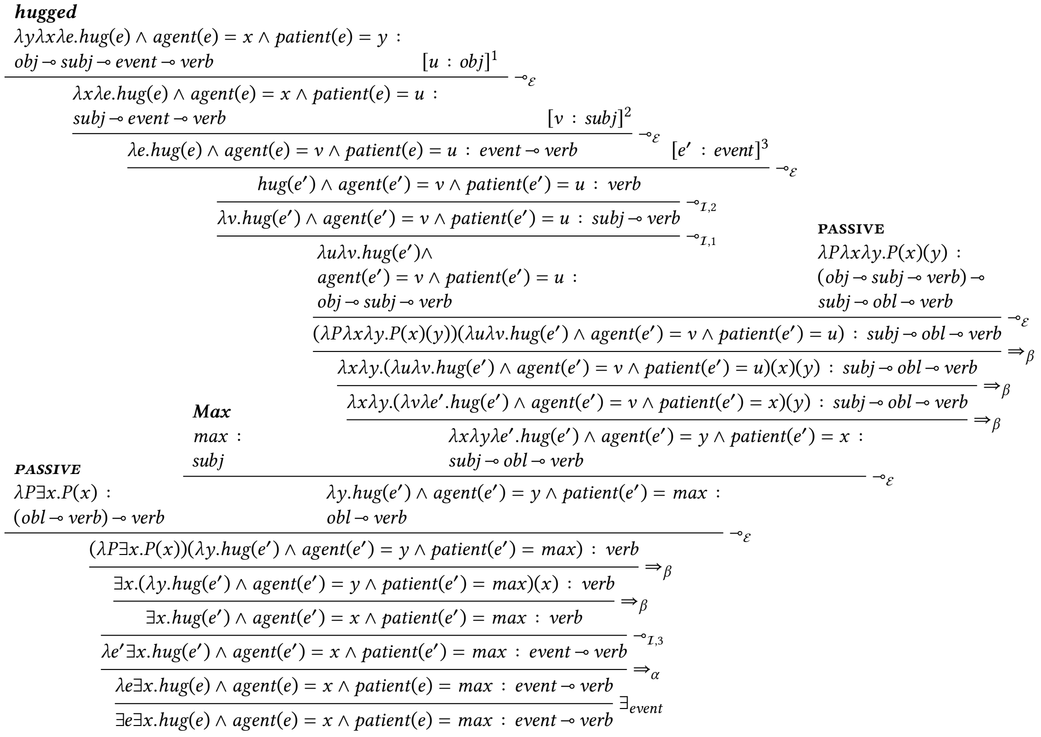
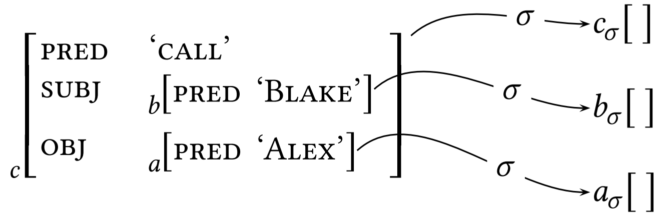


Figure 7: Proof for short passive (38), *Max was hugged*

in the development of Glue Semantics (Dalrymple, Gupta, et al. 1999, Dalrymple 2001), how can there be *distinct* empty s-structures, since an empty AVM seems to correspond to the empty set, which is unique (Kokkonidis 2008, Findlay 2021)?

(44)



One possible solution to the empty s-structure problem is to make the labelling part of the definition of the structure. In other words, if a standard attribute-value matrix is a finite set of attribute-value pairs (see, e.g., Bresnan et al. 2016: 44), then let us define an s-structure as a finite set of pairs, where the first member of each pair is a string (a unique label) and the second member of each pair is a (possibly empty) AVM. In that case, it's clear that the s-structure $\{\langle a_\sigma, \varnothing\rangle\}$ does not equal the s-structure $\{\langle b_\sigma, \varnothing\rangle\}$, even if both of them have the empty AVM as their second coordinate.

However, another issue with the sort of s-structure in (44) is that it's really not a structure at all, since the parts are not connected. In other words, what we have in (44) is really *three* s-structures, not a single one. This does not make a substantive difference to the kinds of proofs one can do in Glue Semantics, but it is a bit strange from a general LFG-theoretic perspective, as we would expect all the modules in the Correspondence Architecture to be structures and all of the ones that have been proposed, aside from the version of s-structure above, indeed are structures.

Asudeh & Giorgolo (2012) solve this last problem by offering a connected s-structure that also fulfills the role of a(rgument)-structure (Butt et al. 1997) in the Correspondence Architecture. Not only does this eliminate the need for a-structure as a separate module in the architecture, it also relates argument structure and mapping theory more strongly to compositional semantics, as the locus for both is now s-structure. Figure 8 shows the Asudeh & Giorgolo (2012) analysis for (45).

(45) Kim ate at noon.

The verb *ate* is semantically bivalent, since it entails that there is something that has been eaten, but it can nevertheless be syntactically intransitive (Asudeh & Giorgolo 2012: 71). This is reflected in the analysis in Figure 8. There is no OBJECT in the f-structure, but there are two arguments in the connected s-structure, which also serves as a representation of argument structure.

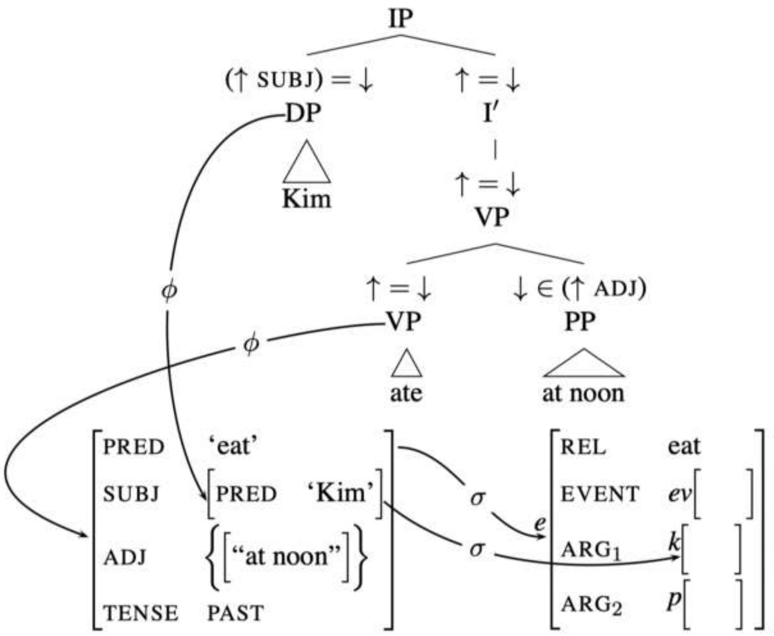


Figure 8: *Kim ate at noon* (Asudeh & Giorgolo 2012: 72; used with permission)

The solution to the syntax/semantics mismatch for the verb *ate* is to allow the verb itself to contribute an optional second meaning constructor that existentially closes the dependency on the second argument:[26]

(46) *ate* $\lambda y \lambda x \lambda e.eat(e) \wedge agent(e) = x \wedge patient(e) = y \;:$
$obj \multimap subj \multimap event \multimap verb$
$(\;\lambda P \exists x.P(x) \;:\; (obj \multimap verb) \multimap verb\;)$

This treatment is similar to the one for the passive in (43). Note that this is a simplification of the actual approach in Asudeh & Giorgolo (2012) and Asudeh et al. (2014), because in those approaches the Glue logic terms are defined using ARG features at s-structure, which allows the analysis to more naturally interact properly with argument alternations.

6.6 Multiword expressions

Multiword expressions (MWEs) are a challenge to a lexicalist theory like LFG, because they show a mixture of idiomaticity and productivity in both their syntax

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[26] Intransitive uses of semantically bivalent verbs also trigger presuppositions about the implicit argument (Fillmore 1986); e.g., *Kim ate at noon* presupposes that what Kim ate is food (for Kim). I do not attempt to model this here, but see Asudeh & Giorgolo (2012) and Asudeh (2021) for some further discussion.

and semantics (Findlay 2019: ch. 1). On the one hand, we find expressions like *by and large* which are idiosyncratic in both their syntax (apparently a coordination of a preposition and an adjective) and semantics (the expression means something similar to the adverb *mostly*, but this can't be compositionally obtained from the usual meanings of its parts). On the other hand, we find expressions like *spill the beans*, which are syntactically unexceptional and possibly yield to a kind of transpositional semantic analysis in which $[\![spill]\!] = [\![reveal]\!]$ and $[\![the\ beans]\!] = [\![the\ secret]\!]$. Nevertheless, even with this MWE we see evidence of particular syntactic and semantic restrictions. For example, the object is necessarily the definite plural *beans* and other forms are either excluded entirely (e.g., #*a bean* or #*the peas*) or else seem at best like metalinguistic word-play (e.g., *the legumes*).

In short, MWEs are challenging because they are like words in the sense that they seem to be lexically stored expressions but are like phrases in having syntactic parts and, in some cases, these parts seem to be visible to syntactic operations. For example, in *It's too late: the beans have already been spilled*, the MWE has been passivized and one part is modified by an adverbial. For a lexicalist theory, simultaneously capturing these lexical and non-lexical properties of MWEs is difficult. Indeed, in order to account for this mixture of lexical and syntactic properties, Findlay (2019) replaces the c-structural part of standard LFG with Tree-Adjoining Grammar (TAG; Joshi et al. 1975, Abeillé & Rambow 2000), which allows expressions to be associated with trees in the lexicon, rather than with a simple category. TAG allows these trees to then be inserted or adjoined in the phrasal syntax. Findlay (2019) calls the resulting theory *Lexicalised LFG*, in a nod to Lexicalized TAG (Schabes et al. 1988), because it allows lexicalization of syntactic structures as TAG trees while maintaining LFG's standard separate level of f-structure and a mapping between the TAG-based c-structures and the f-structures.

No matter how one captures the syntax of MWEs, the syntax/semantics non-isomorphism of Glue Semantics naturally captures their syntax/semantics mismatches and idiomaticity. For example, Figure 9 shows Findlay's (2019) *lexical* entry for *by and large*. It is an adjunct tree, since this is a modifier. The meaning of *by-and-large* is captured by the call to a template, @By-And-Large-Meaning, but we can simplify things as in (47).

(47) *by and large* $\lambda P \lambda x.mostly(P(x)) : (subj \multimap verb) \multimap (subj \multimap verb)$

This is a relatively straightforward example. For more complex examples, see Findlay (2019).

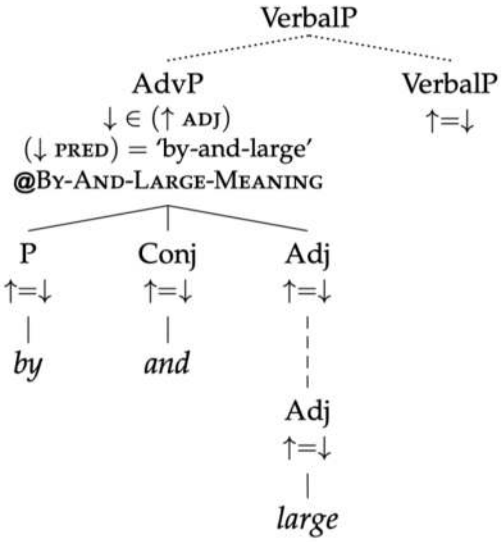

Figure 9: Lexical entry for *by and large* (Findlay 2019: 265; used with permission)

In more recent work, Findlay (2021) has adopted a different formalization of Glue in order to account for MWEs that show form flexibility as long as some kind of core meaning is maintained, like in the following:

(48) a kick up the bum/backside/bottom/buttocks/ass/heinie/keister/booty/…

In this MWE, any word that denotes ⟦*bum*⟧ would seem to do, no matter its form, but anything that doesn't denote ⟦*bum*⟧ doesn't seem to have the idiomatic 'motivational' reading (e.g., #*crotch*).

6.7 Anaphora

Anaphora has been a topic of long-standing interest in Glue Semantics. A recent LFG+Glue treatment and overview of previous literature is given in Dalrymple et al. (2019: ch. 14). Their treatment is a fairly sophisticated one that builds on recent work by Haug (2014) and Dalrymple et al. (2018). Here I present a simpler overview that summarizes the approach in Dalrymple, Lamping, Pereira, et al. (1997) and Asudeh (2004, 2012).

The property of flexible composition means that Glue can provide a variable-free treatment of anaphora, but without requiring that the anaphoric dependency be passed through all intervening material between the anaphor and its antecedent (in the intra-sentential case), as in non-commutative Categorial Grammar approaches (Jacobson 1999 et seq.). The simplest way to capture this would be through an implicational meaning constructor as in (49). I again associate the meaning constructor with an abstract formative to leave aside other aspects of particular personal pronouns, such as person, number, gender.

(49) ANAPHOR $\lambda y.y : antecedent \multimap anaphor$

However, there is a problem with a treatment this simple, because of resource-sensitive composition. If the anaphor consumes the antecedent resource, then the antecedent would no longer be available for composition. This means that whatever function takes the antecedent's denotation as an actual argument can no longer have its resource-sensitive compositional requirements satisfied. There would be no valid proof.

In order to remedy this, a simple solution is to slightly expand the fragment of linear logic that serves as the Glue logic. We add the *multiplicative conjunction* operator, ⊗, which does tensor/pair formation. The meaning constructor in (49) is then revised as follows:

(50) ANAPHOR $\lambda y.y \times y : antecedent \multimap (antecedent \otimes anaphor)$

The anaphor is still a function on its antecedent, but it now returns both its own resource and the antecedent resource.

On this sort of approach to anaphora, the multiplicative conjunction ⊗ is only ever introduced lexically (much as is the linear logic universal for scope points; see above). Therefore we just need to add the elimination rule for this connective, which is the following:

(51) Structured functional application:
Multiplicative conjunction elimination pairwise substitution

$$\dfrac{\begin{array}{c}\vdots\\ \alpha : A \otimes B\end{array} \qquad \begin{array}{c}[\beta : A]^1 \qquad [\gamma : B]^2\\ \vdots \qquad\qquad \vdots\\ \delta : C\end{array}}{\text{let } \alpha \text{ be } \beta \times \gamma \text{ in } \delta : C} \otimes_{\mathcal{E},1,2}$$

The *let* type constructor performs pairwise substitution for the variables x, y in the result.

This is still quite abstract, so it is probably helpful to look at example (52) and its accompanying proof in Figure 10, both from Asudeh (2012: 84).[27]

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[27] Note that I have left out the $\multimap_{\mathcal{E}}$ annotations in the proof to reduce clutter. Also, the following mnemonic Glue terms are used: t for the term contributed by *Thora* (which is both the antecedent of the pronoun and the subject of the sentence), p for pronoun, g for *giggle*, and s for *said*.

(52) Thora said she giggled.

$$\dfrac{\dfrac{\dfrac{\begin{array}{l}\boldsymbol{Thora}\\ thora :\\ t\end{array} \quad \begin{array}{l}\boldsymbol{she}\\ \lambda z.z\times z :\\ t\multimap(t\otimes p)\end{array}}{thora\times thora : t\otimes p}\multimap_{\mathcal{E}} \quad \dfrac{\dfrac{[x : t]^1 \quad \begin{array}{l}\boldsymbol{said}\\ \lambda u\lambda q.say(u,q) :\\ t\multimap g\multimap s\end{array}}{\lambda q.say(x,q) : g\multimap s}\multimap_{\mathcal{E}} \quad \dfrac{[y : p]^2 \quad \begin{array}{l}\boldsymbol{giggled}\\ \lambda x.giggle(x) :\\ p\multimap g\end{array}}{giggle(y) : g}\multimap_{\mathcal{E}}}{say(x,giggle(y)) : s}\multimap_{\mathcal{E}}}{\text{let } thora\times thora \text{ be } x\times y \text{ in } say(x,giggle(y)) : s}\otimes_{\mathcal{E},1,2}}{say(thora,giggle(thora)) : s}\Rightarrow_{\beta}$$

Figure 10: Proof for intra-sentential anaphoric reading of (52), *Thora said she giggled*

For a fuller treatment of anaphora that extends to inter-sentential cases, see Haug & Dalrymple (2020) and Dalrymple & Haug (2022).

7 Conclusion

Glue Semantics is a general framework for semantic composition and the syntax–semantics interface. The focus here has been on Glue for LFG, typically known as LFG+Glue. Four key properties of Glue Semantics are resource-sensitive composition, flexible composition, autonomy of syntax, and syntax/semantics non-isomorphism (Asudeh 2022: 324). Analyses in Glue Semantics are highly constrained by the resource logic *linear logic*, a fragment of which serves as the Glue logic for semantic composition. Although resource-sensitive composition constrains semantic composition, it allows composition to be commutative. This yields the property of flexible composition: The logical syntax of composition is not identical to the structural syntax. From this we can derive the property of autonomy of syntax: Syntax and semantics are separate levels. From this we lastly derive the property of syntax/semantics non-isomorphism: Whatever the basic elements of structural syntax are taken to be (words in the case of standard LFG), these elements may make multiple or no contributions to semantic composition. The best source for further details about Glue analyses of particular phenomena and further Glue references is Dalrymple et al. (2019). However, I've listed a representative sample of Glue work by topic in the appendix.

Acknowledgements

Many thanks to Mary Dalrymple for editing this volume, but also for many useful discussions about Glue Semantics over the last more than two decades. Similarly,

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List of Glue work by topic

Here is a representative sample of work in Glue Semantics, organized alphabetically by topic:[28]

- Anaphora
  Dalrymple, Lamping, Pereira, et al. (1997), Asudeh (2004, 2005b, 2012), Bary & Haug (2011), Belyaev & Haug (2014), Dalrymple et al. (2019: ch. 14), Haug & Dalrymple (2020), Dalrymple & Haug (2022)

- Argument structure and argument realization
  Asudeh & Giorgolo (2012), Asudeh et al. (2014), Asudeh (2021), Arnold & Sadler (2013), Findlay (2014, 2016, 2020), Lowe (2016, 2019), Lowe & Birahimani (2019), Przepiórkowski (2017), Lovestrand (2020)

- Category theory for natural language semantics
  Giorgolo & Asudeh (2012a,b), Giorgolo & Asudeh (2014a,b), Asudeh & Giorgolo (2016, 2020)

- Complex predicates
  Andrews (2007, 2018), Lowe (2016, 2019), Lowe & Birahimani (2019), Lovestrand (2020)

- Computational applications and tools (open source)[29]
  Crouch et al. (1986), Lev (2007), Meßmer & Zymla (2018), Dalrymple et al. (2020), Zymla (2021a,b,c)

- Concomitance
  Haug (2009)

- Constructions
  Asudeh et al. (2008, 2013), Asudeh & Toivonen (2014)

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[28] My apologies to anyone whose work I have inadvertently omitted.

[29] Zymla's (2021c) tool goes with the XLE tools for computational implementation and testing of LFG grammars (Crouch, Dalrymple, Kaplan, King, Maxwell & Newman 2011).

- Control/equi and raising
  Asudeh (2005a), Haug (2013), Dalrymple et al. (2019: ch. 15)

- Conventional implicature
  Asudeh (2004: ch. 4), Potts (2005), Arnold & Sadler (2010, 2011), Giorgolo & Asudeh (2012a)

- Coordination
  Kehler et al. (1999), Asudeh & Crouch (2002a), Dalrymple et al. (2019: ch. 16)

- Copy raising
  Asudeh (2004, 2012), Asudeh & Toivonen (2007, 2012)

- Distance distributivity
  Przepiórkowski (2014a,b, 2015)

- Dynamic semantics
  Crouch & van Genabith (1999), van Genabith & Crouch (1999), Dalrymple et al. (2019: ch. 14)

- Event semantics
  Fry (2005), Asudeh & Giorgolo (2012), Asudeh & Toivonen (2012), Asudeh et al. (2013), Asudeh et al. (2014)

- Evidentiality
  Asudeh & Toivonen (2017)

- Formal foundations
  Dalrymple, Gupta, et al. (1999), Dalrymple, Lamping, Pereira, et al. (1999), Dalrymple, Lamping, Pereira, et al. (1997); Asudeh (2004, 2012: ch. 5) Kokkonidis (2008), Andrews (2008, 2010), Findlay (2021))

- Fragments
  Asudeh (2012: ch. 11)

- Idioms and multiword expressions
  Findlay (2019, 2021)

- Incorporation
  Asudeh (2007), Baker et al. (2010)

- Information structure
  Dalrymple & Nikolaeva (2011), Mycock (2006), Morrison (2017)

- Intensionality
  Dalrymple, Lamping, Pereira, et al. (1997), Asudeh & Toivonen (2012)
- Modification
  Dalrymple et al. (1993), Dalrymple, Lamping, Pereira, et al. (1999), Dalrymple (2001), Asudeh & Crouch (2002b), Andrews (2018), Dalrymple et al. (2019: ch. 13)
- Negative polarity items
  Fry (1999a)
- Perception verbs
  Asudeh & Toivonen (2007, 2012), Asudeh (2012), Camilleri et al. (2014)
- Predication
  Dalrymple (2001), Asudeh & Crouch (2002b), Dalrymple et al. (2019: ch. 13)
- Quantification and scope
  Dalrymple, Lamping, Pereira, et al. (1997), Dalrymple et al. (2019: ch. 8)
- Relational nouns
  Asudeh (2005b)
- Resumptive pronouns
  Asudeh (2004, 2005b, 2011, 2012), Camilleri & Sadler (2011)
- Split nominals
  Kuhn (2001)
- Tense and aspect
  Haug (2008), Bary & Haug (2011), Lowe (2014, 2015), Belyaev (2020)
- Unbounded dependencies
  Asudeh (2012), Dalrymple et al. (2019: ch. 17)

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Chapter 16

Argument structure and mapping theory

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This chapter presents the LFG view of two closely related areas of inquiry: argument structure, a level of structure which represents the syntactically realisable arguments of a predicate, and mapping theory, the theory of how those arguments are linked to grammatical functions at f-structure, as well as of alternations in this linking brought about by processes like passivisation. After introducing some preliminary concepts, the chapter explores various approaches within LFG: the earliest work using lexical rules to explain argument alternations, the "classical" version of Lexical Mapping Theory (LMT) developed in the late '80s and early '90s, and various subsequent modifications, extensions, and reimaginings of LMT, including contemporary work focussing on the formal status of argument structure and mapping theory, and their connection to the rest of the grammar.

1 Introduction

Predicates have both syntactic and semantic arguments, and the two are not always aligned. For instance, expletives, as shown in (1), are syntactic but not semantic arguments of their verbal governors:

(1) a. *It* is snowing.
b. *There* seems to be a problem.

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On the other hand, there are verbs like *saddle*: conceptually, a saddling event involves three entities, the saddler, the saddled (usually a horse), and the saddle itself, but only the first two are expressible in the syntax (cf. Bresnan 1980). Similarly, there are clear patterns regarding which kinds of semantic arguments are realised by which kinds of grammatical functions – in general, more Agent-like arguments are more likely to be subjects than more Patient-like arguments, which are more likely to be objects – but there are also exceptions. There are, for example, verbs which seem to express the same type of event but to realise the semantic participants differently in the syntax (Rappaport 2006 [1983]: 132):

(2) a. Fred fears the prospect of failure.
    b. The prospect of failure frightens Fred.

(3) a. I like a job well done.
    b. A job well done pleases me.

Due to these kinds of mismatches, neither syntactic nor semantic arguments can be reduced to the other, and instead we need some intervening level of representation that can mediate the relationship between them. This is what is known as ARGUMENT STRUCTURE, and in LFG is often taken to constitute a separate module of the grammar called a-structure. Although it sits between syntax and (lexical) semantics, argument structure itself is often taken to be a specifically syntactic level of representation (Alsina 2001),[1] whose primary purpose is to explain a predicate's syntactic valency patterns – while acknowledging that at least some of these explanations are to be found in lexical semantic properties. The arguments represented at argument structure are therefore those which can or must be realised syntactically.

Explaining how exactly these arguments are realised is the purview of MAPPING THEORY. Such a theory seeks generalisations in the mapping between argument structure and syntax proper, and to explain any alternations which are possible (such as passivisation, causativisation, detransitivisation, etc.). In LFG, this means determining what GRAMMATICAL FUNCTION (GF) the argument will instantiate – overt phrasal realisation is then handled by the language-specific phrase-structure rules or case-marking system which determines how particular GFs surface (see Belyaev 2023a,b [this volume] for more on LFG's view of grammatical functions and their relation to phrasal syntax).

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[1] Indeed, in the Minimalist tradition, argument structure is often represented in the phrasal syntax itself – see Harley (2011) and references therein for an overview.

As part of this LFG handbook, the present chapter focusses on providing a survey of work on argument structure and mapping theory which takes a Lexical-Functional approach.[2] The structure of the chapter is as follows: we begin, in Section 2, with a brief high-level introduction to some of the questions and phenomena which we will return to throughout the chapter. Section 3 then looks at the earliest work on these problems in LFG, which used LEXICAL RULES to account for argument alternations. Section 4, the largest of the chapter, presents the still-canonical theory of argument structure and mapping developed in the late 1980s and early 1990s, known as LEXICAL MAPPING THEORY (LMT). Section 5 examines a different version of LMT, that of Kibort (2007, *i.a.*) which, among other things, is designed to extend the empirical coverage of the mapping theory to so-called morphosemantic alternations. Section 6 delves more deeply into some formal issues and alternative proposals, before Section 7 concludes.

2 Background and basic concepts

2.1 From semantics to syntax

There are regularities in the ways that semantic participants of predicates are realised syntactically. For example, in a nominative-accusative language like English, when a verb describes an event that has a volitional Agent and a Theme or Patient affected by the event, the Agent will be realised as the active voice subject and the Theme/Patient as the object:

(4) a. Your dog is chasing my rabbit!
(cf. # My rabbit is chasing your dog![3])
b. The engineers will build the bridge there.
(cf. # The bridge will build the engineers there.)
c. The teacher opened the cupboard.
(cf. # The cupboard opened the teacher.)

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[2] For general introductions as well as critical overviews of work in other traditions, the reader is directed to Grimshaw (1990), Comrie (1993), Levin & Rappaport Hovav (2005), Ramchand (2014), Williams (2015). For a different perspective on the LFG literature, see Dalrymple et al. (2019: ch. 9).

[3] The point of these anomalous alternatives is to illustrate that the (prototypical) situations presented are expressed via the (a) encodings, where the Agent is a subject and the Theme/Patient an object, rather than the *a priori* equally plausible (b) encodings, where the pairings of semantic and syntactic roles are reversed. The (b) sentences are of course perfectly grammatical strings of English, but they describe situations which are at odds with our real-world knowledge or expectations, precisely because the subjects in each case are interpreted as Agents.

Similarly, if the sentence expresses an Instrument used to perform the action described, along with the Theme/Patient, then the Instrument is the subject and the Theme/Patient the object:

(5) a. The key opened the cupboard.
(cf. # The cupboard opened the key.)

But if the Agent is also included, then *it* is the subject:

(6) The teacher opened the cupboard with the key.

This generalisation goes back to Fillmore (1968: 33), who expresses it as follows:

(7) If there is an A [= Agent], it becomes the subject; otherwise, if there is an I [= Instrument], it becomes the subject; otherwise, the subject is the O [= objective, i.e. Theme/Patient].

This is a productive rule (at least in English), as can be seen from the fact that invented words will also follow the same pattern. Alsina (1996: 5–6), for instance, imagines a verb *obliquate*, meaning 'build or place in an oblique position or direction', and notes the clear intuition that, if such a verb existed, we would say things like (8a), but not like (8b):

(8) a. Jim obliquated the door of the closet.
b. # The door of the closet obliquated Jim.

All this goes to illustrate a key explanandum: the semantic relationship which an argument bears to its verb is also implicated in determining its syntactic relationship, but in what way precisely? Mapping theory is interested in discovering the nature of this connection, and in finding generalisations over the links between semantic and syntactic relationships.

The observation in (7) induces a ranking of semantic/thematic roles,[4] where the highest available argument becomes the subject:

(9) A > I > O

This can be seen as a precursor to the well-known THEMATIC HIERARCHY (Jackendoff 1972: 43), of which there have been many versions. The one which has been most influential in LFG comes from Bresnan & Kanerva (1989: 23), and is shown in (10):

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[4] We will use these two terms interchangeably in this chapter, drawing no theoretical distinction between them.

(10) *The Thematic Hierarchy:*
Agent > Beneficiary > Recipient/Experiencer
> Instrument > Theme/Patient > Location

Arguments which are more thematically “prominent” on this hierarchy tend to be realised by more grammatically “prominent” GFs, e.g. as defined by the Keenan-Comrie hierarchy (Keenan & Comrie 1977; see also Belyaev 2023b [this volume]) – in particular, the SUBJ function is usually taken by the the argument highest on the thematic hierarchy (Grimshaw 1990, Speas 1990). This insight is often at the core of mapping theories, and so the thematic hierarchy figures centrally in the standard version of Lexical Mapping Theory, which we explore in Section 4, as well as in other approaches discussed below.

The use of thematic hierarchies has also been challenged, however. For one thing, a consistent list of roles and definitions has proved elusive, and classification of arguments can therefore be problematic and open to disagreement (Gawron 1983, Dowty 1991, Ackerman & Moore 2001, Davis 2011). For another, even when a set of roles is agreed on, the question of their relative ordering has not been settled, and different hierarchies have been proposed for different phenomena, or even for the same phenomenon (Newmeyer 2002: 65ff. Levin & Rappaport Hovav 2005: ch. 6; Rappaport Hovav & Levin 2007). While it is clearly possible that different orderings could be relevant for different things, the extent of the variability in the literature, even with respect to one and the same phenomenon, stands in stark contrast to the putative appeal of a unifying thematic hierarchy where a fixed set of roles is used in order to abstract away from predicate-specific semantic entailments. Because of these concerns, some recent work in LFG’s mapping theory, most notably that of Kibort (2007, *i.a.*), has attempted to do without thematic roles altogether. We discuss Kibort’s work in Section 5.

Some questions of mapping depend not on the semantic relationship between an argument and its verb, but rather on lexical semantic properties of the verb itself. For example, *break* and *hit* both take Agent and Patient arguments, but *break* has an intransitive alternant, where the Patient appears as the subject, which is impossible with *hit*:

(11) a. The teacher broke the ruler.
b. The ruler broke.

(12) a. The teacher hit the ruler.
b. * The ruler hit.

Fillmore (1970) observes that this contrast is not a lexical idiosyncrasy of these two verbs, but actually applies to two large classes of semantically-related verbs, as shown in (13–14):

(13) a. The teacher {bent / folded / shattered / cracked / …} the ruler.
b. The ruler {bent / folded / shattered / cracked / …}.

(14) a. The teacher {slapped / struck / bumped / stroked / …} the ruler.
b. * The ruler {slapped / struck / bumped / stroked / …}.

Once again, we can see that this is a productive generalisation if we examine our intuitions about invented forms. For example, let us imagine a verb *jellate*, meaning 'to turn to jelly'. It is clear that this verb could appear in the same constructions as *break*.

(15) a. The wizard jellated the box.
b. The box jellated.

But if we invent a word like *coude*, meaning 'to touch with one's elbow', it is just as clear that it will pattern with *hit*:

(16) a. I couded the wall.
b. * The wall couded.

We do not want to simply stipulate the possibilities for each new verb, since then we fail to capture the regularity and productivity of our intuitions.

A mapping theory ought to give an account of these patterns. To do this, it must have access to detailed lexical semantic information, such as event structure. For example, a hitting event does not necessarily result in a change of state in the affected entity, whereas a breaking event does; that is, the structure of a hitting event does not contain a result state, in Ramchand's (2008) terms. Now, this may be expressed in the semantic role assigned to the affected entity – in some theories, the difference between Patient and Theme is that the former undergoes a change of state while the latter does not. But often such nuances are not captured by a simple semantic role analysis – for example, the thematic hierarchy in (10) collapses Theme and Patient into a single position – and it is certainly not apparent that there are any principled limits on what kinds of lexical semantic information can be relevant for questions of mapping, so it is quite possible that mapping theory needs access to a very rich representation of lexical semantics. In general, argument structure proposals in LFG have not taken up this challenge, instead treating this level of representation as relatively informationally impoverished (it is often no more than a list of arguments and their associated thematic roles). Nevertheless, there have been, and continue to be a growing number of, exceptions, which we examine in Section 6.1.

2.2 Argument alternations

Accounting for the syntactic realisation of semantic arguments means also addressing the fact that a single predicate may permit multiple ways of expressing its arguments (including not expressing some of them at all) – that is, the existence of ARGUMENT ALTERNATIONS, such as that between the transitive and the inchoative illustrated in (11), above. Perhaps the most famous and well-studied of these is the active-passive alternation, a typologically common pattern whereby a transitive verb alternates with an intransitive in which the subject argument of the transitive form is either unexpressed or expressed as a non-core, oblique grammatical function instead:

(17) a. *Active:*
The dog chased the rabbit.

b. *Passive:*
The rabbit was chased (by the dog).

One important property of the active-passive alternation is that it does not involve any change in lexical semantics. That is, the situations described by (17a) and (the long version of) (17b) are truth-conditionally equivalent, and so this alternation is described as MEANING-PRESERVING (cf. Sadler & Spencer 1998). This label is slightly infelicitous, however, since once we look beyond mere truth conditions there are of course changes to other aspects of "meaning", writ large: for instance, the information-structural Topic is the dog in (17a) but the rabbit in (17b). This is not at all surprising, since language abhors true synonymy (Cruse 1986, Goldberg 2019), and variation of whatever kind is inevitably operationalised for communicative purposes (Clark 1987, Eckert 2018) – but it does mean that the term "meaning-preserving" must be understood in a suitably narrow sense.

Such meaning-preserving alternations are known as MORPHOSYNTACTIC, since they are morphological operations which alter the syntactic alignment of participants; this is in contradistinction to MORPHOSEMANTIC alternations, which involve changes in (truth-conditional) lexical meaning. Another example of a morphosyntactic alternation is locative inversion, illustrated in (18) for Chicheŵa (Bresnan & Kanerva 1989: 2). In this alternation (also found in English, as indicated by the translations below – see Bresnan 1994), a locative phrase which normally appears as an oblique can surface as a subject, demoting the subject of the non-inverted form to object:[5]

(18) a. Chi-tsîme chi-li ku-mu-dzi.
7-well 7-be 17-3-village
'The well is in the village.'

b. Ku-mu-dzi ku-li chi-tsîme.
17-3-village 17-be 7-well
'In the village is a well.'

Once again, this affects certain properties of a sentence's information structure, for instance changing what is available for contrastive focus (Bresnan & Kanerva 1989: 35, Bresnan 1994: 86–87), but it does not alter the truth-conditional meaning.

Morphosemantic alternations, on the other hand, change the lexical meaning of a predicate – a change which may then have syntactic effects, though these are in a sense only incidental, merely following as automatic consequences of the lexical semantic changes (Kibort 2004: 374). Examples include many of the alternations listed in Levin (1993), such as the *spray/load* alternation shown in (19) or the dative shift alternation shown in (20):

(19) a. Carly loaded the wagon with barrels.
b. Carly loaded barrels onto the wagon.

(20) a. Julian brought Elim the message.
b. Julian brought the message to Elim.

In (19a), the Goal/Location *the wagon* is realised as the object, and in this case there is a "holistic" interpretation (Levin 1993: 50), whereby the Goal/Location is understood to be fully affected by the action (i.e. the wagon is filled up with barrels). This entailment is absent from the sentence in (19b), where the Theme is realised as the object instead. Similarly, in (20a), there is an entailment that the dative-shifted Goal object is animate (Goldberg 1995: 146–147), but this same constraint does not hold of the Goal argument in the prepositional variant (20b), as illustrated by the following contrast:

(21) a. # Julian brought Elim's study the message.
b. Julian brought the message to Elim's study.

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[5] Numbers indicate noun classes: this is in part how we can tell that the locative is the subject in (18b), since the verb now agrees with it in this respect.

Both of these alternations involve differing syntactic realisations of the same arguments, but unlike the morphosyntactic alternations shown above, they also change certain properties of the truth-conditional meanings expressed by their governing verbs. Other morphosemantic alternations, such as the causative, also introduce *new* arguments, rather than simply rearranging existing arguments. The causative introduces a new Causer argument, which brings about the event described by the predicate. Here is a classic example from Turkish (Comrie 1974: 5):

(22) a. Hasan öl-dü.
Hasan die-PST
'Hasan died.'

b. Ali Hasan-ı öl-dür-dü.
Ali Hasan-OBJ die-CAUS-PST
'Ali killed Hasan.' (lit. 'Ali made Hasan die.')

As can be seen, this also has syntactic effects, since causativisation increases the valency of the predicate. Here an intransitive becomes a transitive, and the previous subject is demoted to object.

The world's languages are replete with a wide and varied selection of argument alternations, both meaning-preserving as well as meaning-altering, many of which are highly productive. Any mapping theory must therefore be capable of giving an account of such alternations in general, and this has been a major focus of research, as we will see below.

3 Lexical rules

Argument alternations have been at the heart of work in LFG since the very beginning. The seeds of LFG as a framework can be found in Bresnan's (1978) work on the psychological plausibility of transformational grammars, illustrating how the passive can be profitably viewed as an operation on lexical representations, rather than on phrase-level syntactic structures. Bresnan (1980) presents this analysis in a more recognisably LFG-like form, and extends the approach to the formation of intransitives and middles in English. In this and much other early work in LFG, argument alternations are treated as involving LEXICAL RULES, which systematically relate the different alternants of the same verb (e.g. active and passive). In this section, we give a brief overview of this approach, and highlight some of the reasons why it has fallen out of favour in recent work.

In Bresnan (1980), lexical items are assumed to possess abstract predicate-argument structures, which characterise “those arguments of a semantic predicate that are open to grammatical interpretation” (Bresnan 1980: 100). Such argument positions are then associated with grammatical functions by various (undiscussed) lexical processes, with the result being a lexical form – recognisable as what would become in LFG the semantic form value of a pred attribute (Belyaev 2023a [this volume]). For example, the lexical form for transitive *read*, as in *John read my letter*, is given in (23) (Bresnan 1980: 116):

(23) *read* ⟨ (subj) (obj) ⟩

Here the first argument, corresponding to the reader, is linked to subj, and the second argument, the thing read, is linked to obj. The exact nature of this initial linking of arguments to GFs is not spelled out explicitly, and is generally taken to follow from some intrinsic pairings of roles and syntactic functions. What is more, in this early work, the specific role of each argument is not labelled in the representation, and must be inferred from the combination of their ordering and lexical idiosyncrasies of meaning. In other work (e.g. Baker 2006 [1983]), lexical forms are shown with semantic roles alongside their associated GFs, thus highlighting both sides of the linking question explicitly in the representation. For the sake of clarity, we will follow this convention for the rest of this section; thus instead of (23), we will write (24) for the lexical form of *read*:

(24) *read* ⟨ Agent Theme ⟩
(subj) (obj)

However such structures are represented, once the links between arguments and GFs are in place, other rules can then apply to manipulate them, capturing the effect of various argument alternations. For example, intransitivisation is achieved by the following lexical rule (Bresnan 1980: 116):

(25) *Intransitivisation:*
(obj) ↦ ∅

Here the argument previously linked to obj is instead assigned the special null GF ∅, which indicates that the argument is existentially bound in the semantics, and is not expressed overtly in the syntax. The application of (25) to (24) results in the lexical form in (26), corresponding to the intransitive form of *read*, as in *John read all night.*

(26) *read* ⟨ Agent Theme ⟩
(subj) ∅

It is clear to see how this approach can be extended to other, more complex alternations. Bresnan (1982), for instance, proposes the following lexical rule for passivisation:[6]

(27) *Passivisation:*
$(\textsc{subj}) \mapsto \varnothing/(\textsc{obl}_{\textsc{agent}})$
$(\textsc{obj}) \mapsto (\textsc{subj})$

This demotes the subject to either the unexpressed null GF (as in the English short, Agent-less passive), or an oblique (as in the English long, *by*-passive), and promotes the object to subject.

One important strength of such lexical rules is that they manipulate grammatical functions, rather than surface constituent structures; that is, (27) promotes the obj, rather than, say, moving the post-verbal NP to the specifier position of IP. This means that the same rule can be used across the languages of the world, with language-specific variations falling out from the rules for c- to f-structure mapping in those languages (Belyaev 2023a [this volume]).[7] Such an approach is a corollary of the claim that argument alternations operate at the level of argument structure, and not directly on the phrasal syntax.

Lexical rules in LFG are taken to be redundancy rules (Bresnan 1990: 638): they are not applied on-line in the process of parsing, but instead describe regular relations between items in the lexicon. In other words, the existence of a lexical form like (28a) implies the existence of a corresponding passive form like (28b), because of the existence of rule (27):[8]

(28)	a.	*read*	⟨	Agent	Theme	⟩
				(subj)	(obj)	
	b.	*read*	⟨	Agent	Theme	⟩
				$(\textsc{obl}_{\textsc{agent}})$	(subj)	

Such a restriction follows from Bresnan's (1980: 118) claim that "structures which are analyzed by lexical rules must be lexical structures, and cannot be syntactically derived". Bresnan (1982: 6) goes further, and proposes that alterations of

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[6] Bresnan (1982) is in fact the *locus classicus* of the lexicalist approach to the passive in general. In the paper, Bresnan makes a compelling case against the prevailing wisdom that passivisation should be treated as a transformation, i.e. something that takes places in the phrasal syntax. Instead, she shows that it must be treated as a process occurring inside the lexicon. Bresnan et al. (2016: ch. 3) provide a contemporary presentation of the relevant arguments.

[7] This insight originates from work in Relational Grammar (e.g. Perlmutter & Postal 1977).

[8] Bresnan (1980, 1982) presents such rules as directional, so that the active maps to the passive, but they can also be seen as bidirectional, so that the existence of either kind of entry implies the other – this is how it is presented in Bresnan (1990), for example.

argument-to-GF assignments can *only* take place in the lexicon, via lexical rules, and cannot be effected on-line by syntactic rules – she refers to this as the principle of DIRECT SYNTACTIC ENCODING. Although contemporary LFG makes much less (or no) use of lexical rules, it continues to maintain the first part of this principle, and treats all argument alternations as applying in the lexicon, not in the syntax.

While lexical forms, which appear at f-structure as the value of PRED attributes, are obtained by augmenting a predicate-argument structure with linkings to GFs, at this stage in the development of LFG the formal status of the predicate-argument structures themselves is not made explicit. They are certainly not a separate level of representation, akin to c- and f-structure (i.e. there is no a-structure). Indeed, it is not until Butt et al. (1997) that the formal position of argument structure in the LFG architecture is tackled head on – we will have more to say about this in Section 6.1.

A more urgent shortcoming of the early lexical rule approach is that there is no account of how the original assignment of GFs to arguments is accomplished – that is, as Falk (2001b: 96) observes, early LFG has a theory of *re*mapping, via lexical rules, but no theory of the initial mapping. Bresnan (1980: 112) briefly suggests some principles for default assignments, but this is not developed more fully. Since, as we observed in Section 2.1, the initial mapping is also amenable to systematic study, and exhibits a number of clear generalisations, this lacuna is therefore a significant one.

There is also the question of appropriately constraining lexical rules. Clearly the rule of intransitivisation given in (25) cannot apply freely to any verb with an object, otherwise we would expect examples like (29b) to be grammatical, contrary to fact:

(29) a. Naomi told the story to Jim.
b. * Naomi told to Jim.

Lexical rules must be assigned syntactic, semantic, and morphological conditions in order to constrain their application. Even then, it remains a fact that lexical rules are very powerful formal devices: there are no in-principle constraints on what kinds of alternations can be described, which means that any remapping can be represented, including some which are most unnatural in the world's languages (Bresnan 1980: 639ff.).[9]

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[9] Of course, we may not expect formalism to constrain theory in this way (cf. Pollard 1997), and in that case this objection is of less concern.

The unconstrained expressive power of lexical rules arises from the fact that they are not MONOTONIC (Bresnan 1990): since such rules *overwrite* the original assignments of GFs to arguments, they are are not information-preserving.[10] Aside from the possibility of expressing unnatural alternations, another reason why non-monotonicity may be problematic has to do with processing. Arbitrary rewrite rules render a system intractable (cf. Peters & Ritchie 1973), and this is at odds with the LFG desideratum of psychological plausibility (Kaplan & Bresnan 1982: 173–174). However, this objection only carries weight insofar as the rules are applied during on-line processing; if they only apply in the lexicon, their computational power is irrelevant, since lexical entries are stored in memory. The discovery that complex predicates necessitate an analysis whereby argument structures can be assembled in the syntax (Butt 1995, Alsina 1996; Section 4.2.4 below) challenges this solution, however. Another way to neutralise the processing objection is by formally implementing lexical rules in such a way as to make them tractable, such as by treating two lexical entries related by lexical rule as a single lexical entry containing disjunctive specifications (cf. fn. 10). This might result in quite a gap between theoretical LFG and computational implementations (which again runs counter to the Competence Hypothesis of Kaplan & Bresnan 1982), but it does at least avoid intractability.

Although none of these objections may be insurmountable, lexical rules have nevertheless fallen out of favour in LFG. Lexical Mapping Theory has offered a fruitful alternative that avoids the formal and conceptual issues of lexical rules, and also goes further, by providing an account of the initial linking of arguments and GFs. Lexical rules have not entirely disappeared, however, and are still sometimes invoked to capture certain generalisations over the lexicon – see e.g. Bresnan et al.'s (2016: 315–319) analysis of possessors and gerundives. However, such generalisations can also be captured by using TEMPLATES (Dalrymple et al. 2004, Asudeh et al. 2013, Belyaev 2023a [this volume]), providing the possibility of doing away with lexical rules altogether.

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[10] Note that this is not an inherent property of lexical rules *per se*; as a reviewer notes, in XLE (the computational implementation of LFG – Kaplan & Newman 1997, Crouch et al. 2011), lexical rules are implemented as disjunctions of functional descriptions, thereby restoring monotonicity. This approach has also been taken in some theoretical work in LFG, starting with Butt et al. (1997) – see Section 6.2 below. HPSG takes a different approach to lexical rules again, treating them as unary-branching rules in the type hierarchy (see e.g. Davis & Koenig 2021: 155ff.).

4 Classical LMT

Lexical Mapping Theory (LMT) arose in part as a result of dissatisfaction with the shortcomings and unconstrained nature of lexical rules (Bresnan 1990). LMT therefore attempts to offer a more principled and constrained theory of both argument alternations and initial argument-GF mappings. Since the foundational work in LMT (Levin 1986, Bresnan & Kanerva 1989, Bresnan & Zaenen 1990), the theory has undergone many alterations and extensions; some of these build on one other, some offer competing perspectives, and some are simply different ways of saying the same thing. In addition, some are mere extensions or minor tweaks, while others involve rebuilding the theory from the ground up. We feel it would be both convoluted and unilluminating to trace every divergent strand of research in the LMT tradition, and so in this section we try to present a single coherent version of the theory, which we call Classical LMT. In order to maintain this coherence, we will adapt and update analyses where necessary, provided this does not detract from the main goals of the work in question.

Classical LMT represents what many take to be the "canonical" version of mapping theory in LFG, and is the variety which often appears in textbook presentations of the framework (as in e.g. Dalrymple 2001: 202ff. Falk 2001b: ch. 4, Bresnan 2001: ch. 14, Bresnan et al. 2016: ch. 14, and Börjars et al. 2019: ch. 8; see also Butt 2006: pp. 117ff.). However, it has long since been recognised that the name "*Lexical* Mapping Theory" is inappropriate, since "the theory cannot apply exclusively to individual words" (Dalrymple 2001: 212): for example, complex predicates which are formed analytically nonetheless contribute a single (complex) argument structure, despite the fact they contain multiple lexemes (Mohanan 1994, Butt 1995, Alsina 1996; Section 4.2.4 below). For this reason, alternative names have been proposed for the theory, including Mapping Theory *tout court* (as in e.g. Kibort & Maling 2015), Functional Mapping Theory (Alsina 1996), and Linking Theory (Butt et al. 1997). We use "Classical LMT" as a cover term, and for consistency with the large body of literature that uses the moniker "LMT", but we do not thereby intend to deny the importance of the work on complex predicates which shows that LMT cannot apply exclusively in the lexicon.

Our presentation of Classical LMT in this section has two parts: in Section 4.1, we present the basic formal tools and theoretical assumptions which characterise Classical LMT, while in Section 4.2 we discuss several case studies which illustrate the application of the theory to some empirical challenges, some of which necessitate (minor) changes to the theory.

Table 1: Feature decomposition of grammatical functions

	$-r$	$+r$
$-o$	SUBJ	OBL$_\theta$
$+o$	OBJ	OBJ$_\theta$

4.1 The framework

In this section, we present the theoretical and formal tools which are used in Classical LMT. We begin in Section 4.1.1 by introducing the idea of decomposing grammatical functions by means of binary features, which underpins the LMT approach to mapping. In Section 4.1.2, we address the question of the initial (unmarked) mapping of arguments to GFs, something that was ignored in the lexical rule approach. Lastly, Section 4.1.3 discusses the Classical LMT approach to argument alternations.

4.1.1 Feature decomposition

In the theoretical world described above in Section 3, arguments are associated with GFs in the lexicon. If those arguments are realised by different GFs as the result of some alternation, like the passive, the original assignments have to be overwritten. As discussed, this means that argument alternations involve non-monotonic re-writing rules. The key innovation of Classical LMT allowing it to avoid this unhappy conclusion is to underspecify the mappings between arguments and GFs, by grouping GFs into natural classes. Each argument can then be associated with one of these natural classes, rather than a specific GF, thereby constraining but not totally determining its ultimate realisation. And since the groupings of GFs are supposed to be natural, this also answers the complaint of unconstrainedness levelled at the lexical rule approach: no longer can we replace a GF with any other; instead, the choice of GFs available to an argument is limited to a natural class.

To achieve this cross-classification, Classical LMT decomposes the GFs using two binary-valued features, [±*r*] and [±*o*] (Bresnan & Kanerva 1989: 24–25). The first, [±*r*], refers to whether a GF is thematically restricted or not: OBJ$_\theta$ and OBL$_\theta$ are; SUBJ and OBJ are not. The second, [±*o*], refers to whether a GF is objective or not: OBJ and OBJ$_\theta$ are; SUBJ and OBL$_\theta$ are not. This is illustrated in Table 1. Grammatical functions can now be described in terms of two features: SUBJ is [−*r*, −*o*], OBJ is [−*r*, +*o*], OBL_θ is [+*r*, −*o*], and OBJ_θ is [+*r*, +*o*].[11] Each individual feature can also be used to describe a pair of GFs, as seen in each of the two rows and two columns of Table 1. This is what enables the association of an argument with a limited natural class of GFs: in Classical LMT, arguments are linked to a single feature (by means to be explored in the next section), and thereby made compatible with two GFs. This is more permissive than the original LFG approach, where an argument is linked to a specific GF, but still limited: argument alternations can only map the argument to the *other* GF, not to any arbitrarily different GF.

Bresnan & Kanerva (1989: 25) claim that the pairings induced by the feature decomposition just described are natural classes. This is a large part of the explanatory appeal of Classical LMT, so it is worth dwelling on momentarily. In fact, this is an area where Classical LMT has received some criticism. Alsina (1996), for example, observes that the standard feature decomposition fails in both directions: it describes an unnatural class and also fails to capture an important natural one. The pair of GFs described by [+*r*], namely OBJ_θ and OBL_θ, does not seem to form a natural class, in that there are no instances where arguments alternate between them. At the same time, the division between terms/direct GFs and nonterms/obliques has a number of linguistic reflexes (Dalrymple et al. 2019: 15–17), yet no single feature can pick out the terms, i.e. SUBJ, OBJ, and OBJ_θ, or the nonterms, i.e. OBL_θ (Alsina 1996: 29, fn. 9). For this reason, Alsina (1996: 19–20) suggests a different decomposition, according to the features [±subj] and [±obl].

On a related note, Findlay (2020: 130) and Asudeh (2021: 32) object to the "suspiciously circular" (*ibid.*) definition of [±*o*]. While it might be relatively clear what independent content [±*r*] could have (being semantically restricted makes sense outside of the context of grammatical functions), it is much less clear what independent content [±*o*] could possess: it identifies a GF as belonging or not to the set {OBJ, OBJ_θ}, but by virtue of no other property than membership of that set.

Despite these qualms, the cleavages induced by the [*r*] and [*o*] features remain in common usage, even if their interpretation is reimagined (e.g. Kibort 2014: 266 views [+*o*] as picking out the complements from the non-complements, and [−*r*] as picking out the core arguments from the non-core – see Section 5). The most

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[11] If we take this feature decomposition literally, then grammatical functions are no longer primitives in the theory; instead, the features are. Butt (1995: 31) makes this claim explicitly. However, it is also possible to avoid this conclusion, and retain the primitive status of grammatical functions in LFG, by viewing such feature decomposition as merely descriptive, so that it cross-classifies the GFs but does not formally break them down (Butt et al. 1997, Findlay 2016: 298ff.; see Section 6.2 below).

significant reason for this is ultimately their success: the cross-classification in Table 1 has proved incredibly useful in describing a variety of argument structure phenomena in a diverse selection of languages – we will see some examples of this later in this section and especially in Section 4.2.

One potential immediate issue is that using two binary-valued features enables us to describe a four-way classification, but LFG's inventory of grammatical functions has more than four members. Of course, it is no problem that we omit ADJ and XADJ from consideration, since adjuncts are not involved directly in argument structure and mapping, being unable (by definition) to be selected by a predicate.[12] However, the two clausal GFs COMP and XCOMP, both argument GFs, are also missing from Table 1. In fact, and despite some countervailing voices (Dalrymple & Lødrup 2000, Lødrup 2012), many researchers have advocated for eliminating these GFs by assimilating them to one or more of the other complement GFs, *viz.* OBJ, OBJ_θ, and OBL_θ (Zaenen & Engdahl 1994: 197–198, Alsina 1996, Alsina et al. 2005, Forst 2006, Berman 2007, Patejuk & Przepiórkowski 2016, Szűcs 2018). In that case, the omission of COMP and XCOMP from Table 1 is not a problem. Even if the clausal GFs are not eliminated entirely, it seems possible that the distinction between them and the other complement GFs could still be neutralised at the level of specificity required of mapping theory. We can therefore continue to assume that the four GFs in Table 1 are the only ones relevant for mapping.

Besides dividing up the GFs, the $[r]$ and $[o]$ features can also be used to order them. Bresnan & Zaenen (1990: 49) claim that the features indicate markedness of GFs, so that those which possess more negative-valued features are less marked than those which possess more positive-valued ones. This leads to the partial ordering known as the MARKEDNESS HIERARCHY:

(30) *The Markedness Hierarchy:*
$\text{SUBJ} > \text{OBJ}, \text{OBL}_\theta > \text{OBJ}_\theta$

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[12] In fact, it has been argued that there are such things as "obligatory adjuncts", given the existence of contrasts like the following, where the omission of the parenthetical material leads to ungrammaticality on the intended reading of the verb:

(i) a. Cat behaves *(badly).
b. Lister lives *(in space).
c. This book reads *(well).

See Przepiórkowski (2016: 262–263) and references therein for further discussion and exemplification.

subj, bearing a negative value for both features, is the least marked GF, at the top of the hierarchy; obj$_\theta$, with two positive values, is the most highly marked, at the bottom. Since obj and obl$_\theta$ both have one negative- and one positive-valued feature, they sit in the middle, and are not ordered with respect to one another.[13] This hierarchy of GFs is important for the principles which Classical LMT uses to determine the ultimate mapping of arguments to GFs, to which we now turn.

4.1.2 Initial classification and mapping of arguments

Just as in Section 3, we assume that predicates are equipped with an argument structure that lists their syntactically-realisable arguments. (31) shows a simple example for *kick*:

(31) *kick* ⟨ Agent Patient ⟩

Although Classical LMT still offers no formal consensus on its status or position in the architecture of LFG, such a list now starts to be referred to as a-structure, as if it were a separate level of the parallel projection architecture (see Falk 2001b: 97–106 for some discussion). Arguments within a-structure are ordered according to their thematic role, following the thematic hierarchy introduced in (10), and repeated in (32) (Bresnan & Kanerva 1989: 23):

(32) *The Thematic Hierarchy:*
Agent > Beneficiary > Recipient/Experiencer
> Instrument > Theme/Patient > Location

The most important function of this ranking in Classical LMT is simply to identify the most highly ranked argument, which we refer to as $\hat{\theta}$.[14] This is because of the observation that the most "prominent" thematic role often aligns with the

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[13] Note that the order of GFs in this hierarchy differs from the typologically-motivated Functional Hierarchy, which Dalrymple et al. (2019: 11) present as the standard in LFG (based on the Accessibility Hierarchy of Keenan & Comrie 1977):

(i) *The Functional Hierarchy:*
subj > obj > obj$_\theta$ (> xcomp, comp) > obl$_\theta$ (> xadj, adj)

Notably, obj$_\theta$ outranks obl$_\theta$ in (i), while the opposite is true in (30).

[14] This is also sometimes called the thematic subject or a-structure subject, and has also been equated with the concept of logical subject. Such a notion of "most thematically prominent argument" has been shown to play a role outside of mapping theory as well, such as in determining the antecedent of a reflexive (Dalrymple 1993, Joshi 1993, Mohanan 1994, Manning & Sag 1999).

most “prominent” GF, i.e. subj (Fillmore 1968, Grimshaw 1990, Speas 1990). We will see how this is cashed out in Classical LMT below.

Whereas arguments were previously associated with a specific GF in the lexicon, in Classical LMT they are associated with a single $[\pm o/r]$ feature instead (i.e. with a *pair* of GFs). In early versions of LMT, such as Bresnan & Kanerva (1989: 25–26) or Bresnan & Moshi (1990), this is achieved by intrinsic connections between specific named thematic roles and features, as in (33), from Bresnan & Moshi (1990: 168):

(33) *Intrinsic classifications:*

Agent	Theme/Patient	Location
$[-o]$	$[-r]$	$[-o]$

This is based on typological observations about common realisations of various thematic roles across languages: cross-linguistically, for instance, Themes/ Patients canonically alternate between the unrestricted GFs, i.e. subject and object, while other roles like Agent and Location canonically alternate between the non-object functions, i.e. subject and oblique (Bresnan & Kanerva 1989: 26). There is no principled limit on which roles might receive intrinsic classifications like this.

In subsequent work in Classical LMT, this open-endedness is rejected, and the initial classification principles are reduced to three (Bresnan & Zaenen 1990: 49; cf. also Her 2003, 2013; and see Bresnan et al. 2016: 331 for a contemporary textbook presentation), claimed to be general across languages:[15]

(34) *Intrinsic classifications (general):*

patientlike roles:	secondary patientlike roles:	other roles:
θ	θ	θ
$[-r]$	$[+o]$	$[-o]$

While this is an improvement in terms of theoretical parsimony, there is a cost in terms of explicitness. Asudeh (2021: 32), for instance, complains that the notion of being “patientlike” is “obscure”, noting that “it’s not clear what the conditions are for meeting the criterion of being ‘like’ a patient”.

Let us assume, however, that it is clear enough when a role is patientlike or not. What of the secondary patientlike roles? Where verbs have more than one patientlike argument, as in ditransitives, one of the two may be “secondary” in

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[15] “θ” is used to stand for any thematic role, since these principles no longer refer to specific roles.

the sense of Dryer (1986), and this argument will be marked as [+*o*]. Such languages are called asymmetrical object languages, in contrast with symmetrical object languages, which permit multiple patientlike roles to be marked [−*r*] (see Bresnan & Moshi 1990 and Section 4.2.3 below). Even within asymmetrical object languages, there is variation in which of the two arguments counts as primary or secondary – indeed, a single language can permit both possibilities (see discussion of English *give* below).

Given these basic assignments, the a-structure of our simple transitive verb *kick* will be as follows:

(35)
$$\textit{kick}\quad \langle\quad \underset{[-o]}{\text{Agent}}\quad \underset{[-r]}{\text{Patient}}\quad \rangle$$

There is one patientlike role, namely the Patient itself, so this is marked [−*r*]; the one other role is marked [−*o*], according to the third, "elsewhere" principle in (34).

To resolve these single features to fully-specified GFs, Classical LMT makes use of two Mapping Principles:[16]

(36) *Mapping Principles*:

a. Subject roles:

i. $\underset{[-o]}{\hat{\theta}}$ is mapped onto subj when initial in the a-structure;

otherwise:

ii. $\underset{[-r]}{\theta}$ is mapped onto subj.

b. Other roles are mapped onto the lowest featurally compatible function on the Markedness Hierarchy in (30).

As mentioned, the most thematically prominent argument, $\hat{\theta}$, is strongly associated with the subj position; Mapping Principle (a-i) captures this, and requires that a non-patientlike $\hat{\theta}$ maps to subj where possible. The constraint that $\hat{\theta}$ be leftmost in the a-structure is to account for the presence of non-thematic arguments which might take precedence in mapping to subj. For example, the a-structure of a raising verb like *seem* is as shown in (37) (Zaenen & Engdahl 1994: 200):

(37)
$$\textit{seem}\quad \underset{[-r]}{\_\_}\quad \langle\quad \underset{[-o]}{\text{Proposition}}\quad \rangle$$

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[16] We follow the formulation of Bresnan et al. (2016: 334); for the first appearance of these principles, see Bresnan & Zaenen (1990: 51).

Although *seem* only takes a single semantic argument, the Proposition it embeds, this argument cannot surface as the subject, and the verb instead takes a non-thematic, expletive subject:[17]

(38) a. * That Kira smiled seemed.
 b. It seemed that Kira smiled.

For this reason, (37) contains two argument slots, although one is devoid of semantic content and is therefore marked as $[-r]$, since a non-thematic argument, by definition, cannot be semantically restricted. The highest thematic role, $\hat{\theta}$, is still the Proposition, and it is marked $[-o]$, but because it is no longer initial in the a-structure, it is not mapped to SUBJ by Mapping Principle (a-i), leaving the expletive argument available to map to SUBJ by Principle (a-ii).

In addition to the Mapping Principles in (36), there are two other well-formedness conditions on mapping, FUNCTION-ARGUMENT BIUNIQUENESS (Bresnan 1980: 112), and the SUBJECT CONDITION (Baker 2006 [1983], Bresnan & Kanerva 1989: 28):[18]

(39) *Function-Argument Biuniqueness:*
Each a-structure role must be associated with a unique function, and vice versa.

(40) *The Subject Condition:*
Every predicator must have a subject.

The first condition ensures that a predicate cannot select for multiple of the same GF, and that a single argument cannot be realised by multiple GFs of the same predicate.[19] The second represents a supposed language universal, that all predicates possess subjects – even when these are not overtly expressed. There have been some doubts about the universality of this claim (see e.g. Bresnan & Kanerva 1989: 28, fn. 37, Bresnan et al. 2016: 334, fn. 9, Kibort 2006, and references therein), so it may be more appropriate to see this as a parameter which varies by language.[20]

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[17] Of course, there is also the "raised" alternative *Kira seemed to smile*. See Zaenen & Engdahl (1994) and Dalrymple et al. (2019: ch. 15) for the treatment of raising in LFG.

[18] Once again, we take the specific wording from Bresnan et al. (2016: 334).

[19] The first part of this is already barred by the f-structure well-formedness condition called Consistency (Dalrymple et al. 2019: 53–54), which follows from the functional nature of f-structure: each attribute at f-structure, such as a GF like SUBJ or OBJ, can only have a single value.

[20] Kibort (2004: 358–359) reworks the Classical LMT Mapping Principles in such a way that she can do without the Subject Condition altogether – see Section 5 for more details.

Note that these well-formedness conditions are more important in early LMT work, such as Bresnan & Kanerva (1989), since this version of the theory does not include explicit Mapping Principles like (36). Instead, through a richer theory of intrinsic and default assignment of features to arguments, a number of mappings are made possible, which are then filtered down to the unique solution by Function-Argument Biuniqueness and the Subject Condition (Bresnan & Kanerva 1989: 28ff.). In the sense that this involves positing fewer rules, it is a simpler theory – but the rules it does include are more specific (i.e. referring to particular thematic roles by name), making it less general overall.

Let us return now to the example of a simple transitive predicate like *kick* and see how the Mapping Principles apply in practice. Since Agent outranks Patient on the Thematic Hierarchy, the Agent is identified as $\hat{\theta}$; since this argument is also initial in the a-structure, it is therefore mapped to SUBJ. The remaining argument, the $[-r]$ Patient, then maps to the lowest compatible GF on the Markedness Hierarchy: the lowest $[-r]$ GF is OBJ. This correctly gives us the active voice mapping whereby the Agent is realised as the subject, and the Patient as the object:

$$\begin{array}{llcccc} (41) & \textit{kick} & \langle & \text{Agent} & \text{Patient} & \rangle \\ & & & [-o] & [-r] & \\ & & & | & | & \\ & & & \text{SUBJ} & \text{OBJ} & \end{array}$$

What of other predicate types?[21] Intransitives should have their single argument mapped to SUBJ. The initial feature assignment to this argument will depend on whether the predicate is unaccusative or unergative (Perlmutter 1978):

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[21] We consider only verbal predicates in this chapter. This footnote offers a selection of references for the reader interested in learning more about argument structure and mapping phenomena within the nominal domain. The most prominent idea, proposed by Rappaport (2006 [1983]), is that nominals derived from verbs inherit that verb's argument structure, but that the possibilities for mapping are more constrained within the noun phrase – for example, the functions SUBJ and OBJ are not available to the dependents of nouns (cf. *Luke destroyed the Death Star* and *Luke's destruction of the Death Star*). This perspective remains the dominant one – see e.g. Laczkó (2000, 2003, 2007), Kelling (2003), Chisarik & Payne (2001, 2003) – but some have instead argued that nominals either don't have argument structures, or that, where they do, they can differ from the corresponding verbal ones (Ramchand 1997, Lowe 2017, Taylor 2023). Börjars & Lowe (2023) [this volume] provide a useful contemporary summary of the issues.

A wide range of languages have been studied in LFG with respect to nominal argument structures and their mapping possibilities: see Saiki (1987) on Japanese, Markantonatou (1995) on Modern Greek, Laczkó (2000, 2003, 2004, 2010) on Hungarian, Falk (2001a) on Modern Hebrew, Kelling (2003) on French, Sulger (2013) on Hindi-Urdu, Lowe (2017) on Sanskrit and other early Indo-Aryan languages, and Taylor (2023) on Old English.

since the single argument of an unaccusative is patientlike, it will be assigned [−*r*]; unergatives, on the other hand, have more agentlike arguments, which will therefore be assigned [−*o*]. However, in both cases this will result in the correct mapping (in the simple, active case): for the unaccusative verb, (42), Mapping Principle (a-ii) applies, while for the unergative (43), Principle (a-i) does the job.

$$\begin{array}{llccc} (42) & \textit{fall} & \langle & \text{Patient} & \rangle \\ & & & [-r] & \\ & & & | & \\ & & & \text{SUBJ} & \end{array}$$

$$\begin{array}{llccc} (43) & \textit{run} & \langle & \text{Agent} & \rangle \\ & & & [-o] & \\ & & & | & \\ & & & \text{SUBJ} & \end{array}$$

Ditransitives like *give* are slightly more complicated. They of course have three arguments in their a-structure:

$$\begin{array}{llccccc} (44) & \textit{give} & \langle & \text{Agent} & \text{Beneficiary/Recipient} & \text{Theme} & \rangle \end{array}$$

Following the usual initial classifications, the Theme, as a patientlike argument, is linked to [−*r*], and the Beneficiary/Recipient and Agent both receive the "elsewhere" [−*o*] feature. As per the Mapping Principles, the Agent, an a-structure-initial, [−*o*]-valued, $\hat{\theta}$ argument, is mapped to SUBJ. The Beneficiary/Recipient maps to the lowest [−*o*] GF, which is OBL_{θ}, while the Theme maps to the lowest [−*r*] GF, OBJ. This gives us one correct mapping for *give*, illustrated in a sentence like *Peter gave a present to Harriet.*

$$\begin{array}{llccccc} (45) & \textit{give} & \langle & \text{Agent} & \text{Beneficiary/Recipient} & \text{Theme} & \rangle \\ & & & [-o] & [-o] & [-r] & \\ & & & | & | & | & \\ & & & \text{SUBJ} & \text{OBL}_{\theta} & \text{OBJ} & \end{array}$$

But of course there is another way of realising the arguments of a ditransitive like *give*: the dative-shifted version, illustrated in *Peter gave Harriet a present.* Since this involves the same thematic roles, this alternation cannot be derived in Classical LMT without some further stipulation (Kibort 2008: 314). It seems that we can choose to view the Beneficiary/Recipient as patientlike (cf. Toivonen 2013), in which case it is assigned [−*r*] by the intrinsic classification rules

(Bresnan 2003: 14–15; cf. also Bresnan et al. 2016: 337–340). Now, English is an asymmetrical object language, which means it does not permit the presence of two [−*r*] arguments at a-structure (see Section 4.2.3), and so the (lower-ranked) Theme must instead be marked [+*o*], as a secondary patientlike argument, per (34). The Agent receives the “elsewhere” [−*o*] specification as usual, giving us the following a-structure and GF-mapping:

(46)
$$\begin{array}{lccccc} \textit{give} & \langle & \text{Agent} & \text{Beneficiary/Recipient} & \text{Theme} & \rangle \\ & & [-o] & [-r] & [+o] & \\ & & | & | & | & \\ & & \textsc{subj} & \textsc{obj} & \textsc{obj}_{\theta} & \end{array}$$

This is the double object version of *give*: the Agent is mapped to SUBJ as usual, then the other arguments are mapped to the lowest compatible GFs, in this case OBJ for the Beneficiary/Recipient (the lowest [−*r*] GF) and $\textsc{obj}_{\theta}$ for the Theme (the lowest [+*o*] GF). So, Classical LMT can account for the dative shift alternation, but only with the initial stipulation that the Beneficiary/Recipient can be viewed as patientlike, and hence assigned [−*r*] at a-structure. Indeed, morphosemantic alternations in general are problematic for Classical LMT, a shortcoming which Kibort (2007, 2014) attempts to rectify, and which we will examine in more detail in Section 5. For now, though, we consider the well-developed Classical LMT account of (morphosyntactic) alternations.

4.1.3 Argument alternations

Argument alternations in Classical LMT are handled by adding extra specifications to arguments – in this way information is only added, not removed, meaning that “the computational requirement of monotonicity can be met even in the domain of relation changes” (Bresnan 1990: 650).

One common mechanism is that of SUPPRESSION, illustrated schematically in (47):

(47)
$$\begin{array}{c} \theta \\ | \\ \varnothing \end{array}$$

This prevents an argument from being mapped to a GF at f-structure, and existentially quantifies over the argument in the semantics (though it does allow the possibility of the argument being realised by an adjunct, like the English *by*-phrase which can express the Agent of a passive, so this quantification only applies if the argument remains unexpressed). Suppression is restricted to unmarked arguments, i.e. those pre-specified with a negatively-valued feature at a-structure (Alsina 1999; see also Bresnan et al. 2016: 338–340 for a relevant example), a principle known as Recoverability of Suppresion (Bresnan et al. 2016: 333).

Lexical rules involving deletion can be recast in terms of suppression. For example, instead of deleting an obj, as in (25), intransitivisation involves suppression of a Theme/Patient argument:

(48) Intransitivisation: $\begin{array}{c}\text{Theme/Patient}\\ | \\ \emptyset\end{array}$

And rather than deleting or re-writing the subj and changing an obj to a subj, as in (27), passivisation simply involves a single process, *viz.* the suppression of the highest thematic role:

(49) Passivisation: $\begin{array}{c}\hat{\theta}\\ | \\ \emptyset\end{array}$

This simplified analysis of passivisation works because of the general system of mapping assumed in Classical LMT. In a standard two-place predicate like *kick*, the highest, Agent argument will be [−*o*], while the next, Patient argument will be [−*r*]. If the Agent argument is suppressed, Mapping Principle (a-i) will not apply, and instead Principle (a-ii), which maps a [−*r*] argument to subj, will step in, correctly promoting the Patient argument, without any need for further stipulation:[22]

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[22] The way the Mapping Principles are written, it seems to us that argument suppression should lead to a contradiction. Assuming the Principles are intended to be declarative rather than procedural, then (50) would seem to violate Mapping Principle (a-i), since it is not true that a [−*o*], a-structure-initial $\hat{\theta}$ is mapped onto subj: instead, it is not mapped to anything; and the same goes for intransitivisation: the suppressed Theme/Patient argument in a transitive will not be mapped to the lowest featurally compatible function on the Markedness Hierarchy, contrary to Principle (b). Perhaps suppression removes an argument from consideration at a-structure altogether, but in that case it would not be monotonic. One solution would simply be to add the rider "unless suppressed" to each of the Mapping Principles, but this seems far from parsimonious.

$$\begin{array}{llcccc} (50) & \textit{kicked}_{\text{PASSIVE}} & \langle & \text{Agent} & \text{Patient} & \rangle \\ & & & [-o] & [-r] & \\ & & & \mid & \mid & \\ & & & \varnothing & \text{SUBJ} & \end{array}$$

Passivisation also correctly applies to ditransitives in both their a-structure realisations. For example, suppressing the Agent in the non-shifted version, repeated in (51), results in the Theme being promoted to SUBJ, by Mapping Principle (a-ii), since it is a $[-r]$ argument.

$$\begin{array}{llccccc} (51) & \textit{give} & \langle & \text{Agent} & \text{Beneficiary/Recipient} & \text{Theme} & \rangle \\ & & & [-o] & [-o] & [-r] & \\ & & & \mid & \mid & \mid & \\ & & & \varnothing & \text{OBL}_{\theta} & \text{SUBJ} & \end{array}$$

This gives us the correct alternation, illustrated in (52), where the Beneficiary/Recipient remains an OBL_{θ} (since this is still the most marked $[-o]$ GF):

(52) a. Peter gave a present to Harriet.

b. A present was given to Harriet (by Peter).

On the other hand, when the Agent is suppressed in the dative-shifted version, the Beneficiary/Recipient is promoted instead, since it is now the $[-r]$ argument, while the Theme remains an OBJ_{θ} (since this is still the most marked $[+o]$ GF):

$$\begin{array}{llccccc} (53) & \textit{give} & \langle & \text{Agent} & \text{Beneficiary/Recipient} & \text{Theme} & \rangle \\ & & & [-o] & [-r] & [+o] & \\ & & & \mid & \mid & \mid & \\ & & & \varnothing & \text{SUBJ} & \text{OBJ}_{\theta} & \end{array}$$

This again accords with the facts:[23]

(54) Peter gave Harriet a present.

(55) Harriet was given a present (by Peter).

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[23] For those dialects where *%A present was given Harriet (by Peter)* is grammatical, something more needs to be said, of course. It is possible the Asymmetrical Object Parameter (Bresnan & Moshi 1990) is not in force in these varieties of English (see Section 4.2.3 for more on the AOP).

Notice that because Mapping Principle (b) requires that an argument be mapped to the *lowest* compatible GF on the hierarchy, the [+*o*] argument of such double object verbs remains an obj$_\theta$ in the passive, and is not, for example, "promoted" to obj. That this is the correct result is not at all obvious from English data alone: the usual test for obj-hood is the possibility of promotion through passivisation, but we cannot passivise a passive. In the absence of any morphological marking of the distinction between obj and obj$_\theta$, there is no obvious way to tell which of these two GFs *a present* bears in example (55).

Data from other languages, however, such as the Bantu language Chicheŵa, support the Classical LMT analysis. Ditransitive verbs can be formed in Chicheŵa by applicativisation, and when the applied argument is a Beneficiary, it is assigned a [−*r*] classification at a-structure, while the Theme is assigned [+*o*], exactly as in the English double object construction, and resulting in the same GF assignments as we saw above (Alsina & Mchombo 1993: 28). In such Chicheŵa applicatives, only the obj (the Beneficiary) can be indexed by an object marker on the verb, while the obj$_\theta$ (the Theme) cannot (Bresnan & Moshi 1990; Alsina & Mchombo 1993: 22):[24]

(56) a. Chi-tsîru chi-na-wá-gúl-ir-á m-phâtso (a-tsíkāna).
7-fool 7s-pst-2o-buy-appl-fv 9-gift 2-girls
'The fool bought a gift for them (the girls).'

b. * Chi-tsîru chi-na-í-gúl-ir-á a-tsíkāna (m-phâtso).
7-fool 7s-pst-9o-buy-appl-fv 2-girls 9-gift

Now, given the a-structure assignments, we also observe the same passivisation pattern for Chicheŵa applicatives as for the English double object construction, with the Beneficiary obj being promoted to subj (Alsina & Mchombo 1993: 29):

(57) Atsíkāna a-na-phík-ír-idw-á nyêmba.
2-girls 2s-pst-cook-appl-pass-fv 10-beans
'The girls were cooked beans.'

Crucially, we now have a diagnostic to identify the GF of the remaining Theme argument: if it is promoted to obj, it should be compatible with the presence of an agreeing object marker on the verb; if it remains an obj$_\theta$, then the use of the object marker will not be possible. In fact, use of the object marker in this construction is ungrammatical (Alsina & Mchombo 1993: 30):

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[24] Object NPs indexed on the verb can be omitted, indicated here by parentheses. Numbers signify noun classes; s = subject marker; o = object marker; fv = final vowel.

(58) * Atsíkāna a-na-zí-phík-ír-idw-á (nyêmba).
2-girls 2s-pst-10o-cook-appl-pass-fv 10-beans
'The girls were cooked beans.'

This incompatibility shows that the Beneficiary argument here must still be an obj$_{\theta}$, not an obj, and this therefore motivates Mapping Principle (b), where arguments are linked to the *most* marked compatible GF (though the empirical landscape may not be quite so straightforward as this single data point would suggest: see Kibort 2008 for some discussion of the complexities).

Along with suppression, argument alternations can involve adding new arguments to an a-structure, as in the Bantu applicative (Bresnan & Moshi 1990), or the English benefactive (Toivonen 2013). For example, Toivonen (2013: 514) gives the rule in (60) for the benefactive in English, which takes a transitive verb into a ditransitive, as in (59):

(59) a. I'll pack some sandwiches.
b. I'll pack the children some sandwiches.

(60)
$$\text{English benefactive:} \quad \left\langle \begin{array}{ccc} & \overset{\varnothing}{\downarrow} & \\ \hat{\theta} & \text{Beneficiary/Recipient} & \text{Theme} \\ [-o] & [-r] & [+o] \end{array} \right\rangle$$

Note that the symbol ∅ is used differently here from above, where it represented argument suppression. Here it captures the fact that the Beneficiary/Recipient is added to an a-structure which otherwise contains only a Theme and a $\hat{\theta}$, whatever role that may play; i.e. (60) adds the Beneficiary/Recipient where previously there was no argument.

As well as adding or suppressing arguments, alternations can also involve constraining the mapping possibilities of arguments. This is what happens in locative inversion, for example. The relevant examples from Chicheŵa are repeated in (61):

(61) a. Chi-tsîme chi-li ku-mu-dzi.
7-well 7-be 17-3-village
'The well is in the village.'

b. Ku-mu-dzi ku-li chi-tsîme.
17-3-village 17-be 7-well
'In the village is a well.'

Bresnan & Kanerva (1989: 27) analyse the relevant process in the following terms:

(62)

$$\begin{array}{lccccc} \text{Locative inversion:} & \langle & \text{Theme} & \ldots & \text{Location} & \rangle \\ & & & & [-r] & \end{array}$$

That is, when a Location appears in the same a-structure as a Theme, assign it the specification [−*r*] in addition to whatever its intrinsic feature assignment is. Let us see how this provides the contrast in (61).

In the relevant sense, the verb *-li* 'be' takes a Theme and a Location argument; as per the intrinsic specifications of (34), the patientlike Theme is assigned [−*r*] and the other role is assigned [−*o*]. All things being equal, this will provide the mapping instantiated by (61a), where the Theme maps to SUBJ, by Mapping Principle (a-ii), and the Location maps to $\textsc{obl}_\theta$, the lowest [−*o*] GF.

(63)

$$\begin{array}{lcccc} \textit{-li} & \langle & \text{Theme} & \text{Location} & \rangle \\ & & [-r] & [-o] & \\ & & | & | & \\ & & \textsc{subj} & \textsc{obl}_\theta & \end{array}$$

When we apply the additional assignment in (62), however, things change:

(64)

$$\begin{array}{lcccc} \textit{-li} & \langle & \text{Theme} & \text{Location} & \rangle \\ & & [-r] & [-o] & \\ & & | & [-r] & \\ & & | & | & \\ & & \textsc{obj} & \textsc{subj} & \end{array}$$

Here, the Location argument is fully specified as a SUBJ, meaning that the Theme is prevented from also being mapped to SUBJ, owing to Function-Argument Biuniqueness. Instead, it must map to the lowest available GF on the Markedness Hierarchy, namely OBJ. This gives us the mapping instantiated by (61b).

This section has served to provide a sampling of the different approaches to argument alternations in Classical LMT. By suppressing, adding, or further specifying arguments, the theory can give succinct accounts of a variety of different phenomena. To the extent that these simple descriptions make the correct predictions in conjunction with the underlying theory, this also serves as a vindication of the latter. Of course, we have hardly been able to do justice to such a rich literature in a handful of pages, but we hope to have illustrated the key technical points. In the following section, we provide a few more case studies, further showcasing areas where Classical LMT has provided elegant and illuminating analyses.

4.2 Case studies and extensions

The framework of Classical LMT has been shown to offer an elegant solution to many thorny empirical issues, but it has also sometimes been necessary to expand or modify the theory in the face of empirical deficiencies or theoretical shortcomings. In this section, we discuss various topics which showcase the workings of Classical LMT.

4.2.1 Resultatives

As first observed by Simpson (2006 [1983]), resultative predicates in English can be applied to the objects of transitives or to the subjects of their corresponding passives, as shown in (65), and to the subjects of unaccusative intransitives but not of unergatives, as shown in (66) (examples from Bresnan & Zaenen 1990: 46):

(65) a. We pounded the metal flat.
b. The metal was pounded flat.

(66) a. The river froze solid.
b. * The dog barked hoarse.

The question then arises: how should we characterise all and only the arguments which can have resultatives predicated of them?

The generalisation cannot be based on surface grammatical function. For one thing, the data above show that both subjects and objects can take resultative predicates. What is more, only some subjects are implicated: (66b) is ungrammatical, and (65a) would be too if it were intended to mean that we pounded the metal until *we* were flat.

Given the contrast between unaccusative and unergative predicates, we might think instead to appeal to the thematic role of the arguments in question: perhaps resultatives can be applied to Themes, and not to Agents? This would account for the data in (65–66), but unfortunately there are other data which invalidate such a generalisation. Resultatives can also be applied to non-thematic arguments such as "fake reflexives", illustrated in (67), or "non-subcategorised objects" which do not stand in a direct semantic relation to the main verb, illustrated in (68) (examples from Bresnan & Zaenen 1990: 47):

(67) a. The dog barked itself hoarse.
b. We ran ourselves ragged.

(68) a. The dog barked us awake.
b. We ran the soles right off our shoes.

The tools of Classical LMT offer a straightforward solution to this descriptive challenge: the arguments in question are simply those which are assigned [−*r*] as their initial feature value at a-structure. For the Themes in (65–66), this follows from their being patientlike, while for the problematic arguments in (67–68) this follows from their being non-thematic (and so by definition semantically unrestricted). The more agentive subjects of transitive and unergative verbs will instead by classified as [−*o*] by the "elsewhere" condition, which sets them apart.

4.2.2 Proto-roles and unaccusativity

Another area where intrinsic classification of argument positions at a-structure has proved a more useful discriminator than other notions is in Zaenen's (1993) analysis of unaccusativity in Dutch. Before we consider the data, however, we first introduce Zaenen's innovative approach to intrinsic feature specification.

Rather than having to decide impressionistically whether an argument is "patientlike" or not, in order to decide whether it should be assigned [−*r*] or [−*o*] as its initial feature specification at a-structure, Zaenen (1993: 146–154) proposes to operationalise Dowty's (1991) notion of semantic PROTO-ROLE.

Dowty (1991: 571–575) envisages semantic roles as prototypes: arguments can possess a number of both proto-agent and proto-patient properties, with their behaviour depending on the balance between the two groups. This allows a fuzzier notion of semantic role, and avoids some of the definitional challenges of using named roles. Proto-agentivity and proto-patientivity are determined by a number of lexical entailments, including volition, change of state, and movement, which describe aspects of the relationship between participant and event (Dowty 1991: 572):

(69) *Proto-agent entailments:*

- volitional involvement in the event or state
- sentience (and/or perception)
- causing an event or change of state in another participant
- movement (relative to the position of another participant)
- exists independently of the event named by the verb

(70) *Proto-patient entailments:*

- undergoes change of state
- incremental theme[25]
- causally affected by another participant
- stationary relative to movement of another participant
- does not exist independently of the event, or not at all

Dowty (1991: 576) uses these proto-properties to determine the assignment of the subject and object GFs to arguments (the argument with more proto-agent properties becomes the subject, while the argument with more proto-agent properties becomes the object), but Zaenen (1993: 149) instead uses them to determine the intrinsic feature specification of an argument at a-structure: those that have more proto-agent properties will be classified as [−*o*], while those that have more proto-patient properties will be classified as [−*r*]. This therefore captures the same general intuition as the Classical LMT intrinsic assignment principles in (34), namely that patientlike arguments are [−*r*] and others are [−*o*], but does so in a way which makes it more explicit what criteria an argument has to satisfy to count as patientlike. (Of course, determining whether an argument satisfies the proto-properties can also sometimes be rather impressionistic, but many are clear-cut enough to at least afford one an analytical toehold.)

A problem arises when an argument possesses an equal number of proto-agent and proto-patient properties (including zero). Dowty (1991: 576) proposes that in this situation both mappings are available. Zaenen (1993: 150) instead assumes that in such a case the argument is assigned [−*r*]. This is somewhat self-serving in that it gives her the correct results for Dutch (see below), but, as she observes, it does not seem unreasonable that it is precisely in areas such as this, where the distinctions are less clear-cut, that languages vary, and so perhaps a degree of arbitrariness is unavoidable.

Let us now turn to the Dutch data which Zaenen (1993) uses these tools to analyse. Intransitive verbs in Dutch take different auxiliaries in the compound past tense depending on whether they are unaccusative or unergative. The unergatives take *hebben* 'have' and the unaccusatives take *zijn* 'be':

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[25] Dowty (1991: 588) defines an incremental theme as "an NP that can determine the aspect of the sentence […]; the event is 'complete' only if all parts of the NP referent are affected (or effected)". For example, in *Chrisjen ate a pistachio*, the eating event is only complete once all (edible) parts of the pistachio are eaten.

(71) **Unergative verbs:**

a. Hij heeft/*is gelopen.
he has/is run
‘He has run.’

b. Ze heeft/*is getelefoneerd.
she has/is telephoned
‘She has telephoned.’

(72) **Unaccusative verbs:**

a. Ze is/*heeft overleden.
she is/has died
‘She has died.’

b. Hij is/*heeft gevallen.
he is/has fallen
‘He has fallen.’

This also correlates with another contrast: the possibility of using the past participle as a pre-nominal modifier. This is impossible with the unergative, *hebben*-taking verbs, but perfectly productive with the unaccusative, *zijn*-taking verbs:

(73) a. * de gelopen/getelefoneerd man
the run/telephoned man

b. de overleden/gevallen vrouw
the deceased/fallen woman
‘the deceased/fallen woman’

Now, if the intransitives were the only verbs we had to consider here, then a semantic explanation would be possible. For one thing, the single argument of an unaccusative is generally Theme/Patient-like. Zaenen (1993: 132–136) also discusses other semantic criteria which distinguish the two classes of verbs. However, a class of transitive verbs (those with an experiencer argument) also exhibit the same syntactic split, despite having different semantics. Firstly, some take *hebben* and some take *zijn* in the compound past tense:

(74) a. Dat is/*heeft me jarenlang goed bevallen.
that is/has me for.years well pleased
‘That has pleased me well for years.’

b. Hij heeft/*is me jarenlang geïrriteerd.
he has/is me for.years irritated
'He has irritated me for years.'

And this distinction once again maps onto a difference in the use of the past participle as a pre-nominal modifier. When the past participles of those verbs that take *zijn* are used pre-nominally, their head noun can be understood as the equivalent of their active voice subject, whereas this is not the case for those that take *hebben*:

(75) het hem goed bevallen boek
the him well pleased book
'the book that pleased him well'

(76) a. de geïrriteerde jongen
the irritated boy
'the irritated boy'

b. # de geïrriteerde fouten
the irritated mistakes
'the mistakes that were irritated', not 'the mistakes that caused irritation'

But here the semantic explanation is not available: the subject of a verb like *bevallen* 'please/suit' is not a Theme/Patient, but rather a Stimulus or equivalent. And Zaenen (1993: 144) notes that "if there are any semantic properties that distinguish the two classes of experiencer verbs under consideration, they are not the same as the ones distinguishing the two classes of intransitives".

In fact, once again the solution is to look at intrinsic assignment of features at a-structure. The subjects of verbs like *bevallen* do not, in Zaenen's (1993: 149) view, possess any proto-agent or proto-patient entailments; in the event of a tie, Zaenen (1993: 150) assumes that the argument is assigned [−*r*], and so these arguments are treated as being patientlike. We now have an explanation for the shared unaccusative/unergative split across intransitives and transitives. Just as with resultatives, the presence of a [−*r*] argument is the significant factor: verbs in which the intrinsically [−*r*]-marked argument becomes subject take the auxiliary *zijn* (otherwise verbs take *hebben*), and the head noun of the pre-nominal participle corresponds to the [−*r*] argument – this makes such participial uses simply impossible for unergative intransitives, which have no [−*r*] argument, and means that the head noun corresponds to the "logical object" of transitives.

4.2.3 Double object constructions

The world's languages are divided in how they treat ditransitive predicates. For some, both objects of a ditransitive are treated equally: for example, either can be promoted to subject by passivisation, flagged by object marking on the verb, etc. As mentioned above, these languages are called symmetrical object languages. Other languages, called asymmetrical object languages, exhibit strong differences between "primary" and "secondary" objects, whereby only one object is eligible for promotion by passivisation, flagging by object marking on the verb, etc. This distinction was first drawn as a result of work on the Bantu languages (e.g. Gary & Keenan 1977, Kisseberth & Abasheikh 1977, Baker 1988), where the divide is particularly clear: since these languages have a productive process of applicativisation, ditransitive predicates are very frequent, and a number of grammatical features are sensitive to objecthood.

To illustrate the contrast between symmetrical and asymmetrical object languages, we consider two languages from the Bantu family: Kichaga and Chicheŵa. Kichaga is a symmetrical object language, and so either of the post-verbal arguments in the active can be promoted to subject by passivisation (Bresnan & Moshi 1990: 150):

(77) a. N-a̋-i̋-lyì-í-à m̀-kà k-élyà
FOC-1S-PRS-eat-APPL-FV 1-wife 7-food
'He is eating food for/on his wife.'

b. M̀-kà n-a̋-i̋-lyì-í-ò k-élyâ
1-wife FOC-1S-PRS-eat-APPL-PASS 7-food
'The wife is being eaten food for/on.'
(i.e. 'The wife is being benefitted/adversely affected by someone eating food.')

c. K-élyà k-i̋-lyì-í-ò m̀-kà
7-food 7S-PRS-eat-APPL-PASS 1-wife
'The food is being eaten for/on the wife.'

Chicheŵa, on the other hand, is an asymmetrical object language. Here, only the immediately post-verbal argument in the active can be promoted to subject in the passive (Baker 1988: 248):

(78) a. Kalulu a-na-gul-ir-a mbidzi nsapato.
hare S-PST-buy-APPL-ASP zebras shoes
'The hare bought shoes for the zebras.'

b. Mbidzi zi-na-gul-ir-idw-a nsapato (ndi kalulu).
zebras S-PST-buy-APPL-PASS-ASP shoes by hare
'The zebras were bought shoes (by the hare).'

c. * Nsapato zi-na-gul-ir-idw-a mbidzi (ndi kalulu).
shoes S-PST-buy-APPL-PASS-ASP zebras by hare
'Shoes were bought for the zebras (by the hare).'

There are a number of other properties which correlate with the passivisation facts (Bresnan & Moshi 1990: 150–153). Either or both post-verbal arguments in Kichaga can be omitted if they are encoded on the verb by an object marker, for instance, while in Chichewâ, only the immediately post-verbal Beneficiary argument can be encoded/omitted this way; Kichaga allows unspecified object deletion of the Patient in a ditransitive where Chichewâ does not; Kichaga allows the Patient argument to be eliminated by reciprocal marking on the verb in the presence of any applied object, while this is not the case in Chichewâ; and all of these properties can interact in different ways.

These patterns receive an elegant explanation in Classical LMT, by way of the Asymmetrical Object Parameter (AOP; Alsina & Mchombo 1990, Bresnan & Moshi 1990: 172). This is a well-formedness constraint on a-structures, parametrised so that some languages apply it (i.e. asymmetrical object languages) and others do not (i.e. symmetrical object languages).

(79) *Asymmetrical Object Parameter*

$$* \begin{array}{ccc} \theta & \dots & \theta \\ | & & | \\ [-r] & & [-r] \end{array}$$

The AOP prohibits the presence of two intrinsically classified $[-r]$ arguments in the same a-structure: when it is in force, secondary patientlike arguments are assigned $[+o]$ by the intrinsic linking principles introduced in Section 4.1.2; when it is not, we permit multiple patientlike arguments to be assigned $[-r]$ instead. Let us consider how this can explain the passivisation facts shown in (77) and (78).

Chichewâ is an asymmetrical object language, so the AOP is active. The a-structure for an applicative verb like we see in (78a) is therefore as follows:

(80)	*gulira* ‘buy-for’	⟨	Agent	Beneficiary	Theme	⟩
			[−*o*]	[−*r*]	[+*o*]	
			│	│	│	
			SUBJ	OBJ	OBJ_θ	

Just as with the English ditransitive above, we interpret the Beneficiary as patientlike, and so assign it the intrinsic feature [−*r*]. By the AOP, the second patientlike argument cannot also be marked [−*r*], so it is instead classified as [+*o*]. This leads to the (correct) mapping shown in (80).

In the passive, only the Beneficiary is eligible for promotion to SUBJ when the Agent is suppressed, since the [+*o*] Theme is featurally incompatible. This explains the contrast between (78b) and (78c).

(81)	*guliridwa* ‘buy-for$_{\text{PASSIVE}}$’	⟨	Agent	Beneficiary	Theme	⟩
			[−*o*]	[−*r*]	[+*o*]	
			│	│	│	
			∅	SUBJ	OBJ_θ	

Now consider Kichaga. Since it is a symmetrical object language, we are free to ignore the AOP ban on having two intrinsically [−*r*]-marked arguments. However, if we do, then we run into trouble in the active:

(82)	*lyìíà* ‘eat-for’	⟨	Agent	Beneficiary	Patient	⟩
			[−*o*]	[−*r*]	[−*r*]	
			│	│	│	
			SUBJ	OBJ	*	

Since the Agent will be mapped to SUBJ, we are left with only one remaining [−*r*] GF to share between two arguments. So here Kichaga must take the same option as Chichewâ of assigning the non-Beneficiary argument [+*o*] instead:

(83)	*lyìíà* ‘eat-for’	⟨	Agent	Beneficiary	Patient	⟩
			[−*o*]	[−*r*]	[+*o*]	
			│	│	│	
			SUBJ	OBJ	OBJ_θ	

However, in the passive, things are different. Now that the Agent is not mapped to any GF, there are still two [−*r*] GFs available. This means the unrestricted intrinsic mapping of two arguments to [−*r*] is possible, and will in fact lead to two possible final mappings:

(84)	*lyìíò* ‘eat-for$_{\text{PASSIVE}}$’	⟨	Agent	Beneficiary	Patient	⟩
			[−*o*]	[−*r*]	[−*r*]	
			│	│	│	
			∅	SUBJ/OBJ	OBJ/SUBJ	

This is exactly the right prediction, since both (77b) and (77c) are grammatical.

The other properties can also be made to follow from the possibility of having multiple [−*r*] arguments or not. Recall that the argument structure operation of suppression is limited to unmarked arguments (those that possess negatively-valued intrinsic features) – it then follows that e.g. unspecified object deletion applies more freely in symmetrical object languages, which can have more arguments with negatively-valued features than asymmetrical object languages.

4.2.4 Complex predicates

Complex predicates are predicates which syntactically head single clauses, but whose meanings incorporate multiple semantic heads and which therefore have complex argument structures. They have been at the centre of LFG work on argument structure and mapping theory since the earliest days, and have consistently drawn a great deal of attention in the literature (e.g. Ishikawa 1985, Alsina 1992, 1996, Butt 1995, 2014, Mohanan 1994, Matsumoto 1992, 1996, Andrews & Manning 1999, Lowe 2016, Lovestrand 2020, among many, many others; see also Dalrymple et al. 2019: 351–352 for an overview of the range of cross-linguistic work on complex predicates carried out in LFG).[26] As one might expect, therefore, this work has also led to various innovations and extensions of Classical LMT. In this section, we discuss two of these: the idea that one a-structure can be embedded inside another, with appropriate fusion of overlapping arguments, and the claim that this a-structure composition can take place in the syntax proper, not just in the lexicon, thus putting paid to the “lexical” aspect of Lexical Mapping Theory.

The first of these points can be seen by considering causatives in Chicheŵa (Alsina 1992). Verbs containing the causative suffix *-íts* add an additional Causer argument which, in the active, surfaces as the subject, with the previous subject being demoted, either to object or oblique status (Alsina 1992: 518):

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[26] There has also been extensive work on computational grammars for LFG that can handle complex predicates, with a particular focus on Hindi-Urdu: see Butt et al. (2003, 2012), Butt & King (2007), Bögel et al. (2009), Sulger (2013).

Another strand of research worth highlighting studies the consequences of complex predicates for the syntax-semantics interface: see Dalrymple, Hinrichs, et al. (1993), Kaplan & Wedekind (1993), Andrews & Manning (1999), Andrews (2007), Homola & Coler (2013), Lowe (2015).

(85) Nǔngu i-na-phík-íts-a kadzidzi maûngu.
9.porcupine 9s-pst-cook-caus-fv 1a.owl 6.pumpkins
'The porcupine made the owl cook the pumpkins.'

(86) Nǔngu i-na-phík-íts-a maûngu (kwá kádzīdzi).
9.porcupine 9s-pst-cook-caus-fv 6.pumpkins to 1a.owl
'The porcupine had the pumpkins cooked by the owl.'

Now, we might imagine that such causative forms have a simple a-structure, containing three argument positions for the Causer, Causee, and original Patient (here *maûngu*, 'pumpkins'). Instead, Alsina (1992: 521) suggests they have a complex argument structure, formed by embedding the base verb's a-structure into the a-structure of the cause predicate, whose Patient is then merged with one of the arguments of the base predicate:

(87) $$\textsc{cause}\ \langle\ \text{Agent}\quad \text{Patient}\quad \underbrace{\textsc{pred}\ \langle \ldots \theta \ldots \rangle}_{\text{caused event}}\ \rangle$$

Where the base predicate has more than one argument, this means there are multiple possibilities for this argument fusion: for instance, the causative's Patient argument may fuse with either the Agent or Patient of *phīka* 'cook'. Alsina (1992: 523–524) claims that this is precisely the difference between the two realisations in (85) and (86). In (85), the causative Patient is combined with the embedded verb's Agent, meaning the Causer's goal was to make the owl carry out the cooking; this sentence, but not (86), is therefore a possible answer to the question "What did the porcupine do to the owl?". In (86), however, the causative Patient is fused with the embedded verb's Patient, meaning the Causer merely intended for the pumpkins to get cooked, but did not especially care whether the owl did it; this sentence, but not (85), is therefore a possible answer to the question "What did the porcupine do to the pumpkins?".

The fact that an argument of the base predicate is the Patient of the causative morpheme itself has a number of effects. For instance, although the verb *phīka* 'cook' normally allows deletion of its object, in its causative form this is not possible, showing that in this respect the object behaves like an argument of the causative morpheme, rather than of the base predicate (Alsina 1992: 524–525):

(88) Kadzīdzi a-na-phík-a (maûngu).
1a.owl 1s-pst-cook-fv 6.pumpkins
'The owl cooked (the pumpkins).'

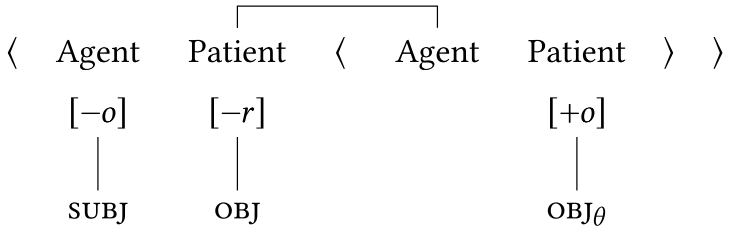
(89) Nǔngu	i-na-phík-îts-a	*(maûngu)	(kwá	kádzīdzi).
9.porcupine	9S-PST-cook-CAUS-FV	6.pumpkins	to	1a.owl

‘The porcupine had the pumpkins/something cooked (by the owl).’

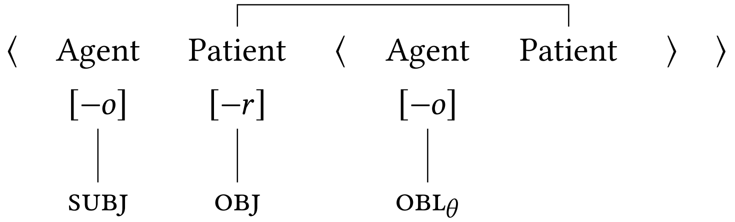
At the same time, the fused argument is also sensitive to its thematic role within the embedded predicate – for example, if it is an Agent in the base predicate it cannot be extracted (e.g. by relativisation), whereas if it is a Patient then it can (Alsina 1992: 529–530). This mixed behaviour motivates the idea that two argument positions are fused in the a-structure of these complex predicates.

The assumption of argument fusion also allows a straightforward Classical LMT account of the mapping possibilities open to causatives in Chichewa̐. The alternation between (85) and (86), for example, follows naturally if we assume that when two arguments fuse it is only the higher one which receives its intrinsic feature assignment:[27]

(90) a. *phikītsa* ‘cause to cook’



b. *phikītsa* ‘cause to cook’



When the causative Patient is fused with the embedded Agent, the embedded Patient is marked [+*o*] as a secondary patientlike argument (the higher Patient taking priority owing to its ranking in the a-structure). When it is fused with the embedded Patient instead, the embedded Agent now receives a [−*o*] specification, but since the higher Agent is leftmost in the a-structure, it will map to SUBJ, leaving this lower Agent to map to OBL$_\theta$ instead.

We can also see why the causatives of intransitives do not exhibit this same alternation – their Causee can only surface as an OBJ, never as an OBL$_\theta$:

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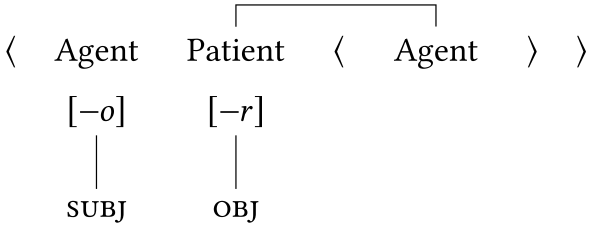
[27] We diverge somewhat from Alsina’s (1992) proposal here – albeit only in detail and not in spirit – in order to harmonise with the approach to mapping we introduced earlier.

(91) Chatsalĭra a-ku-nám-íts-á (* kwá) mwắina.
1.Chatsalira 1s-prs-lie-caus-fv to 1.child
‘Chatsalira is making the child tell lies.’

This follows naturally from the argument structure facts: since the embedded predicate only has a single argument, that will necessarily be the argument that fuses with the causative Patient, and so it is mapped to obj, not to obl$_\theta$:

(92) *namĭtsa* ‘cause to lie’



Chichewâ forms causatives morphologically, and so the processes of a-structure composition and argument fusion can be thought of as taking place in the lexicon. However, some complex predicates are made up of multiple words, and so their argument structures must be built in the syntax rather than in the lexicon. Butt (1995), studying Hindi-Urdu permissive and aspectual constructions, and Alsina (1996), studying Romance causatives, were among the first to make this observation. We will illustrate the phenomenon with Hindi-Urdu data.

In Hindi-Urdu, complex predicates can be formed from a combination of a main verb and a light verb. In the case of so-called permissive complex predicates, the light verb in question is *de* ‘let’, homophonous with the lexical verb meaning ‘give’ (Butt 1995: 35). As with the causative morpheme, the light verb contributes its own arguments, which are added to and overlap with the arguments of the main predicate. For example, in (93), *saddaf=ko* is at once the “lettee” argument of the light verb *diyaa* and the “maker” argument of *banaane* ‘make’ (other arguments belong to only one verb: *anjum=ne* is only an argument of *diyaa* – she is the the one giving permission – and *haar* ‘necklace’ is only an argument of *banaane* – it is the thing being made).

(93) anjum=ne saddaf=ko haar banaa-ne
Anjum.f=erg Saddaf.f=dat necklace.m.nom make-inf.obl
di-yaa.
give-perf.m.sg
‘Anjum let Saddaf make a necklace.’

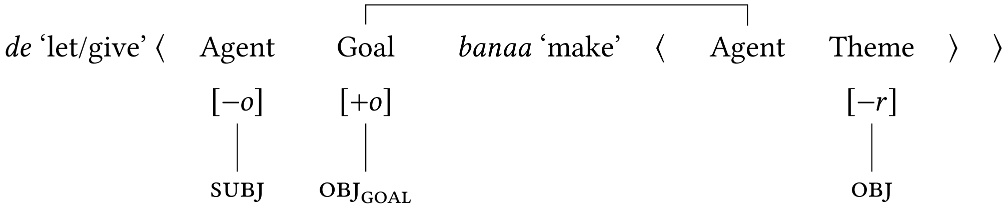
The light verb and main predicate do not have to be adjacent or form a constituent at c-structure, so there is no sense in which they can be analysed as a single, morphologically complex word (Butt 1995: 46):

(94) a. anjum=ne saddaf=ko haar [**banaa-ne di-yaa**].
b. anjum=ne **di-yaa** saddaf=ko [haar **banaa-ne**].
c. anjum=ne [haar **banaa-ne**] saddaf=ko **di-yaa**.

Nevertheless, these sentences do not involve clausal embedding: with respect to agreement, anaphora, and control, they behave monoclausally (see Butt 1995: 36–43 for detailed evidence of this). That is, they have a flat f-structure, shown in (95):[28]

(95)
$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{let-make}\langle\textsc{subj},\textsc{obj},\textsc{obj}_{\textsc{goal}}\rangle\text{’} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘Anjum’}\end{bmatrix} \\ \textsc{obj}_{\textsc{goal}} & \begin{bmatrix}\textsc{pred} & \text{‘Saddaf’}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{necklace}\text{’}\end{bmatrix} \end{bmatrix}$$

This means the complex predicate must also have a single, composite a-structure:

(96)


But this a-structure cannot be the property of any one word in the lexicon, since it combines information from two words, and the light verb can freely combine with various predicates. What is more, complex predicates can be recursively embedded – Butt et al. (2010) give an example involving four levels of embedding, for instance:

(97) taaraa-ne amu-ko (bacce-se) haathii pinc kar-vaa
Tara-ERG Amu-DAT child.OBL-INS elephant.M.SG.NOM pinch do-CAUS
le-ne dii-yaa.
take-INF.OBL give-PRF.M.SG
‘Tara let Amu have the elephant pinched (by the child) (completely).’

---

[28] The question of how the composite PRED value emerges here is an unanswered one – see Lowe (2016: sec. 2) for a sceptical review, and see Asudeh & Rad (2023: sec. 4) for a technical solution.

The core meaning here is the noun-verb complex predicate made up of *pinc* ‘pinch’ and *kar* ‘do’. This is then embedded under a causative predicate, which is hosted morphologically on this same light verb. Then we have a “completive” light verb *le* (with the lexical meaning ‘take’). Finally, this whole complex is embedded under the permissive light verb *de*, which we saw above.

The conclusion such data must lead us to is that complex predicate formation is a productive, syntactic process, which means that we need to be able to combine a-structures on-line, outside of the lexicon. Apart from anything else, this means that the name “Lexical Mapping Theory” is a misnomer, since the theory must not apply only to individual words, but also to complex predicate-argument structures built up syntactically.

5 Kibort MT: incorporating morphosemantic alternations

We’ve now seen a sampling of the successes of and challenges for Classical LMT. In this section, we turn to a rather different view of LMT, that developed by Kibort over a series of papers (Kibort 2001, 2007, 2008, 2009, 2013, 2014, Kibort & Maling 2015), which purports to improve on Classical LMT in a number of respects, not least of which being its ability to handle morphosemantic alternations. We will refer to this theory as Kibort MT.

As we saw in Section 4.1.2, the dative shift alternation poses a challenge for Classical LMT, in that the theory must assume two distinct initial assignments of features to arguments in order to be able to derive the two alternants. Other morphosemantic alternations are even more challenging. Consider again the *spray/load* alternation (Levin 1993: 50–51), illustrated in (98):

(98) a. Adam sprayed the paint on the wall.
 b. Adam sprayed the wall with the paint.

This is morphosemantic insofar as the entailments of the alternants differ: in each case, the participant corresponding to the obj is completely affected – i.e. in (98a) the paint is fully used up, while in (98b) the wall is totally covered. Once again, both alternants involve the same thematic roles, and so the basic Classical LMT a-structure will be the same for both:

(99) *spray* ⟨ Agent Goal Theme ⟩

We would expect the Theme, being patientlike, to be assigned [$-r$], and the other arguments to receive the default [$-o$] assignment; this correctly produces the alternant in (98a), where the Theme surfaces as obj, and the Goal as an obl$_\theta$:

(100)	*spray*	⟨	Agent	Goal	Theme	⟩
			[−*o*]	[−*o*]	[−*r*]	
			SUBJ	OBL$_\theta$	OBJ	

Producing the other alternant, in (98b), is much more difficult, however. Compared to (98a), we need the Goal and Theme to switch GFs: the former now surfaces as an OBJ, and the latter as an OBL$_\theta$. We could try the same trick as we did for ditransitive *give*, and say that the Goal argument counts as patientlike: this will allow us to classify it as [−*r*], so that it can map to OBJ. But now the Theme will receive a [+*o*] assignment as a secondary patientlike argument, which is incompatible with the [−*o*] GF OBL$_\theta$. Indeed, patientlike arguments can only be classified as [−*r*] or [+*o*] by the intrinsic assignments in (34), which is precisely the opposite of what is needed to be compatible with the [+*r*, −*o*] specification of OBL$_\theta$.

In Kibort's view, the problem arises because Classical LMT conflates syntactic arguments and semantic participants, representing both simultaneously in the list of arguments-*cum*-thematic roles. She proposes therefore to expand the domain of a-structure and mapping theory to include not only ARGUMENT-FUNCTION MAPPING, i.e. what we have been considering as the domain of mapping theory up to now, but also ARGUMENT-PARTICIPANT MAPPING.[29] This is illustrated in Figure 1, representing the typical active voice realisation of the Polish double object verb *dać* 'give' (cf. Kibort 2014: 265).[30]

semantic participants	Agent	Theme	Recipient	SEMANTIC VALENCY
arguments of the predicate	⟨ arg$_1$	arg$_2$	arg$_3$ ⟩	LEXICAL VALENCY
grammatical functions	SUBJ	OBJ	OBJ$_\theta$	FUNCTIONAL SUBCATEGORISATION

Figure 1: The separation of levels in Kibort MT

Before providing the Kibort MT solution to the *spray/load* puzzle, we first introduce the theory in more detail.

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[29] In other works by Kibort, these are referred to as "argument-**to**-function/participant mapping", but since the connections are intended to be bidirectional, we omit the preposition here to minimise the procedural implications.

[30] As Kibort (2007: 252) points out, separating argument positions from semantic participants in fact goes back to early LFG work (such as Bresnan 1982), and has been argued for by others such as Grimshaw (1988: 1), Mohanan (1990), Ackerman (1991: 12, 1992: 57ff), Mohanan (1994: 15ff), Joshi (1993), Alsina (1996: 37), Falk (2001b: 105), and Ackerman & Moore (2013: 40ff).

Kibort retains the Classical LMT mapping features [±*r*] and [±*o*], but, in keeping with the separation of syntax and semantics shown in Figure 1, she reinterprets them in purely syntactic terms, according to two traditional classifications of verbal dependents (Kibort 2014: 266):[31]

(101)	[−*o*]	non-complements	(the "external" argument and oblique arguments)
	[+*o*]	complements	("internal arguments" of the predicate)
	[−*r*]	core arguments	(subject and object only)
	[+*r*]	non-core arguments	(all arguments except subject and object)

These features are associated with positions in a universally available lexical valency frame, from which predicates select a subset of argument positions:

(102)
$$\langle \begin{array}{cccccc} \text{arg}_1 & \text{arg}_2 & \text{arg}_3 & \ldots & \text{arg}_4 & \ldots \\ [-o]/[-r] & [-r] & [+o] & [+o] & [-o] & [-o] \end{array} \rangle$$

The ordering and feature assignment in (102) is based on the standard LFG Functional Hierarchy, repeated in (103):

(103) *The Functional Hierarchy:*
SUBJ > OBJ > OBJ$_\theta$ (> XCOMP, COMP) > OBL$_\theta$ (> XADJ, ADJ) .

The first position in (102), called mnemonically arg$_1$, corresponds to the canonical subject, and is associated with one of the two features which describe the SUBJ function (it is marked [−*o*] in unergative predicates, emphasising its non-complement status, and [−*r*] in unaccusative ones, emphasising its core status).[32] The second position, arg$_2$, corresponds to the canonical direct object, and is marked [−*r*] (core). The next position, arg$_3$, corresponds to the restricted object, and is marked [+*o*] (complement). Lastly, arg$_4$, corresponds to a canonical oblique argument, and is marked [−*o*] (non-complement). Predicates can select any number of arguments from this frame, but, as indicated, they can only choose one arg$_1$ and arg$_2$, though they can select multiple arg$_3$s and arg$_4$s – this corresponds to the fact that a predicate can subcategorise for only a single SUBJ and

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[31] At least two other LFG linguists have proposed LMT feature sets which make no reference to semantic/thematic restrictions: Alsina (1996) and Hemmings (2012).

[32] Although the unergative/unaccusative distinction was originally applied only to intransitive predicates (Perlmutter 1978), subsequent work has extended it to predicates of all valencies: see Kibort (2004: 74–75) for discussion, and cf. the Dutch experiencer verbs discussed in Section 4.2.2, which exhibited the same syntactic split as intransitive unergatives/unaccusatives.

obj, whereas multiple obj_θs and obl_θs are permitted, being individuated by their subscripts (e.g. $\text{obj}_{\text{THEME}}$ vs. obj_{BEN}).[33]

What we have considered as mapping so far in this chapter corresponds to "argument-function mapping" in Kibort MT, i.e. the linking of argument positions and GFs. As in Classical LMT, arguments in Kibort MT are associated with a feature specification that makes them compatible with two different GFs, and mapping therefore consists in determining which of the two (if either) will realise the argument syntactically. Kibort MT diverges from Classical LMT, however, in only having a single Mapping Principle (Kibort 2014: 267; cf. Her 2013):

(104) *Mapping Principle (Kibort MT):*
The ordered arguments are mapped in turn onto the highest (i.e. *least* marked) compatible grammatical function on the Markedness Hierarchy.

This inverts Mapping Principle (b) of Classical LMT, which maps arguments to the lowest, i.e. *most* marked, compatible GF, and in so doing removes the need for Mapping Principle (a), along with the Subject Condition, as we shall see. This is clearly a huge gain in parsimony, though it is not without cost, as we discuss below.

By way of illustration, consider again the simple transitive (and unergative) verb *kick*. This has the following Kibort MT a-structure:

(105) $\textit{kick} \; \langle \begin{array}{cc} \text{arg}_1 & \text{arg}_2 \\ [-o] & [-r] \end{array} \rangle$

By the Mapping Principle, we first map the highest argument, arg_1, onto the highest compatible GF: in this case, the highest $[-o]$ GF is subj, so this is what we choose. Next, arg_2 is mapped onto the highest $[-r]$ GF available: since subj is already taken, this is obj.[34] Note that despite the procedural talk here and in the Mapping Principle itself (arguments are mapped "in turn"), this process is intended to be understood declaratively. It can be seen as optimising the alignment between two hierarchies: are the highest arguments linked to the highest

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[33] While these functions are often indexed by thematic roles, this can be understood purely for distinctiveness, having no semantic content: instead of $\text{obj}_{\text{THEME}}$ and obj_{BEN} we could use other mnemonic labels such as cases (e.g. obj_{ACC} vs. obj_{DAT}, etc.) or preposition names (e.g. obl_{TO} vs. obl_{ON}, etc.), or purely arbitrary labels such as obj_1 and obj_2. Thus, the retention of the GFs obj_θ and obl_θ does not diminish the syntactically-motivated characterisation of GFs in Kibort MT.

[34] Function-Argument Biuniqueness still applies in Kibort MT, although it may not be necessary to stipulate it as a separate principle – see fn. 19.

GFs? This can then be solved using various constraint-based tools such as those of Optimality Theory (Prince & Smolensky 1993, 2004; cf. also Asudeh 2001 for an application of OT to mapping in an LFG context).

Morphosyntactic argument alternations interfere with the default argument-function mapping. As in Classical LMT, this is achieved monotonically, by further specifying the mapping possibility of an argument. However, Kibort MT goes even further in this respect, eschewing the use of suppression altogether, and thus sidestepping the issues mentioned in fn. 22. For instance, Kibort (2001: 170) treats passivisation as a further specification of arg$_1$ as [+*r*], illustrated in (106) for passive *kicked* (cf. (50) above):

(106)

$$\textit{kicked}_{\text{PASSIVE}} \quad \langle \begin{array}{ll} \text{arg}_1 & \text{arg}_2 \\ [-o] & [-r] \\ [+r] & \end{array} \rangle$$

The argument which by default would map to SUBJ is instead fully specified as an OBL$_\theta$, and, as a result, the arg$_2$, if there is one, becomes the SUBJ. Note that this gives the correct result for the English long passive, where the Agent is expressed as an oblique *by*-phrase, but in the short passive the Agent is not expressed grammatically at all. Kibort (e.g. 2004: 29) refers to such obliques as "optional", but it is not clear what determines this – it cannot be the case that OBL$_\theta$s are always optional, for instance, since there are certainly cases of obligatory obliques, as in *I gave the book *(to my friend).*

In general, morphosyntactic operations are assumed to involve making arguments more marked, by adding additional +-valued specifications:

(107)
a. adding the [+*r*] specification to a [−*o*] argument
(e.g. passivisation)
b. adding the [+*r*] specification to a [+*o*] argument
(e.g. secondary object preservation – Kibort 2007: 268)
c. adding the [+*o*] specification to a [−*r*] argument
(e.g. locative inversion – Kibort 2004: 364–367)

One thing to note about argument-function mapping in Kibort MT is that the Subject Condition of Classical LMT is absent. The motivation for this is that genuinely subjectless predicates are quite common in the world's languages (see Kibort 2006 and Lowe et al. 2021 for discussion). For instance, Polish intransitives can be passivised, resulting in a subjectless sentence (Kibort 2006: 304–307):

(108) Było codziennie sprzątane (przez firmę).
was.3SG.N every-day clean.PART.SG.N (by company)
'There was cleaning every day (by a company).'

This follows quite naturally in Kibort MT, where the verb will have the following a-structure, resulting in the first and only argument being mapped to OBL$_\theta$, rather than SUBJ:

(109)
$$\textit{sprzątać}_{\text{PASSIVE}} \quad \langle \begin{array}{c} \text{arg}_1 \\ [-o] \\ [+r] \end{array} \rangle$$

The strong cross-linguistic preference for subjects is captured in the Mapping Principle: since arguments are mapped to the highest available GF on the Markedness Hierarchy, and since SUBJ is at the top of that hierarchy, SUBJ will always be the most preferred GF, meaning *something* will usually map to it. But by making this a strong preference rather than a principle of the grammar, Kibort MT also allows for the possibility of subjectless predicates in marked circumstances – such as the passivisation of an intransitive.

One negative side effect of this choice, however, is that Kibort MT apparently makes the wrong predictions about the passive of double object verbs. As mentioned above in Section 4.1.3, when a double object verb is passivised, and so the primary object is promoted to SUBJ, it is apparently *not* the case that the secondary object is promoted to primary object – but this is exactly what Kibort MT predicts should happen, since the [+*o*]-valued arg$_3$ of a secondary object argument is compatible with OBJ, and OBJ is less marked than OBJ$_\theta$ (though see Kibort 2008).

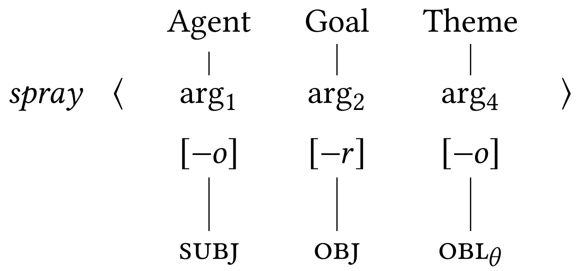
The Kibort MT approach to argument-function mapping offers a different perspective from Classical LMT, and perhaps represents an advancement in certain areas, in particular with respect to theoretical parsimony. However, the real advantage of the theory is in the fact that argument-*participant* mapping can interact in interesting ways with argument-function mapping. Let us return now to the question of the *spray/load* alternation. The verb *spray* in this sense will have the following a-structure and argument-function mappings:

(110)
$$\textit{spray} \quad \langle \begin{array}{ccc} \text{arg}_1 & \text{arg}_2 & \text{arg}_4 \\ [-o] & [-r] & [-o] \\ | & | & | \\ \text{SUBJ} & \text{OBJ} & \text{OBL}_\theta \end{array} \rangle$$

In fact, these GFs are the same ones which appear in both alternants – the only difference is which participants map to which GFs. Because Kibort MT posits a separate level of semantic participants, the mapping between those participants and the argument positions – and so, indirectly, the GFs – can be allowed to vary.

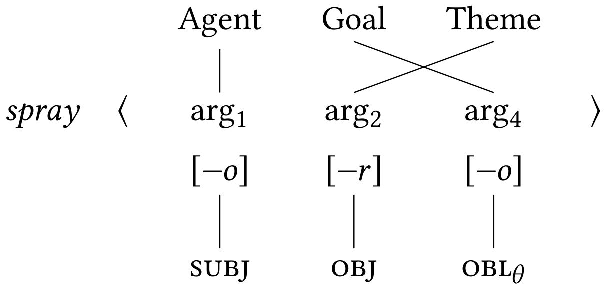
(111) a. Adam sprayed the wall with the paint.

b.



(112) a. Adam sprayed the paint on the wall.

b.



Although for a human reader it may be easier to track the re-aligned participants in diagrams like (111b) and (112b) if they are represented by thematic role labels, Kibort MT takes the criticisms of thematic roles mentioned in Section 2.1 to heart, and so they play no role in the theory. Furthermore, Kibort (2014) argues that neither Dowty-style proto-roles nor feature decomposition attempts are adequate either. In the absence of an adequate and complete representation of lexical knowledge, Kibort MT instead adopts a very minimal representation of semantic participants. In this system, semantic participants are labelled by numbers which identify which arg positions they can map to (Kibort 2014: 275ff.). For example, the a-structure of *spray* would be augmented as follows:

(113)
$$\begin{array}{lccccc} & & 1 & 24_{\text{TH}} & 24_{\text{GO}} & \\ \textit{spray} & \langle & \text{arg}_1 & \text{arg}_2 & \text{arg}_4 & \rangle \\ & & [-o] & [-r] & [-o] & \end{array}$$

The first semantic participant is labelled 1 since it can only be linked to the arg_1 position, but the other two are labelled 24 since they can be linked to either the arg_2 or the arg_4 position. The subscripts on the semantic participants are purely for distinctness, to individuate the two participants with identical labels, and have no semantic content.

Argument-participant mapping has no principles beyond stating that participants with label *n* can be linked to argument $\arg_n$; arguments whose labels contain multiple numbers, like the Theme and Goal in (113), are assumed to bear multiple labels, i.e. each of the Theme and Goal in (113) simultaneously has the label 2 and the label 4. In cases where multiple mappings are possible, Kibort MT predicts that neither is more basic than the other, since there is no preference ranking encoded in the argument-participant mapping. This is certainly right for the *spray/load* alternation, since there does not seem any reason to assume that one alternant is derived from the other or that one is more basic than the other, especially given that this alternation is unmarked in English (i.e. there is no morphological or syntactic marker in either version).[35]

Kibort MT thus draws a clear formal distinction between morphosyntactic (meaning-preserving) and morphosemantic (meaning-altering) alternations: the former affect the argument-function mapping, using techniques very similar to those of Classical LMT; the latter affect the argument-participant mapping, something made possible by separating out these two levels of representation.

In sum, Kibort MT offers a mapping theory that on the one hand simplifies, and on the other hand elaborates on Classical LMT. It is simpler in that there is a universal valency frame, a single Mapping Principle, and no mention of thematic roles, but it is more complex in that it separates out the notion of argument from semantic participant. This does, however, offer the possibility of straightforwardly representing the effects of meaning-altering, morphosemantic alternations, something that was not always possible in Classical LMT.

6 Formal issues and recent developments

Aside from Kibort's focus on expanding the empirical coverage of LMT, another major thread in contemporary work on argument structure and mapping theory has been an increased interest in questions of formalisation. In this section, we address three areas in this vein: the formal status of a-structure, the nature of mapping, and the integration of mapping theory and compositional semantics.

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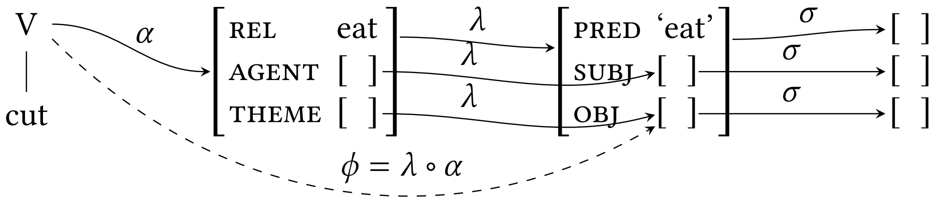
[35] It may be possible to argue that one of the variants is more basic on non-linguistic grounds, e.g. by reference to the relative prominence of cognitive concepts like Figure and Ground (Talmy 1978; see also Schätzle 2018 for an implementation of these concepts within LFG's mapping theory), but a strength of Kibort MT is that such a move is not *necessary*, even if it may sometimes be independently motivated.

6.1 The position and nature of a-structure

In Kibort MT, Classical LMT, and earlier work, the position of argument structure in the architecture of the grammar is left vague or unmentioned. Sometimes, it is (implicitly) assumed to be situated inside f-structure, as (part of) the value of PRED, but otherwise the question does not arise.

Butt et al. (1997: 1) are the first to address this formal deficiency head on, and propose that argument structure forms its own level of representation, a-structure, situated in the LFG projection architecture between c-structure and f-structure:

(114)



(Butt et al. 1997: 1, their ex. (1))

This positioning is motivated by the complex predicate facts discussed in Section 4.2.4. Since complex a-structures can correspond to simplex (monoclausal) f-structures, and since the projection functions, as functions, can be many-to-one but not one-to-many, a-structure must be mapped to f-structure, and not vice versa. On the other hand, since complex a-structures can be built from discontinuous pieces in the syntax, and are not necessarily generated in the lexicon, a-structure must be positioned after c-structure, so that information can be passed from the latter to the former.

One immediate effect of this positioning is to break up the traditional ϕ mapping from c- to f-structure: it is now the composition of two functions, the α function from c- to a-structure, and the λ function from a- to f-structure, i.e. $\lambda \circ \alpha$.[36] Some have seen this as undesirable: for example, Asudeh & Giorgolo (2012) propose a change to the architecture (to be discussed shortly), one of the effects of which is to restore ϕ to its atomic status, and they claim this as an advantage of their proposal (Asudeh & Giorgolo 2012: 71) – but if this is an advantage, we do not see how it can be anything other than an aesthetic one.

Unlike in most earlier approaches, for Butt et al. (1997), a-structures are not simply lists of arguments, but are instead AVMs. This allows for a richer internal structure: for example, complex predicates have nested a-structures (Butt et al.

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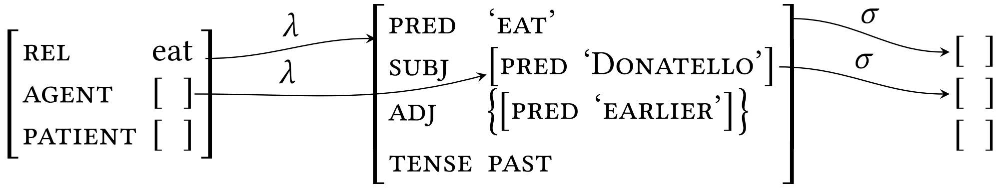
[36] Butt et al. (1997: 1) identify ϕ with $\alpha \circ \lambda$ (rather than $\lambda \circ \alpha$), but this must be an error, since α has to be applied before λ, given their architecture.

1997: 12). Each a-structure contains a REL attribute that names the semantic relation it encodes, and attributes labelled with thematic role names corresponding to argument positions. Nothing further is said about the value of these attributes, and they are represented as empty AVMs in Butt et al. (1997). These must be shorthand for more complete structures, however, since otherwise, under a standard set-theoretic interpretation of AVMs, all the "empty" AVMs would in fact be one and the same.[37]

Asudeh & Giorgolo (2012) criticise Butt et al.'s (1997) architecture and propose an alternative which has since proven influential. They do so on the basis of verbs which take optional objects, like *eat* in English:

(115) a. Donatello ate a pizza earlier.
b. Donatello ate earlier.

Although the Patient argument does not need to be expressed in the syntax, it must still be present in the a-structure, since it remains part of the core relation expressed by the verb (eating events involve something being eaten), and must also be represented at s-structure, since it is interpreted semantically: the truth of *Donatello ate* implies the truth of *Donatello ate something*. This poses a problem for the Butt et al. (1997) architecture, since there is no route through the projection architecture from the a-structure PATIENT to its corresponding s-structure without going via its f-structure representation, and it appears not to have one:

(116)


One might therefore be tempted to posit an unpronounced OBJ attribute at f-structure corresponding to the Patient, but there is empirical evidence against this (Asudeh & Giorgolo 2012: 71). For example, this putative null pronoun cannot antecede another, subsequent pronoun:

(117) a. Donatello ate a pizza, but it turned out to be Raphael's.
b. * Donatello ate, but it turned out to be Raphael's.

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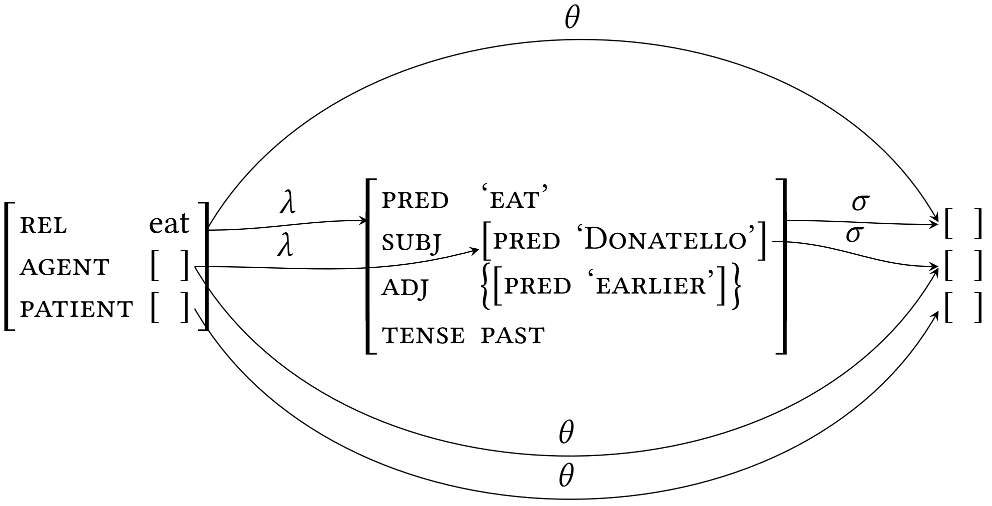
[37] For discussion of a similar problem, this time with regard to s-structure, see Findlay (2021: 348–353).

Given this, we are forced to propose a new function which projects directly from a-structure to s-structure (i.e. it is not simply the composition of σ and λ); Asudeh & Giorgolo (2012: 70) call this the θ projection. (118) shows this new situation.

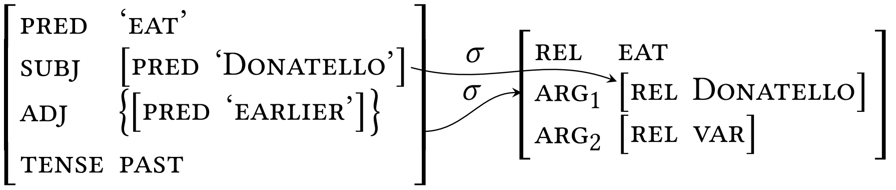
(118)



This move adds formal complexity to the grammar (a whole new projection function) and also adds indeterminacy: when an element of a-structure *is* expressed at f-structure, there are now two ways of reaching its s-structure – one via $\sigma \circ \lambda$ and one via θ directly. Even if this solves the problem of unexpressed arguments, it is a formally unhappy scenario to be forced into.

Asudeh & Giorgolo's (2012) solution is to do away with a-structure as a separate level of representation, and to replace it with a new, connected version of s-structure – that is, rather than the s-structures for the arguments being separate from the s-structure for the clause (and from each other), they are instead embedded inside it. This makes this new conception of s-structure very similar to Butt et al.'s (1997) a-structures. An example is shown in (119):

(119)



Ultimately, it is a fairly arbitrary choice whether we call this new connected structure s-structure or a-structure. Asudeh & Giorgolo (2012) call it s-structure since they continue to use it as part of the linear logic component of Glue Semantics meaning constructors, but it has a lot in common with Butt et al.'s (1997) a-structure as well, being internally structured/connected and expressing the predicate-argument structure of the clause. What is more, later developments have sought to imbue this new structure with additional information about tense, aspect, and event structure (see e.g. Lowe 2014, Lovestrand 2018, 2020, Findlay 2021), thereby incorporating some information which is also present in Butt's (1995) "elaborated" a-structures (on which see below). For consistency with other work, however, we will continue to call these s-structures here.

The exact content of these s-structures is subject to ongoing research, but they are assumed to at least include a REL attribute identifying the semantic relation expressed (cf. Asudeh et al. 2013: 24), and potentially several numbered ARG attributes, e.g. ARG_1, ARG_2, for each of that relation's arguments. Asudeh & Giorgolo (2012) use REL only for predicates, and leave argument s-structures as "empty" AVMs, just like Butt et al. (1997). Lovestrand (2018: ch. 8.3) and Findlay (2020: 135f.), however, generalise the presence of REL to argument as well as predicate s-structures, and Findlay (2020: 144) proposes to use "var" as the REL value for unexpressed/suppressed arguments.

The numbered ARG attributes are used instead of Butt et al.'s (1997) thematic role labels in part because Asudeh & Giorgolo (2012) make use of a neo-Davidsonian meaning language (Parsons 1990) such that thematic role information is expressed directly in the semantics – i.e. instead of (120a), the meaning of *eat* is expressed by (120b) – and so it would be redundant to also encode this information in s-structure.

(120) a. $\lambda x \lambda y \lambda e.\mathbf{eat}(e, x, y)$
b. $\lambda x \lambda y \lambda e.\mathbf{eat}(e) \wedge \mathbf{agent}(e, x) \wedge \mathbf{theme}(e, y)$

This has the additional benefit of relegating thematic roles to the meaning language rather than making them part of the meta-language of the grammar itself. There they can be treated as abbreviations for whatever sets of semantic entailments we take them to encode (*à la* Dowty 1991), with whatever level of granularity is required, leaving the grammar itself free of the nebulous notion of thematic role.

The significance, or lack thereof, of the ARG labels has been the subject of disagreement, however. They were originally intended as arbitrary labels merely to achieve distinctness at s-structure, but Findlay (2016) imbues them with meaning, identifying them with the numbered arg positions of Kibort MT (see Section 5), as part of an implementation of that theory within the new architecture. This view has been adopted by others (e.g. Asudeh et al. 2014, Lowe 2016, Lovestrand 2018, 2020), but Findlay (2020) argues for a return to the *status quo ante*, where these labels have no significance in and of themselves, and shows that the same implementation of Kibort MT can be achieved while avoiding reifying the s-structure attribute names.

The title of Findlay (2016) is "Mapping theory without argument structure", but this is in many respects a mischaracterisation of the research programme inspired by Asudeh & Giorgolo's (2012) architectural proposal. Rather than doing away with argument structure, this work has served more as a rationalisation of the LFG architecture: instead of having two levels, a-structure and s-structure, the latter of which is rather informationally impoverished, we have a single level of representation which shares properties of both.[38]

As mentioned above, some researchers have imbued this new structure with additional information about lexical semantics and event structure (e.g. Lowe 2014, Lovestrand 2018). But suggestions to add this kind of information to a-structure are not new. Butt (1995) develops what she calls an ELABORATED A-STRUCTURE (Butt 1995: 133), which includes much more structure and much more semantic information than Classical LMT's minimalist a-structures. This elaborated a-structure is based on Jackendoff's (1990) LEXICAL CONCEPTUAL STRUCTURES (LCSs), but only includes the concepts relevant to linking and semantic case marking (Butt 1995: 143). An example of the elaborated a-structure for the Urdu main verb *de* 'give' is shown in (121):

(121)
$$\left[\begin{array}{l} \text{de `give'} \\ \left[\begin{array}{l} \text{CS}([\alpha], \text{GO}_{Poss}([\ \ ], \text{TO}[\ \ ])) \\ \text{AFF}([\ \ ]^{\alpha}, \ ) \\ \text{ASP}(\_\ \_\ \_) \end{array}\right]_{E} \end{array}\right]$$

The inner box is the actual a-structure, and contains three levels. The first two are borrowed from Jackendoff's LCSs: the THEMATIC TIER and the ACTION TIER.

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[38] The observant reader may be entertaining an architectural concern at this point: earlier, we motivated the Butt et al. (1997) architecture by drawing on the facts of complex predicates: a complex a-structure can correspond to a simplex (monoclausal) f-structure, and so we need the former to precede the latter in the projection architecture in order to retain the functional nature of the projection relations. However, in the new architecture, the connected s-structure which represents predicate-argument structure comes after f-structure, so we appear to be in trouble. Two solutions to this puzzle have been proposed. Lowe (2016) gives the first analysis of complex predicates in this new framework, and argues that they should be given a flat s-structure (in contrast to the articulated a-structures usually assumed), representing their complexity in the meaning language instead. This avoids any problems arising from having a flat f-structure, since it is no longer required to subsequently project a more articulated s-structure. Alternatively, Lovestrand (2020) proposes to give complex predicates articulated f-structures after all, which means a complex s-structure is also possible without losing the functional nature of σ. There are empirical shortcomings with both of these approaches, but they fare no worse than existing, alternative approaches, and serve to illustrate how the apparent monoclausality of complex predicates does not force us to assume an articulated a-structure which precedes f-structure in the projection architecture.

The former, the Thematic Tier, describes the lexical meaning of the verb in decompositional terms – here that one entity *causes* (CS) *possession* of another to *go* (GO_{Poss}) *to* a third entity (TO). The latter, the Action Tier, describes the relationship between Actor, Patient, and Beneficiary roles – in other words those roles which usually receive structural case. As Butt (1995: 137) points out, it can also be thought of as encoding an analogue of Dowty's (1991) proto-roles. Here the argument labelled α, i.e. the "giver" (the one causing the transfer of possession) is indicated to be *affecting* (AFF) something else. The second slot of the function AFF is left empty, indicating that there is no true Patient or Beneficiary here (Butt treats the recipient as a simple Goal instead of a Beneficiary). There are also subtypes of the AFF function which provide information about volitionality or conscious choice.

The final tier is the Aspect Tier. This is not borrowed from Jackendovian LCSs, but is an innovation by Butt. It represents aspectual information: specifically, whether a verb is positively or negatively specified for inception, duration, and/or completion (Butt 1995: 142). The function ASP contains three slots, one for each of these properties, and each can be specified positively, with a '1', negatively, with a '0', or left unspecified, indicated by a '_'. In (121), all three slots are empty, showing that this verb is unspecified for this aspectual information.

Clearly, this conception of argument structure is far more complex than the ordered lists used in Classical LMT, and more informationally rich than either of the structures discussed already in this section.[39] Butt argues that this complexity is motivated by its capacity to offer an elegant account of complex predicates. For one thing, the elaborated a-structures expose more lexical semantic content to the grammar, enabling appropriately fine-grained constraints to be placed on complex predicate formation (see e.g. Butt 1995: 147–155 for examples). For another, they add articulation and structure, and, as we saw in Section 4.2.4, the proper treatment of complex predicates necessitates assuming a more articulated a-structure than is standard in Classical LMT – at least one capable of recursive embedding.

On Butt's (1995) approach, the light verbs which are used in complex predicates have a-structures which themselves have argument slots for *other a-struc-*

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[39] Indeed, one reviewer suggests that the level of representation proposed by Butt (1995) is not argument structure at all, but rather some kind of "event structure" or "semantic structure". To the extent that the additional information is necessary to handle argument structure phenomena like complex predicate formation, and given that these structures also do everything else we would want from an argument structure (see e.g. Butt 1995: ch. 6 on mapping), it is hard to know what to make of this complaint. Perhaps a more minimal a-structure would in fact be sufficient, but if so that is a matter to be demonstrated empirically, rather than settled by definitional fiat.

tures, labelled as transparent events (E_T), since the light verbs that host them can "see into" their internal structure. This visibility allows different kinds of argument fusion to take place, whereby participants of the embedded event are identified with participants of the event described by the light verb (as discussed in Section 4.2.4). We omit the full details here – see Butt (1995: ch. 5) for more information. By way of illustration, the a-structure for the Urdu permissive light verb *de-* 'let' is given in (122) (Butt 1995: 156):

(122)
$$\left[\begin{array}{l} \text{de- `let'} \\ \left[\begin{array}{l} \text{CS}([\alpha], \text{GO}_{Poss}(\{\ \ \}_{E_T}, \text{TO}[\ \ ])) \\ \text{AFF}([\ \ ]^{\alpha},\ ) \\ \text{ASP}(\_\ \_\ \_) \end{array}\right]_{E} \end{array}\right]$$

This is very similar to the a-structure in (121), the only difference being that the first argument of GO_{Poss} has been replaced by a transparent event (indicated by the curly braces and subscript E_T). The "letting" event expressed by this light verb is viewed metaphorically as a transfer event, where the thing transferred is the permitted event. This gives some explanation to the fact that both verbs share the same form in Urdu, for example, and shows how the embedded verb contributes to the overall interpretation of the complex predicate. It also allows for the recursive construction of complex predicates which are embedded under more than one light verb.[40]

A more contemporary approach to expanding the coverage of a-structure, but without assuming the Asudeh & Giorgolo (2012) architecture, is that of Schätzle (2018: ch. 6). She assumes a richly multidimensional version of Kibort MT's a-structure, where each argument can be annotated with a variety of non-standard semantic information, such as whether it is a Figure or Ground (Talmy 1978), and which kind of event participant it is in the typology of Ramchand's (2008) first-phase syntax. This, Schätzle (2018: 202) claims, enables a more "semantically realistic" account of mapping and of argument alternations, a goal shared by other recent work – see Section 6.3.

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[40] Other work on complex predicates and LMT, including Butt's own later work, has tended to eschew these more complex a-structures in favour of the simpler, ordered list representations of Classical MT (e.g. Alsina 1996, 1997, Butt 2014). But this leads to enormous difficulty in appropriately formalising the process of predicate fusion: see Lowe (2016: sec. 2) for critical discussion.

6.2 Mapping as co-description

The relationship between different levels of structure, such as a-structure and f-structure, has been approached in two different ways in LFG: CO-DESCRIPTION and DESCRIPTION BY ANALYSIS (Kaplan 1995, Dalrymple et al. 2019: 267–270). In co-description, multiple levels of structure are described simultaneously – for example, LFG's annotated phrase-structure rules simultaneously describe both c-structure and f-structure. This is the most commonly used approach in LFG. The alternative, description by analysis, involves determining the description of one structure by inspecting and analysing another. This was used in early LFG proposals for semantic analysis (e.g. Halvorsen 1983). Findlay (2021: 344–345) discusses various shortcomings of the description by analysis approach: notably, it ignores the possibility of mismatches between levels, and fails to meet the desideratum of constraint-based grammars laid down by Pollard & Sag (1994: 13) that they be "process neutral": description by analysis inevitably introduces directionality into parsing, which co-description does not. Co-description therefore "most directly captures the spirit of the constraint-based approach to linguistic analysis" (Findlay 2021: 344), which may explain why it has come to dominate in LFG analyses – indeed, while description by analysis was prominent in early accounts of semantics in LFG, those approaches have since been replaced by Glue Semantics (Dalrymple, Lamping & Saraswat 1993, Dalrymple 1999, Asudeh 2022), which employs co-description.

Classical LMT, though, is very much in the spirit of description by analysis: GF assignments at f-structure are determined by inspecting a-structure, and by analysing it using the Mapping Principle(s). This state of affairs meant that LFG work on argument structure and mapping was out of sync with the theoretical mainstream, where co-description was the norm. Once again, Butt et al. (1997: 6) were the first to tackle this formal issue, treating mapping as co-description of both a- and f-structure.

For example, to say that a predicate's Agent argument is expressed as its SUBJ GF, we could include the following piece of functional description in its lexical entry (where $*$ refers to the c-structure node bearing the annotation, and $\hat{*}$ to its mother node):

(123) $(\hat{*}_{\alpha}\ \textsc{agent})_{\lambda} = (\hat{*}_{\alpha\lambda}\ \textsc{subj})$

The expression $\hat{*}_{\alpha}$ refers to the lexical item's a-structure, via the α projection from c- to a-structure, while the expression $\hat{*}_{\alpha\lambda}$ refers to the lexical item's f-structure (the equivalent of the more familiar ↑). This constraint therefore picks out the f-structure corresponding to the a-structure AGENT, and identifies it with the verb's f-structure SUBJ.

But, of course, we generally don't want to associate an argument with only a single GF. Instead, Classical LMT associates it with a feature which describes a *pair* of GFs. Butt et al. (1997: 6) make this disjunctive meaning of the features explicit: instead of associating an argument with a feature, a disjunction of mapping equations like (123) is given, as in (124) or (125):

(124) *AGENT links to* $[-o]$*:*
$(\hat{*}_{\alpha}\ \textsc{agent})_{\lambda} = (\hat{*}_{\alpha\lambda}\ \textsc{subj}) \vee$
$(\hat{*}_{\alpha}\ \textsc{agent})_{\lambda} = (\hat{*}_{\alpha\lambda}\ \textsc{obl}_{\textsc{agent}})$

(125) *THEME links to* $[-r] \vee [+o]$*:*
$(\hat{*}_{\alpha}\ \textsc{theme})_{\lambda} = (\hat{*}_{\alpha\lambda}\ \textsc{subj}) \vee$
$(\hat{*}_{\alpha}\ \textsc{theme})_{\lambda} = (\hat{*}_{\alpha\lambda}\ \textsc{obj}) \vee$
$(\hat{*}_{\alpha}\ \textsc{theme})_{\lambda} = (\hat{*}_{\alpha\lambda}\ \textsc{obj}_{\textsc{theme}})$

Butt et al. (1997: 6) suggest that these intrinsic specifications can be universal, like (124) for AGENTS and (125) for THEMES, or they can be parameterised on a language-by-language basis, as is the case for other roles like LOCATION, GOAL, or INSTRUMENT.

Of course, these specifications alone do not determine the final mapping. In fact, Butt et al. (1997: 6) propose an important theoretical break from Classical LMT in this respect:

> Our approach departs most radically from the LMT literature in that we do not assume that a-structure roles are deterministically and uniquely linked to grammatical functions via a set of default principles. Instead, we propose a set of preference constraints which impose an ordering on the available linking possibilities; the most preferred possibility or possibilities are chosen.

In essence, their approach rejects the mechanistic, rule-driven approach of Classical LMT, and instead proposes that there is a hierarchy of GFs, and that those mappings which realise more highly ranked GFs are preferred. The hierarchy they propose is as follows:[41]

(126) $\textsc{subj} > \textsc{obj} > \textsc{obl}_\theta, \textsc{obj}_\theta$

That is, SUBJ outranks OBJ, which in turn outranks $\textsc{obl}_\theta$ and $\textsc{obj}_\theta$, which have the same rank as each other. This means, for each argument, that it is preferable for it to be realised as a SUBJ, or, failing that, as an OBJ, or, lastly, as either an $\textsc{obl}_\theta$ or an $\textsc{obj}_\theta$. The argument will therefore be linked to the highest GF on this hierarchy with which it is compatible, given the disjunctive specifications provided in its intrinsic classification.[42] This gives us a much more dynamic system than in Classical LMT: there are no explicit Mapping Principles, and arguments simply compete for the highest available GFs. In a nod to Mapping Principle (a-i) of Classical LMT (see Section 4.1.2), Butt et al. (1997: 6) do include a preference for the SUBJ to be linked to the highest available argument on the thematic hierarchy, but crucially this is just a preference, and so is not inviolable.

The final mapping chosen is the one deemed "optimal" in terms of realising the highest number of the most highly ranked GFs, and in terms of satisfying any other preference constraints, such as the subject preference just mentioned (as well as not violating Function-Argument Biuniqueness or the Subject Condition). Butt et al. (1997: 7) use a numerical system to express the relative weightings of

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[41] Butt et al. (1997: 7) claim that the hierarchy in (126) can be recast as a preference for negative-valued features in the classic $[\pm o/r]$ schema:

(i) a. $[-r] > [+r]$
    b. $[-o] > [+o]$

But the expressions in (i), which is their (15), do not match the authors' prose description, which only applies (i-b) within the $[-r]$ GFs. If we simply take (i) as expressing two independent preference rankings, we get the Markedness Hierarchy of Classical LMT (see Section 4.1.1):

(ii) $\textsc{subj} > \textsc{obj}, \textsc{obl}_\theta > \textsc{obj}_\theta$

Alternatively, if we see (i-a) as taking precedence over (i-b), then we obtain another ranking, this time a total ordering:

(iii) $\textsc{subj} > \textsc{obj} > \textsc{obl}_\theta > \textsc{obj}_\theta$

It is of course an empirical matter which of these rankings (if any) is correct.

[42] Just like Kibort MT's Mapping Principle (see Section 5), this reverses the Classical LMT mapping principle where GFs *lower* down the hierarchy are preferred. This means that Butt et al.'s (1997) proposal shares the weakness of Kibort MT that it makes the wrong prediction about the passives of ditransitives – see Section 4.1.3.

different GFs and of other constraints, but this is not a crucial component of the theory, and any appropriate means of ranking different solutions in terms of a set of preferences could be used – for example, the authors speculate (p. 7) that the proposal could be reformulated in terms of Optimality Theory (Prince & Smolensky 1993, 2004, *et seq.*).

By way of illustration, consider a simple transitive like *kick* again. For every argument, the most preferred GF is subj. But is each compatible with subj? According to the disjunctions in (124) and (125), assuming that the intrinsic classification for Theme also applies to Patients, subj is a possible realisation of both arguments. But we cannot map both to subj, or we fall foul of Function-Argument Biuniqueness, so we must decide which one to map to subj, and which to map to the next most highly ranked compatible GF. Since, following the thematic hierarchy, the Agent argument of *kick* outranks its Patient argument, the subject preference will be satisfied if we map the Agent to subj but not if we map the Patient to subj, so the former mapping is preferred; the next highest GF compatible with the Patient intrinsic specification is obj, and so we end up with the correct outcome whereby the Agent is linked to subj and the Patient to obj.

The theoretically most interesting consequence of the Butt et al. (1997) approach to mapping is that certain constructions may have more than one optimal linking. Butt et al. (1997: 8ff.) argue that this in fact characterises alternations which are motivated by semantic/pragmatic constraints (such as the dative shift) and not by morphosyntactic ones (such as the passive).[43] This offers a more natural account of the dative shift alternation than the Classical LMT analysis, which requires two different initial assignments of features to the arguments. In the Butt et al. (1997) framework, both realisations of the dative shift alternation in English are made available automatically, since they have equivalent preference rankings:

(127) [Garak] gave [the datarod] [to Sisko].
subj obj obl$_{\text{goal}}$

(128) [Garak] gave [Sisko] [the datarod].
subj obj obj$_{\text{theme}}$

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[43] However, their distinction does not seem to perfectly match that between meaning-preserving (morphosyntactic) and meaning-altering (morphosemantic) alternations, since they consider the locative inversion to be grouped with the dative shift (as being explained by the presence of more than one optimal linking) and distinct from the passive, when the locative inversion is no more meaning altering than the passive (neither alternation affects truth-conditional semantics, but only alters the information structural prominence of its arguments).

Both involve a SUBJ (linked to the highest argument) and an OBJ, and since OBJ_θ and OBL_θ are equally ranked, the different realisations of the third argument make no odds when it comes to the relative weightings of the two mappings. Therefore both mappings are made available by the grammar, and the choice between them must be determined by other factors, such as lexical preference (the shifted variant is impossible with verbs of Latinate origin, for example) or semantic/pragmatic considerations (see Bresnan 2007 and Bresnan et al. 2007 for usage-based/probabilistic accounts of the alternation, and Goldberg 1995: ch. 6 on the special meanings associated with the double object construction in English).

Work which assumes the Asudeh & Giorgolo (2012) architecture also makes use of co-description to express mapping possibilities, although here the directionality is changed: we are mapping from f-structure to s-structure, rather than from a-structure to f-structure. The equivalent of (123), assuming ARG_1 corresponds to the Agent (see Section 6.3), is (129):

(129) $(\uparrow \text{SUBJ})_\sigma = (\uparrow_\sigma \text{ARG}_1)$

As in Butt et al. (1997), feature decomposition is replaced by explicit disjunctions over GFs. Findlay (2016: 299) uses abbreviations to describe the (supposedly) natural classes captured by the traditional features:

(130) a. $\text{MINUSO} \equiv \{\text{SUBJ}|\text{OBL}_\theta\}$
b. $\text{PLUSO} \equiv \{\text{OBJ}|\text{OBJ}_\theta\}$
c. $\text{MINUSR} \equiv \{\text{SUBJ}|\text{OBJ}\}$
d. $\text{PLUSR} \equiv \{\text{OBL}_\theta|\text{OBJ}_\theta\}$

This gives us (131) as the equivalent of (124):

(131) $(\uparrow \text{MINUSO})_\sigma = (\uparrow_\sigma \text{ARG}_1)$

In fact, since arguments may not be realised by any GF – for example, the Agent argument of a short passive – we also need a description which says that the argument in question does not correspond to any GF at f-structure. We achieve this by stating that the inverse of the σ mapping from f- to s-structure is empty when applied to that argument, as in (132):

(132) $(\uparrow_\sigma \text{ARG}_1)_{\sigma^{-1}} = \varnothing$

This says that the s-structure ARG_1 has no f-structure correspondent, i.e. that this argument is not realised syntactically.

Findlay (2016: 319, 321) proposes to use templates to abbreviate these mapping equations and make them more readable:[44]

(133) Map(D, A) $\equiv$ $(\uparrow \mathrm{D})_\sigma = (\uparrow_\sigma \mathrm{A})$

(134) NoMap(A) $\equiv$ $(\uparrow_\sigma \mathrm{A})_{\sigma^{-1}} = \varnothing$

The first of these, (133), says that the GF or disjunction of GFs D is mapped to the s-structure argument A, while (134) says that the s-structure argument A has no GF correspondent at f-structure.[45] These templates can then be combined, so that e.g. the correct expression to capture the mapping possibilities of an Agent assigned to ARG_1 is the following:

(135) $\{$@Map(minuso, ARG_1) | @NoMap(ARG_1)$\}$

That is, either this argument is mapped to one of the two minuso GFs (subj or OBL_θ), or it is not expressed syntactically at all.

Using disjunctions over GFs like minuso or plusr instead of assuming features like $[-o]$ and $[+r]$ sidesteps any formal issues arising from seeing GFs as decomposable into features (as discussed in Section 4.1.1), and simply represents the most significant empirical claim of the feature-based approach – that GFs can be grouped into natural classes (whether the $[\pm o/r]$ classification is the correct way of grouping them is orthogonal). It has been objected that this use of disjunctions makes the approach somehow more arbitrary or less well motivated than earlier incarnations of LMT, since we could just as easily have written a different set of disjunctions in (130). Such an objection is misplaced for two important reasons. Firstly, it purports to contrast the arbitrariness of the disjunctive approach with the theoretical motivation of the feature-decomposition approach. But this is only true to the extent that the features used in the latter have independent motivations. While a case could be made for $[\pm r]$ on these grounds (one could imagine an independent criterion for determining semantic restrictedness), as we mentioned in Section 4.1.1, this seems not to be the case for $[\pm o]$, which has no content other than identifying the two object functions obj and OBJ_θ, and whose definition is therefore circular. Given this situation, we take the use of the explicitly "arbitrary" mechanism of disjunction to in fact be an advantage

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[44] On templates, see Dalrymple et al. (2004), Crouch et al. (2011), Asudeh et al. (2013) and Belyaev (2023a: §5.1 [this volume]).

[45] One problem with the NoMap template is that in the event an argument is not expressed syntactically, nothing will ensure its presence at s-structure. Findlay (2020: 135–136) argues therefore that existential constraints must accompany the introduction of each argument.

over the classical approach, since it wears its arbitrariness on its sleeve rather than concealing it behind a veneer of theoretical motivation.

Secondly, and much more significantly, such an objection misses the crucial distinction between formalism and theory. The formalism *itself* need not be expected to say anything about what natural groupings of GFs occur in the world's languages. Rather, the formalism gives us tools for making explicit claims about such things – and it is those claims which constitute the theory. As Pollard (1997: 9) puts it, "it is the theory that imposes the constraints, not the language in which the theory is expressed". So, although we could've written different disjunctions in (130), it is precisely in writing one set of expressions rather than another that we make a theoretical claim. This claim may turn out to be true or false, but if it is false, we would prefer to be able to use the same familiar tools to express a different, revised hypothesis, rather than have to throw away our tools entirely because they have been over-engineered to fit one particular view of reality. Once again, therefore, we see this property as being an advantage of the disjunctive approach. As an example, consider the objection by Alsina (1996: 29, fn. 9), noted in Section 4.1.1, that the traditional $[\pm o/r]$ features cannot be used to describe the natural class of terms, or direct GFs, i.e. SUBJ, OBJ, and OBJ$_\theta$. He instead proposes a different classification using the features [±subj/obl], where [−obl] describes the terms (Alsina 1996: 27–30). In the traditional view, this approach and the Classical LMT approach are simply incommensurable: they represent two different formalisms which contain different primitive elements. But in the view we are considering, both can be expresed in the *same* terms – compare (130) and (136) – thereby highlighting their status as competing theoretical claims rather than totally distinct formal approaches.

(136) a. MINUSSUBJ ≡ {OBJ|OBJ$_\theta$|OBL$_\theta$}
b. PLUSSUBJ ≡ SUBJ
c. MINUSOBL ≡ {SUBJ|OBJ|OBJ$_\theta$}
d. PLUSOBL ≡ OBL$_\theta$

It is an empirical matter which of these analyses is correct, and we should not generally expect the formalism to adjudicate on empirical matters. Rather, the theory which we develop in using that formalism is what we expect to align with the facts.

6.3 Connection to semantics

While the most influential research in Classical LMT was being conducted, there was no canonical theory of the syntax-semantics interface in LFG to appeal to. With the acceptance of Glue Semantics (Glue) into the LFG mainstream around the turn of the millennium, this changed.[46] One of the most important goals of recent work on mapping theory has therefore been to integrate the theory into a Glue-based analysis of the syntax-semantics interface. In particular, this strand of research assumes that Glue's concept of resource sensitivity (Asudeh 2012: ch. 5) subsumes the traditional LFG principles of Completeness and Coherence, so that pred features at f-structure no longer contain an argument list. That is, instead of (137a), we have (137b):[47]

(137) a. $\left[\textsc{pred}\ \text{`}\textsc{eat}\langle\textsc{subj}, \textsc{obj}\rangle\text{'}\right]$
b. $\left[\textsc{pred}\ \text{`}\textsc{eat}\text{'}\right]$

This creates greater flexibility when it comes to argument realisation, since one and the same pred value can correspond to different syntactic realisations of its arguments. In the previous conception, each argument array required a separate pred value (and therefore a separate lexical entry), since pred values cannot be manipulated in the syntax (cf. the principle of Direct Syntactic Encoding introduced in Section 3, and discussed further in Kaplan & Bresnan 1982, Bresnan et al. 2016: sec. 5.2, and Dalrymple et al. 2019: 329).

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[46] Although Glue first appeared in the early '90s (Dalrymple, Lamping & Saraswat 1993), it was still not well established in the LFG community by the time much of the the work discussed in the earlier sections of this chapter was carried out. The first major collection of Glue work connected to LFG was Dalrymple (1999), and the theory later appeared in Dalrymple's (2001) handbook-style presentation of LFG, as well as the latest reference guide to LFG, Dalrymple et al. (2019: ch, 8.5). We cannot include an introduction to Glue Semantics in this chapter for reasons of space, but see the references just cited, along with Asudeh (2022) and Asudeh (2023) [this volume] for further information.

[47] The idea of using linear logic's resource sensitivity to account for Completeness and Coherence goes back to the very first Glue paper (Dalrymple, Lamping & Saraswat 1993), and was noted again by Dalrymple et al. (1999), Kuhn (2001), and Asudeh (2012: 112ff.), though it didn't find its way into more mainstream LFG work until the research programme initiated by Asudeh & Giorgolo (2012).

One oft-noted (potential) problem with viewing Completeness and Coherence as reducible to semantic resource sensitivity is expletive arguments, i.e. syntactic arguments which do not correspond to semantic ones. Since, by hypothesis, they make no semantic contribution, they will not be required by constraints of semantic resource sensitivity, even though they *are* required for grammaticality. As Asudeh (2012: 113) points out, however, this is far from an insurmountable problem, and there are a number of potential solutions (including rejecting the idea that expletive arguments are semantically empty in the first place – see Bolinger 1977).

A typical lexical entry in this strand of work is given in (138):

(138) *kick* V $(\uparrow\ \textsc{pred}) = \text{‘kick’}$
$(\uparrow_{\sigma}\ \textsc{rel}) = \text{kick}$

$\big\{@\textsc{Map}(\textsc{minuso}, \textsc{arg}_1) \mid @\textsc{NoMap}(\textsc{arg}_1)\big\}$
$\big\{@\textsc{Map}(\textsc{minusr}, \textsc{arg}_2) \mid @\textsc{NoMap}(\textsc{arg}_2)\big\}$

$\lambda x \lambda y \lambda e.\mathbf{kick}(e) \wedge \mathbf{agent}(e, x) \wedge \mathbf{patient}(e, y)\ :$
$(\uparrow_{\sigma}\ \textsc{arg}_1) \multimap (\uparrow_{\sigma}\ \textsc{arg}_2) \multimap (\uparrow_{\sigma}\ \textsc{event}) \multimap \uparrow_{\sigma}$

The first two lines provide the pred value along with a value for rel at s-structure.[48] The next two lines provide the mapping information, using the technique explained in the previous section: either the arguments map to one of a pair of GFs, or they are not realised syntactically. This corresponds to argument-function mapping in Kibort MT (see Section 5). The crucial advantage of incorporating a theory of the syntax-semantics interface is that we can also express the equivalent of Kibort MT's argument-participant mapping, via the meaning constructor in the final line. Here the variable x is identified as the Agent of the kicking event, and connected via the linear logic term to $\textsc{arg}_1$ at s-structure; similarly, y is identified as the Patient, and connected to $\textsc{arg}_2$. That is, the link between GFs and semantic participants, a key part of any mapping theory, is mediated by the intervening level of s-structure, here playing the same role as Kibort MT's lexical valency frame. And just like in Kibort MT, this setup allows for the realignment of participants to argument positions – see Findlay (2016: 328–332) for an example of this with the English benefactive.

By bringing together information about mapping and about semantics, which are just the same kind of object in this approach, *viz.* pieces of functional description, it becomes far easier to express semantic constraints on, and semantic consequences of, argument alternations and other argument structure operations (cf. also the discussion of Butt's 1995 enhanced a-structures above). Asudeh (2021: 32–39) shows the potential of this approach in his analysis of the English "non-agentive dynamic intransitive", and contrasts it with what he calls the "low resolution" of Classical LMT, which only has access to very spartan semantic information (usually just the thematic roles of arguments).

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[48] The current status of pred and rel in LFG is not settled: many if not all of the important functions of pred have been taken over by Glue Semantics (Andrews 2008), and rel really has no substantive role in the theory (Lovestrand 2018: 169ff. although see Lowe 2014). They also seem to both express the same information in (138), which adds a degree of redundancy to the grammar. Nevertheless, they at least serve to help distinguish different f- and s-structures, as well as making the representations more readable.

One promising area of research made possible by this “joined up” approach to mapping is the idea of incrementally bundling up semantic and mapping information into more and more complex valency templates (as employed in e.g. Asudeh & Giorgolo 2012, Asudeh et al. 2014, Findlay 2020), which, coupled with the notion of an inclusion hierarchy between templates (see especially Asudeh et al. 2013: 17–20), could lead to a mapping theory based purely on a richly structured and hierarchical lexicon, along the lines of Davis & Koenig (2000). This potential has yet to be fully explored, though Przepiórkowski (2017) has pointed the way.

7 Conclusion

New approaches to argument structure and mapping theory phenomena were at the heart of what gave rise to LFG as a separate approach to linguistic theory in the first place: Bresnan’s (1980, 1982) observations about the lexical character of argument alternations and the benefits afforded by separating out lexical predicate-argument structures from surface syntactic structures were what laid the foundations for LFG’s lexicalist, modular view of the grammar. The advent of Lexical Mapping Theory (LMT) helped to constrain the theory of argument alternations, and also offered new explanatory tools which proved successful in characterising a number of linguistic phenomena across a fairly typologically diverse range of languages. Recent developments in both theory and formalism show that the field is ripe for a renaissance, and that while great strides have been made, many important questions still remain unanswered. This chapter has attempted to give a broad and expository overview of the status quo, along with a little of how we got here, with the hope that by drawing together different theoretical perspectives we can both encourage dialogue among experienced researchers, and bring new scholars up to speed, so that both can be in the best position to contribute to a field which remains full of untapped potential.

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Chapter 17

Prosody and its interfaces

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LFG has always had a strong focus on syntax and semantics, but the last two decades have seen significant progress with regard to the integration of p(honological)-structure into LFG. This chapter first briefly introduces important concepts for the analysis of prosody and gives an overview of widely adopted approaches to the syntax–prosody interface. The second part surveys the different proposals for the integration of p-structure and its interfaces into LFG, with a particular focus on the architectural assumptions behind each approach and the resulting implications for the architecture of grammar.

1 Introduction

LFG has always had a strong focus on syntax and semantics. However, with the realisation that prosodic information can significantly contribute to linguistic analyses and is often crucial for the correct interpretation of meaning (e.g., in form of prosodic disambiguation of syntactically ambiguous structures or for the correct interpretation of information structure), the last two decades have seen significant progress with regard to the integration of prosodic structure into LFG.

LFG assumes that different aspects of grammar (i.e., syntax, semantics, etc.) are represented by unique modules (also called ‘projections’), each guided by its own principles and constraints, and with representations well-suited to their unique functions (cf. Dalrymple 2001, Sadock 1991, see also Belyaev 2023b [this volume]). The syntactic component, for example, is represented by c(onstituent)- and f(unctional)-structure and is concerned with constituency (via phrase structure rules) and the encoding of grammatical functions and morphosyntactic features, while phonology (including prosody) is represented by p(honological)-

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structure and is concerned with phonological and prosodic properties like prosodic phrasing, rhythmic constraints, and intonation.[1]

Communication between the different modules is handled by LFG's correspondence architecture, which allows for relevant information to be made available at the respective interfaces. The establishment of these interfaces necessarily presumes a specific grammar architecture; that is, it presupposes an explicit positioning of modules with respect to each other. Discussing the architectural assumptions made in each p-structure proposal is thus essential for the understanding of the (in parts fundamental) differences in the representation of prosody and the communication at the interfaces.

This chapter provides an overview of the different approaches to prosody and its interfaces in LFG, and places these with respect to proposals made in the wider literature. It furthermore discusses the architectural assumptions made in each proposal and offers insights into a more general view of grammar. The chapter is structured as follows: Section 2 provides a general introduction into two major aspects of prosody (phrasing and intonation) and discusses current approaches to prosody and its interfaces in the wider literature. A discussion of the LFG grammar architecture and the placement of the phonological module (including prosody) is provided in Section 3. This section also establishes a fundamental difference between the proposals with respect to how grammar is viewed in general. Section 4 provides a chronological overview of the different approaches to prosody and its interfaces in LFG, in particular with respect to the architectural assumptions made in each proposal. Section 5 concludes the chapter.

2 Prosody and its interfaces

The LFG approaches to prosody discussed in Section 4 draw on a number of notions and theories established in the wider literature. This section first gives an overview on the general features that are particularly relevant with respect to the analysis of prosody at the interfaces and then describes the major approaches to the interface between syntax and prosody.

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[1] In most of the approaches discussed in Section 4 the 'p' in p-structure represents p(rosodic)-structure, as prosodic features ususally contain relevant information for analyses at the interfaces to syntax, semantics, and information structure. However, prosody is only one part of the larger field of phonology and some phenomena that are not part of prosody (e.g., postlexical sandhi phenomena) can be closely interlaced with prosody in that they can indicate a specific prosodic domain. This chapter will thus use the term p(honological)-structure, of which prosody is part, but which does not, per se, restrict p-structure to represent prosody alone.

2.1 What is prosody?

Prosody is a term used to describe suprasegmental phonology. It goes beyond the phonemic level of segmental phonology and is concerned with larger units in spoken language, including prosodic grouping, intonation and/or tones, rhythm, and stress patterns. Prosody can be used to express a number of properties and functions, among these clause type, clause structure, semantic scope, concepts of information structure such as topic and focus, but also speaker emotion, irony, or sarcasm. A detailed description of prosody goes far beyond the aim of this chapter and this section will only focus on some basic notions of prosody deemed fundamental for the current state of the art in LFG, namely prosodic phrasing, intonation, and the relationship between prosody and other modules of grammar.

Traditionally, it is assumed that spoken language is grouped into hierarchically structured **prosodic domains** (e.g., Selkirk 1978, Nespor & Vogel 1986, Hayes 1989). Example (1) shows the most widely used proposal for the prosodic hierarchy originally made in Selkirk (1978) (building on an earlier proposal by McCawley 1968; see also Frota 2012 for different suggestions).

(1) The Prosodic Hierarchy (Selkirk 1978)

Prosodic hierarchy

U utterance (Ut)
|
ι intonational phrase (IntP)
|
φ phonological phrase (PhP)
|
ω prosodic word (PW)
|
Σ foot (Ft)
|
σ syllable (Syll)

In addition, the constraints in (2) are assumed to apply to the prosodic hierarchy.[2]

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[2] These constraints have been challenged and are now mostly considered to be ‘soft’ constraints, see, e.g., Bennett & Elfner (2019).

(2) **Constraints on Prosodic Domination (Selkirk 1995: ex. 4)**
(where C^n = some prosodic category)
   (i) *Layeredness:* No C^i dominates a C^j, j > i,
      e.g. “No syllable dominates a foot.”
   (ii) *Headedness:* Any C^i must dominate a C^{i-1} (except if C^i = syllable),
      e.g. “A prosodic word must dominate a foot.”
   (iii) *Exhaustivity:* No C^i immediately dominates a constituent C^j, j < i-1,
      e.g. “No prosodic word immediately dominates a syllable.”
   (iv) *Nonrecursivity:* No C^i dominates C^j, j=i,
      e.g. “No foot dominates a foot.”

The identification of a prosodic unit is based on various types of evidence and can vary greatly across languages. Among these types of evidence are sandhi processes (e.g., linking and intrusive /r/ in English (Wells 1970)), tonal events (e.g., Beckman & Pierrehumbert 1986, Pierrehumbert & Beckman 1988), and rhythmic patterns (e.g., Liberman 1975, Nespor & Vogel 1989). A phonological phrase in English, for example, is assumed to be intonationally represented by a pitch accent and a phrase accent, and to show phrase-final lengthening, where the last syllable is significantly longer compared to the other syllables of the phonological phrase (Lehiste et al. 1976, Frota 2012).

Tonal events like accents and boundary tones can contribute significantly to the meaning of a clause. These events are often described in terms of High and Low tones and tone combinations following the ToBI annotation conventions.[3] The first set of conventions was developed for American English in 1992 (Silverman et al. 1992); others have followed with specific adaptations to other languages (e.g., German GToBI (Grice & Baumann 2002)). The ToBI conventions distinguish between three tonal events:

- Pitch accents (L* and H*, and combinations like L+H* and L*+H) are usually found on the words that are most important for an interpretation. In a neutrally pronounced sentence like *Amra went to the playground to meet her friends*, ‘Amra’, ‘playground’ and ‘friends’ would usually carry pitch accents. Pitch patterns can reflect information structure (Zaenen 2023 [this volume]): Contrastive focus in Germanic languages, for example, can be indicated by the use of an accent with a notably larger pitch span compared to the other accents of the clause (see, e.g., Féry 2020).

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[3] The Autosegmental-Metrical/Tone and Break Indices framework (AM/ToBI) (Pierrehumbert 1980, Silverman et al. 1992, Beckman et al. 2005) is a generally adopted set of conventions to describe tonal events in the intonational contour. Break indices, which indicate the strength of a break between words, are not further discussed in this chapter.

- Boundary tones (H% and L%) are only associated with phrase edges of larger prosodic units, most often the intonational phrase boundary. They can, for example, signal the difference between a question and a statement with identical linear word order by means of rising or falling final phrase boundary tones.

- Phrase accents (H- and L-) are situated between a pitch accent and a boundary tone. They are often related to the edge of a prosodic domain below the intonational phrase, but there is some variation (see the discussion in Grice et al. 2000). They can significantly contribute to the disambiguation of syntactically ambiguous structures.

While these conventions are adopted by the vast majority of the field, proposals with a more fine-grained understanding of tonal events in combination with, for example, a distinct level of prominence (which is essential for the interpretation of focus type), have recently been developed (e.g., DIMA: Kügler et al. 2019). Whether these proposals allow for a more thorough interpretation of prosody and meaning is subject to future research.

Both areas, prosodic constituency and intonation, are deeply intertwined with each other, and are also closely associated with **segmental phonology**, in that phonological processes (e.g., resyllabification) may be constrained to a particular prosodic domain (e.g., the phonological phrase), or the quality of a vowel may change if it is associated with a pitch accent. Segmental and suprasegmental prosody both are part of lexical and postlexical phonology. Prosodic constituency and (lexical) stress are also part of a word's lexical entry, as is the knowledge about prosodically deficient clitics, while segmental phenomena frequently also occur between two words and hence are not restricted to the lexicon. As a consequence, p-structure should not only represent prosodic structure, but should rather include lexical and postlexical segmental and suprasegmental phonology (cf. fn 1).

Phonetics can be viewed as the physical translation of phonology into a concrete speech signal (and vice versa), which is reflected in the close relationship between prosodic terms like pitch, length, or loudness, and phonetic terms like fundamental frequency, duration, and intensity (see Kingston 2019 for a detailed discussion). Phonetics has not been in the focus of the proposals made in LFG, although initial approaches towards its integration have been undertaken (see Butt et al. 2020, Bögel 2020; also Section 4.5).

It is clear that prosodic structure is governed by p-structure internal principles and constraints, and that, for example, rhythm and the prosodic status of words (prosodic words vs. prosodically deficient clitics) can determine the formation of prosodic domains. It is, however, equally assumed that prosody is influenced by syntactic structure and discourse-related aspects like the differentiation between new and given information and the expression of different focus-types (Zaenen 2023 [this volume]). Furthermore, 'extralinguistic' factors such as speaking rate or frequency effects can affect p-structure.[4] The exact influence of these and other factors on prosody is far from being fully explored. As the vast majority of research (within and outside of LFG) has focussed on the exploration of the relationship between syntax and prosody, the major approaches to this interface are briefly introduced here, before turning to the role of p-structure and the different proposals to prosody and its interfaces in LFG.

2.2 Theories of the prosody-syntax interface

The literature on how the syntactic and the prosodic modules interact can be roughly divided into two major camps: **direct reference** and **indirect reference** (see Bennett & Elfner 2019 for a detailed discussion of each approach). The direct reference approach proposes that phonological rules and groupings can directly be conditioned on syntactic relations or properties, e.g., on c-command, sister relations, or 'head' status, without the intervention of a separate prosodic structure (e.g., Kaisse 1985; see Elordieta 2008 for an overview). As LFG assumes a modular view of grammar and none of the LFG approaches propose the (non-modular) direct reference approach, this chapter will not further discuss this particular approach to the interface.

The other school of thought pursues the indirect reference approach, which assumes that syntactic structure is first mapped to prosodic domains as shown in (1). Phonological rules are then conditioned based on these prosodic domains (e.g., Hayes & Lahiri 1991). Prominent proposals include the **end-based** approach (Selkirk 1986, Chen 1987) which assumes that the mapping algorithm is restricted to the edges of syntactic heads and maximal projections. In the abstract example in Figure 1, each syntactic head receives a prosodic word boundary and each XP receives a phonological phrase boundary at its right edge. As all XPs align at their right edge, only one phonological phrase boundary is included.[5] Function words ('fw') are excluded from the mapping algorithm.

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[4] See Shattuck-Hufnagel & Turk (1996) for a thorough discussion of different constraints on prosody.

[5] Whether the right or the left edge is aligned seems to be subject to language-specific constraints.

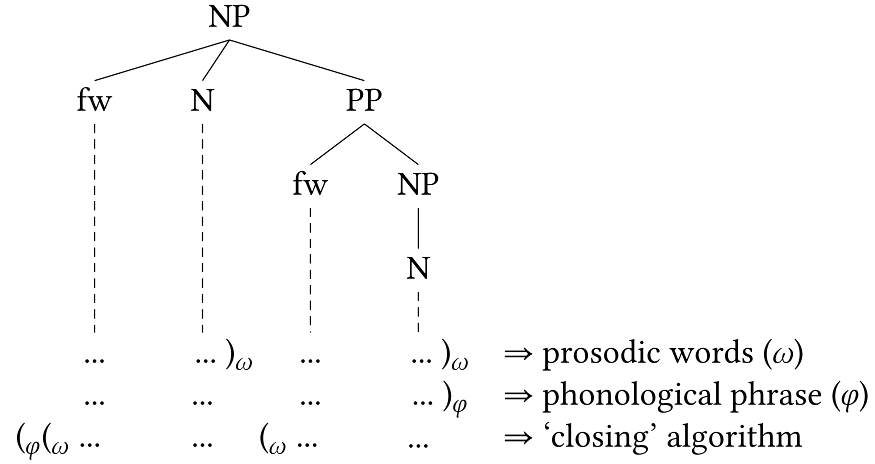

Figure 1: The end-based approach (Selkirk 1986: 387, shortened and modified)

All prosodic domains in this example are 'closed' by assuming an automatic insertion of a left boundary with the neighbouring right boundaries or at the edges of the whole construction. This effectively groups all function words together with their corresponding syntactic heads into prosodic words and places both prosodic words within the phonological phrase: $(_{\varphi}(_{\omega}\text{fw N})_{\omega}(_{\omega}\text{fw N})_{\omega})_{\varphi}$.

The end-based approach has been reformulated as a generalized alignment constraint in Optimality Theory (OT; McCarthy & Prince 1993, Prince & Smolensky 2004) and is generally represented in this format, for example as Align-XP-R(ight): Align (XP, R; φ, R)[6] (Selkirk 1995).

In later work, Selkirk (2009, 2011) introduced **match theory** (which has ancestors in, e.g., Ladd 1986). In contrast to the previous end-based approach, match theory assumes that both edges of a syntactic constituent are simultaneously matched to a prosodic constituent.

- match-clause: A clause in syntactic constituent structure must be matched by a corresponding intonational phrase (ι) in prosodic constituent structure: match (clause, ι)
- match-phrase: A phrase in syntactic constituent structure must be matched by a corresponding phonological phrase (φ) in prosodic constituent structure: match (xp, φ)

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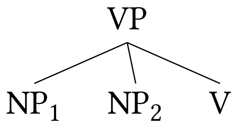
[6] Read as: "Align the right edge of an XP with the right edge of a phonological phrase/φ".

- match-word: A (lexical) word in syntactic constituent structure must be matched by a corresponding prosodic word (ω) in prosodic constituent structure: match (lex-word, ω) (Selkirk 2011: 439, modified)

Match theory reflects the syntactic structure in much more detail; in particular (and in contrast to the end-based approach) it predicts recursion, as syntactically nested XPs will be phrased as recursive structures in prosodic constituency. The (modified) example in (3) from Selkirk (2011) illustrates this point for a transitive verb phrase.

(3) Different mapping approaches for a transitive verb phrase



Align-L(eft): $(\mathrm{NP}_1)_\varphi\ (\mathrm{NP}_2\ \mathrm{V})_\varphi$
Match-phrase: $((\mathrm{NP}_1)_\varphi(\mathrm{NP}_2)_\varphi\ \mathrm{V})_\varphi$

In (3), each VP/NP receives a preceding left phonological phrase boundary in the end-based approach (Align-L). The φ-boundary for NP_1 is identical with the boundary for the VP. The right boundary for NP_1 is placed (‘closed’) before NP_2, and the second right φ-boundary is placed after V, which does not receive any boundaries by itself. The first phonological phrase thus contains NP_1 and the second phonological phrase groups the verb together with NP_2. In contrast, the match algorithm maps each XP (NP_1, NP_2, and VP) into a phonological phrase, thus creating a recursive structure.

Besides these two major schools of direct and indirect reference, a third proposal with regard to the formation of prosodic structure has been adopted into the LFG community as well (most prominently in Dalrymple & Mycock 2011, Mycock & Lowe 2013, and subsequent work), which will be called the **parallel approach** in this chapter. The main motivation for the parallel approach is the frequently observed non-isomorphism between syntactic and prosodic constituency as illustrated in example (4).

(4) Syntactic Phrasing: [Drink [[a pint] [of milk]] [a day]]
Phonological Phrasing: (Drink a) (pint a) (milk a) (day)
(Lahiri & Plank 2010: 376, modified)

This frequent mismatch seemingly rules out any approaches which map syntactic constituents to prosodic domains, but suggests that prosodic structure is built up on prosodic principles alone. Based on observations of rhythmic patterns (e.g., Sweet 1904), Lahiri & Plank (2010) assume the trochaic foot (X –) to be the determining element for the creation of prosodic structure in English, with the stressed syllable as the initial element of each prosodic chunk. Lahiri and Plank discuss this approach to prosodic phrasing with respect to a number of diachronic and synchronic examples which support the assumption that function words are frequently grouped together with preceding strong syllables (as in example 4) and not necessarily with the following syntactic head (as suggested in Figure 1).

However, while the parallel approach provides a suggestion for the creation of the lower prosodic domains (foot and prosodic word structure), no suggestion is made for the formation of the higher domains (phonological phrase and intonational phrase); nor do Lahiri and Plank explicitly exclude the influence from other modules of grammar. Furthermore, it has long been part of the indirect reference tradition that it is "crucially [...] not the case that all syntactic boundaries of a certain type must correspond to prosodic boundaries of a given type and vice versa" (Frota 2012: 256). Most researchers assume "prosodic restructuring" (Nespor & Vogel 1986: 172) based on, for example, the type of word (function word vs. lexical word), the size of the phonological phrase, or the amount of recursive nesting.[7] The indirect reference approaches thus do not take prosodic constituency to be a simple derivative of syntax, but assume that prosodic structure is also formed by means of syntax-independent constraints, among them the rhythmic constraints proposed by the parallel approach.

The difference between these two approaches to prosody and its interfaces necessarily reflects two distinct views of grammar in general. As both directions have been pursued in the proposals made in LFG, the following section briefly discusses how prosodic structure is integrated into the overall grammar architecture and how the indirect reference approach and the parallel approach differ with respect to the communication at the interfaces.

3 Prosody in LFG's grammar architecture

Several proposals have been made with respect to LFG's grammar architecture (see also Belyaev 2023b [this volume]) and a closer discussion of the different approaches to prosody and its interfaces presented in this chapter provides interesting insights into the positioning of the different modules on the one hand, and a general understanding of grammar on the other hand.

Prosodic structure is especially interesting as it is usually taken to represent FORM and is thus placed at one 'end' of the FORM-MEANING relationship as, for

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[7] For prosodic restructuring mechanisms/'prosodic markedness constraints' as expressed in Optimality Theory, see Selkirk (2011: 468ff) for an overview.

example, discussed in Kaplan (1987: 362). In Kaplan's original proposal, shown in Figure 2, p-structure was not yet part of the grammar architecture; instead, the (word) string was taken to be the external form of the sentence. This is also reflected in Asudeh (2009: 110), where the string is understood as a 'representation of linear phonology' and as the center of the syntax–phonology interface, a proposal that has concretely been pursued in the approaches of Bögel et al. (2009, 2010), Dalrymple & Mycock (2011), and Mycock & Lowe (2013) (see Section 4).

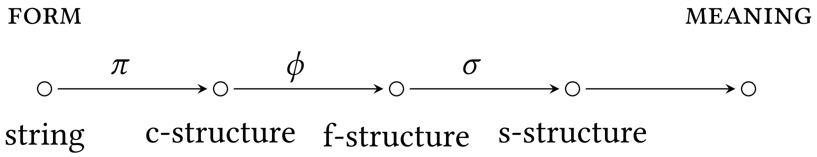

Figure 2: (Simplified) FORM-MEANING relationship in Kaplan (1987: 362)

Proposals in the wider literature have assumed a slightly more complex representation of FORM. Very early, Selkirk (1984) proposed that syntactic structure is first mapped to a phonological (including prosodic) representation, which is then further processed by means of phonological rules and constraints before being mapped to a phonetic representation. In this model the string is not placed between the syntactic and the phonological module, but is the output of the phonological and the phonetic modules. Such a model is very much in line with psycholinguistic models of speech production and comprehension, e.g., as found in Levelt (1999) and in Jackendoff's (2002) work on Parallel Grammar; see Varaschin 2023 [this volume].

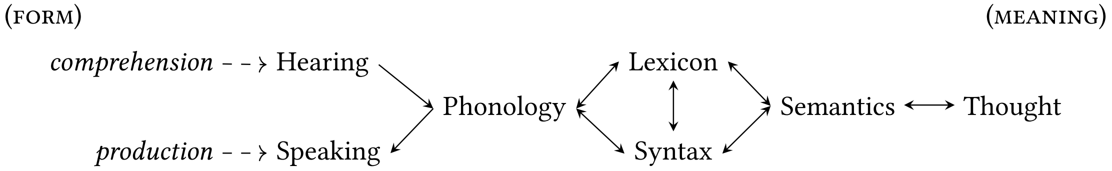

Figure 3: The language processor (cf. Jackendoff 2002: 197, modified)

The model in Figure 3 states clearly what is only implicitly expressed in theoretical LFG:[8] The different modules, placed between FORM and MEANING, assume a certain directionality, generally termed as 'comprehension' (parsing) and 'production' (generation) in the wider literature. This is seemingly in conflict with

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[8] For example, in Figure 2 by means of arrows, and more explicitly in the pipeline architectures of the numerous computational LFG grammar implementations (see Forst & King 2023 [this volume]).

the assumption that the different modules exist in ‘parallel’ in LFG (Dalrymple et al. 2019: 265); however, as Jackendoff explicitly remarks, this is not necessarily a hindrance:

> P[arallel] A[rchitecture] is nondirectional, but its constraints can be implemented in any order suited to particular processing tasks. (Jackendoff 2009: 589)

‘Parallel’ under this approach refers to the general understanding that each module is subject to its own principles and constraints (= modularity). It does not mean that each component builds a completely isolated structure which then has to be aligned to the output of other modules. Instead, the individual constraints should be adjusted to the processing task at hand (which is either from FORM to MEANING (comprehension/parsing) or from MEANING to FORM (production/generation)).

While this distinction might not carry much weight if a linguistic analysis is provided within one module of grammar (e.g., a syntactic phenomenon), it is crucial when modelling constraints at an interface, as the involvement of two (or more) modules always involves a ‘direction’. The assumptions made by Selkirk above, for example, are made from the perspective of production, while the architecture proposed by Kaplan in Figure 2 (and in general the vast majority of LFG-related linguistic analyses) is made from the comprehension perspective. The acknowledgement of this bidirectionality as made explicit in Figure 3 is fundamental for the discussion of any interfaces between different modules, and thus essential for the proposals on the integration of prosody and its interfaces into LFG.

Models which follow the parallel approach to prosody and its interfaces as detailed in Section 2.2 by assuming that modules are built up independently of each other and that their output is matched for the best alignment at each interface might seemingly be in line with the concept of modules existing in parallel. However, such models are not built to reflect the processing of a given speech signal to understand its meaning (→ comprehension), or the production of a signal expressing a specific thought (→ production).

4 LFG approaches to prosody and its interfaces

With respect to prosody and its interfaces, both the indirect reference and the parallel approach have been explored within the LFG community, mostly with a directional perspective. As these proposals frequently influence each other and furthermore represent very different views of grammar, the following section provides a chronological overview of the different approaches with a specific focus on the architectural assumptions behind each proposal.

4.1 From c-structure to p-structure: Butt & King (1998)

Butt & King (1998) were the first to introduce a discussion of the syntax-prosody interface and p-structure to LFG. They assumed a mutually constraining model where d(iscourse)- and p-structure are projected off c-structure (in parallel to f-structure), as shown in Figure 4.

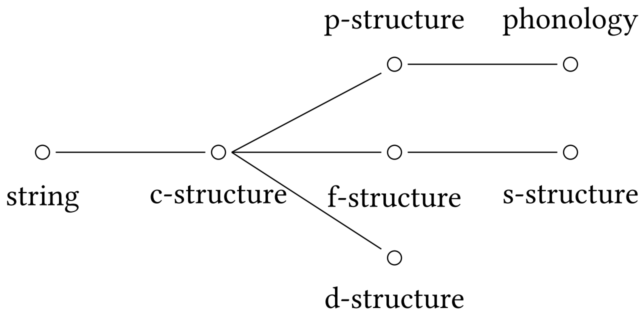

Figure 4: Grammar architecture according to Butt & King (1998: modified)

Under this approach, c-structure is a pivot point between d- and p-structure.[9] P(rosdic)-structure is viewed as an intermediate between c-structure and the phonological component itself which also contains postlexical phonological rules.

Based on work by Hayes & Lahiri (1991), Butt and King focus on syntactically ambiguous sentences in Bengali, such as example (5).

(5) ami bHut dekH-l-am
I ghost see-PST-1SG
a. 'I was startled' (idiomatic)
b. 'I saw a ghost.' (transitive)

Following findings discussed in Hayes and Lahiri, Butt and King assume that prosody can be applied to differentiate between the idiomatic and the transitive interpretation. For Bengali, the assumption for the syntactic-prosodic constituent mapping is that every clause is mapped to an Intonational Phrase (ι, IntP),

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[9] In contrast to this chapter which takes prosody to be part of phonology (see footnote 1), Butt and King differentiate between a p(rosodic)-structure and a phonological component.

every NP to a Phonological Phrase (φ, PhP), and every main V or complex predicate is phrased separately. Figure 5 shows the c-structures for (5) and the phrasing possibilities for *bHut dekHlam* which consist of separate phonological phrases in the transitive, and a single phonological phrase in the idiomatic reading.

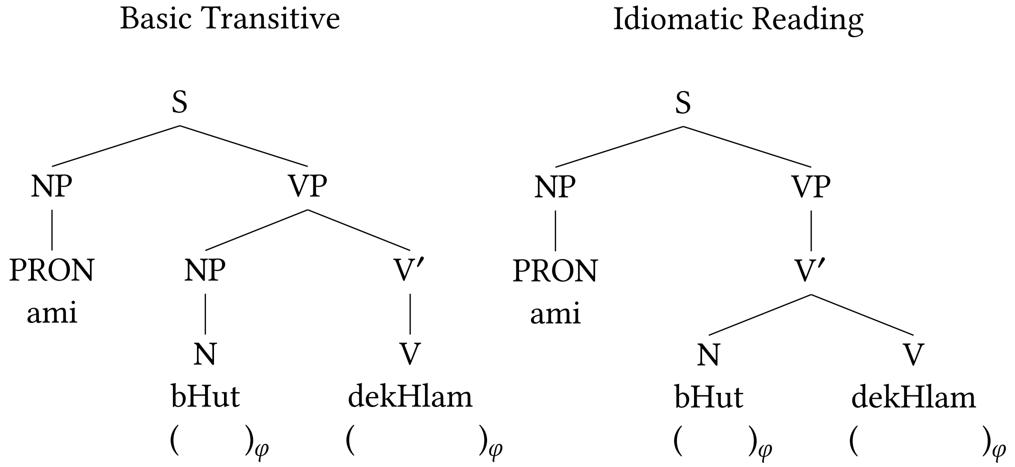

Figure 5: Two c-structure analyses for example (5), Butt and King (1998, modified)

Butt & King (1998) represent p-structure as an AVM structure based on the prosodic hierarchy as shown in (1) above. The AVM structure allows for the inclusion of more detailed information beyond the prosodic domain and the p(honological)-form, such as pitch accents or boundary tones. Butt and King also discuss the linearity issue given with any AVM approach. In order to apply phonological and phonetic processes, it is necessary to preserve the linear order of the string. For a possible solution to this issue, Butt and King point towards projection precedence (Zaenen & Kaplan 1995), which arranges the attributes in p-structure similarly to the string.

Figure 6 shows the prosodic structure of the idiomatic reading in (5), where *bHut* and *dekHlam* are phrased into one phonological phrase (DOM(AIN): P-PHRASE).

The AVM includes all the information in the tree structure and the additional information known about the tones in the language, for example, that in a neutral (non-phonological) focus construction, a high tone is associated with the left p-word in the rightmost p-phrase and the whole clause receives a low boundary tone. This information is stored in the AVM (TONE HIGH), but the final association of the hight tone with the correct p-form (and the correct syllable in this p-form) is left to the phonological component itself. The reason is that the final p-phrase can only be identified once prosodic phrasing is complete and that the placement

$$\left[\begin{array}{ll}
\textsc{dom} & \textsc{intonational-phrase}\\
 & \left\{\left[\begin{array}{ll}\textsc{dom} & \textsc{p-phrase}\\ & \left\{\left[\begin{array}{ll}\textsc{dom} & \textsc{p-word}\\ \textsc{p-form} & \text{ami}\end{array}\right]\right\}\end{array}\right]\right\}\\
 & \left\{\left[\begin{array}{ll}\textsc{dom} & \textsc{p-phrase}\\ & \left\{\begin{array}{l}\left[\begin{array}{ll}\textsc{dom} & \textsc{p-word}\\ \textsc{p-form} & \text{bHut}\end{array}\right]\\ \left[\begin{array}{ll}\textsc{dom} & \textsc{p-word}\\ \textsc{p-form} & \text{dekHlam}\end{array}\right]\end{array}\right\}\end{array}\right]\right\}\\
\textsc{tone} & \textsc{high}\\
\textsc{bnd-tone} & \textsc{low}
\end{array}\right]$$

Figure 6: Prosodic structure relating to the idiomatic reading in example (5), neutral focus

of the pitch accent on the correct syllable is solely depending on the phonological structure of the word itself.

Contrastive focus, on the other hand, is indicated by a low pitch accent and a high (intermediate) boundary tone at the level of the phonological phrase, as shown in Figure 7. As the target of the contrastive focus is determined by grammar (here d(iscourse)-structure), the associated pitch accent and boundary tone can be mapped to p-structure together with their domain.

$$\left[\begin{array}{ll}
\textsc{dom} & \textsc{intonational-phrase}\\
 & \left\{\left[\begin{array}{ll}\textsc{dom} & \textsc{p-phrase}\\ & \left\{\left[\begin{array}{ll}\textsc{dom} & \textsc{p-word}\\ \textsc{p-form} & \text{ami}\end{array}\right]\right\}\end{array}\right]\right\}\\
 & \left\{\left[\begin{array}{ll}\textsc{dom} & \textsc{p-phrase}\\ \textsc{tone} & \textsc{high}\\ & \left\{\begin{array}{l}\left[\begin{array}{ll}\textsc{dom} & \textsc{p-word}\\ \textsc{tone} & \textsc{low}\\ \textsc{p-form} & \text{bHut}\end{array}\right]\\ \left[\begin{array}{ll}\textsc{dom} & \textsc{p-word}\\ \textsc{p-form} & \text{dekHlam}\end{array}\right]\end{array}\right\}\end{array}\right]\right\}\\
\textsc{bnd-tone} & \textsc{low}
\end{array}\right]$$

Figure 7: Prosodic structure relating to the idiomatic reading in example (5), contrastive focus

Butt and King determine the tone distribution by using c-structure as a pivot between d-structure and p-structure, as shown in (6).[10]

(6) ($\downarrow_d$ FOCUS-TYPE) $=_c$ CONTRASTIVE
($\uparrow_p$ TONE) = HIGH → phrasal high
($\downarrow_p$ TONE) = LOW → local low

The approach proposed by Butt & King (1998) was later taken up in Bögel et al. (2008) in their analysis of Urdu *ezafe*. In the *ezafe* construction in (7), the *ezafe* clitic is syntactically grouped with the following modifying noun, but is prosodically attached to the previous head noun.

(7) sher=e panjAb
lion=Ez Punjab
'a/the lion of Punjab'

Syntactic Phrasing: [[sher] **[e** panjAb]]
Prosodic Phrasing: ((sher **e)** panjAb)

Example (7) shows a typical mismatch between syntactic and prosodic structure, which is difficult to account for if prosodic constituency is directly based on syntactic constituency. The solution proposed in Bögel et al. (2008) integrates the *ezafe* clitic (CL-FORM) into the phonological phrase using a number of bookkeeping features to make sure an *ezafe* clitic is present, as shown in Figure 8.

NPez′ ⟶ N: ($\uparrow_p$ DOM) = P-WORD
($\downarrow_p$ P-FORM) = sher
($\downarrow_p$ CL-FORM) = ezafe
($\uparrow$ CHECK EZAFE) $=_c$ +

ezafe: ($\uparrow$ CHECK EZAFE) = +

$$\left[\begin{array}{ll} \text{DOM} & \text{P-PHRASE} \\ & \left\{\left[\begin{array}{ll}\text{DOM} & \text{P-WORD}\\ & \left\{\left[\begin{array}{ll}\text{P-FORM} & \text{sher}\\ \text{CL-FORM} & \text{EZAFE}\end{array}\right]\right\}\end{array}\right]\right\} \\ & \left\{\left[\begin{array}{ll}\text{DOM} & \text{P-WORD}\\ & \left\{\left[\begin{array}{ll}\text{P-FORM} & \text{panjAb}\end{array}\right]\right\}\end{array}\right]\right\}\end{array}\right]$$

Figure 8: (Reduced) *ezafe* rule and the resulting p-structure in Bögel et al. (2008)

This approach is not entirely satisfactory. For one, in this approach it is actually the noun which is 'checking' for a following clitic, instead of the clitic 'asking' to be grouped with a preceding prosodic host. Furthermore, this approach does not allow for a language-specific expression of prosodic principles, e.g.,

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[10] For the interested reader: Focus in Bengali can also be signalled by the clitic *-o*. Following Lahiri & Fitzpatrick-Cole (1999), Butt and King assume a lexical high tone which is introduced onto the prosodic word with the clitic's lexical specifications.

the general integration of *en*clitics into the preceding prosodic domain, and of *pro*clitics into the following prosodic domain. Instead, individual specifications have to be created for each clitic. This is not only unintuitive, but also does not allow for any predictions to be made about prosodic structure in general.

Summing up, Butt and King make a first proposal to include prosodic information into LFG and show how this can interact with d- and c-structure. In contrast to Hayes & Lahiri's (1991) original approach (and in contrast to the claim made in Dalrymple et al. 2019), their model does not permit the direct reference of phonological restructuring rules to relations internal to syntactic structure (e.g., to 'right sister' or modifier-head-constructions), but provides an indirect, modular approach to the interface.

Butt and King distinguish between two structures: p-structure and the phonological component. P-structure only includes the information that is pre-determined by other modules of grammar, e.g., pitch patterns introduced by different sentence types and focus, and prosodic constituency based on syntactic constituency. This information serves as input to the phonological component (not further defined in their paper) and its inherent rules and constraints, which include prosodic restructuring, or the placement of pitch accents on the correct syllables within the right domains. This directional analysis from c-structure to p-structure to phonology reflects part of the production process in Figure 3. However, Butt and King's model (as shown in Figure 4) is generally not in line with the architectural assumptions made in Figure 2 and Figure 3 in that the string is not the representative of FORM: neither is the string equal to the phonological output nor is it closely associated with the phonological module. Without this connection, it is unclear how the string could be realised in terms of a (physical) speech signal.

4.2 Prosody and i-structure: O'Connor (2005)

In his thesis, O'Connor (2005) discusses the interface between prosody and information structure. O'Connor (2005) assumes a bidirectional approach, which distinguishes between a 'hearer-based' and a 'speaker-based' approach. He explicitly focusses only on the hearer-based direction (from p- to d-structure → comprehension) and leaves the speaker-based direction (from d- to p-structure → production) to further research.

O'Connor's approach is based on the AM/ToBI framework (see Section 2.1), but the description of accents is restricted to High and Low tones only.[11] He is

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[11] O'Connor does not distinguish between different types of pitch accents and how these may relate to specific i-structure categories, e.g., the distinction between broad and narrow focus based on different pitch patterns (a.o., Baumann et al. 2007).

mostly concerned with utterances where a difference in meaning is expressed solely by means of prosodic emphasis (expressed by capital letters in example (8)).

(8) a. He rode [a green DRAGON]$_{foc}$.
b. He rode a [GREEN]$_{foc}$ dragon.

The two propositions have a different information structure. Example (8a) can be the answer for a question with a broad focus (e.g., *Did he ride a green dragon or a thestral?*), while example (8b) is more likely to be the (contrastive) answer to a question like *Did he ride a green dragon or a blue dragon?*

In his proposal, O'Connor assigns a central role to i-structure. As the AM/ToBI system is not concerned with the influence of syntactic structure on prosody, O'Connor assumes that prosody and i-structure can be related to each other without syntactic mediation, as shown in Figure 9.[12]

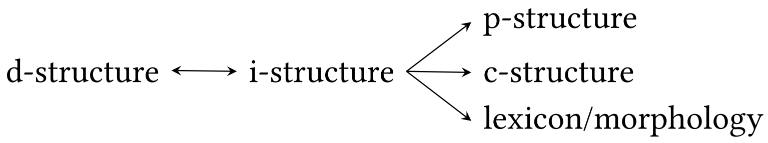

Figure 9: Architecture proposed in O'Connor (2005: Fig 6.3, 142, modified)

Following the general idea behind autosegmental approaches (Goldsmith 1976), O'Connor pursues the idea of a representation of tonal information independent from the segmental/phonemic representation. He proposes that p-structure should be represented by a hierarchical constituent structure (thus paralleling c-structure). Via so-called 'tune structure rules' like the ones in (9), a tree-like structure is created to represent intonation where the terminal nodes correspond to underspecified tonal events: t^* represents a pitch accent, t^- a phrase accent, and t% a boundary tone.

(9) $n \geq 1$
a. $\textsc{Tune}_{IP} \rightarrow \text{tune}_{ip}^{n}\ \ t\%$
b. $\text{tune}_{ip} \rightarrow t^{*n}\ \ t^{-}$

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[12] O'Connor does not completely exclude the influence of c-structure on prosody, but only acknowledges a relevance of the linear and hierarchical syntactic structure of the clause for the length of the transition between tonal events and the alignment of the pitch in general.

As a result, each prosodic tree constructed on the basis of these rules has four obligatory nodes: the prosodic ‘intermediate phrase’ (tune$_{ip}$) consists of a nuclear accent t^* and a phrase accent t^- while the prosodic ‘intonational phrase’ (TUNE$_{IP}$) consists of at least one intermediate phrase and a boundary accent t%. For example (5) (see also Figure 5, basic transitive) from Butt & King (1998), O’Connor proposes the p-structure in Figure 10.

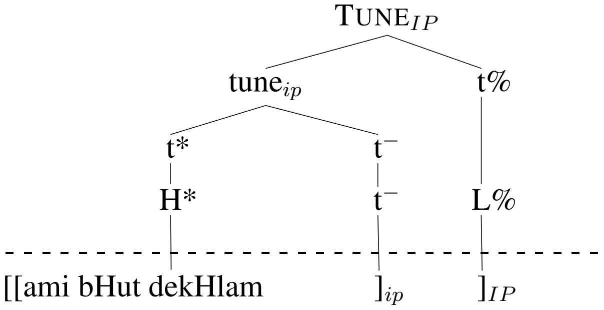

Figure 10: O’Connor’s p-structure as applied to example (5) from Butt & King (1998)

The tree representation is mainly concerned with the organisation of tonal events; the material below the dashed line includes the orthographic tier and the prosodic domain information in the form of bracketing.[13]

O’Connor emphasises the point that under his approach, the association of the High tone is not left to a further phonological component as proposed in Butt & King (1998) and discussed above in Section 4.1. It is however not quite clear how the High tone is associated with the correct string sequence in O’Connor’s approach, as no formal alignment of string and pitch (i.e., c-structure and p-structure) is established in his thesis. Indeed, in the data provided by Butt and King, the High tone should be assigned to the ‘leftmost’ prosodic word in the ‘rightmost’ phonological phrase. As O’Connor collapses all three phonological phrases proposed by Butt and King under one tune$_{ip}$, it is not clear how the association of the High tone with the correct word can be ensured.

With respect to i-structure, O’Connor assumes that categories like FOCUS and TOPIC are organised linearly in an utterance, and assigns each to one tune$_{ip}$, as shown in (10). If there are not enough tunes, then the assumption is that there is no topic correspondent.

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[13] As O’Connor’s (2005) main focus is on the relation between intonation and discourse functions, the encoding of further prosodic/phonological information, e.g., syllable structure, or lexical stress, is not further discussed in his thesis.

(10) $$\textsc{Tune}_{IP} \longrightarrow \begin{array}{c} \text{tune}_{ip} \\ \downarrow \in \{\uparrow_d \textsc{topic}\} \end{array} \quad \begin{array}{c} \text{tune}_{ip} \\ \downarrow \in \{\uparrow_d \textsc{focus}\} \end{array} \quad \text{t\%}$$

As O'Connor notes, there are a number of cases where the proposed association of i-structure categories and tunes does not work. Sentences like *'It broke.'* will only have one tune, indicating a FOCUS. However, in i-structural terms, *It* is a TOPIC. This mismatch between tunes and i-structure roles is discussed (O'Connor 2005: 161), but not resolved.

In conclusion, O'Connor's indirect, directional approach to the relationship between prosody and i-structure suggests an alternative to the syntactocentric view proposed in Butt & King (1998). However, there are a number of outstanding questions. Besides the incomplete association of i-structure categories to tune-structure rules just discussed, there is also the fundamentally important question as to how tonal events can be associated with their targets without reference to the morphosyntactic string, or how common phenomena, e.g., the (syntactic) scope of a prosodically expressed focus, can be determined without reference to syntactic constituency. The missing association of p-structure, string, and c-structure, and other unresolved questions thus only allow for an analysis of a more descriptive nature.

4.3 The string as an interface between c- and p-structure: Bögel et al. (2009, 2010)

Based on the realisation that the frequent misalignment of prosodic and syntactic constituents would seriously complicate previously established prosody-syntax mapping algorithms, Bögel et al. (2009) pick up on the notion of the parallel approach discussed in Section 2.2. The underlying assumption is that the prosodic component operates independently of syntax and that the two components are not related via LFG's projection architecture. To account for the cases where syntax is influenced by prosody, Bögel et al. (2009) assume a directional 'pipeline' architecture (from the comprehension perspective): First, an independent prosodic component interprets various phonological properties thus establishing the boundaries of prosodic units. This information on prosodic constituency is then made available to syntax by inserting prosodic bracketing features into the terminal string of c-structure.[14]

Bögel et al. (2009) discuss a number of different phenomena, among them Urdu *ezafe* (Bögel et al. 2008: see Section 4.1). They extend the c-structure rules by

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[14] Under this approach, the string has a central role as it includes information from both the syntactic and the prosodic component (similar to the understanding of the string in Asudeh 2009: 110 as a 'linear representation of phonology').

adding left and right prosodic brackets ('lexical categories' RB and LB) which reflect prosodic constituency.

(11) a. EzP ⟶ EZ RB N
b. NPez′ ⟶ LB [...] N

The inclusion of brackets greatly simplifies the rule originally used in Bögel et al. (2008: Figure 10) where a number of CHECK-features were applied to control for an *ezafe* clitic following the head noun. The resulting c-structure representation, shown in Figure 11, allows for the depiction of the misalignment between syntactic and prosodic structure.

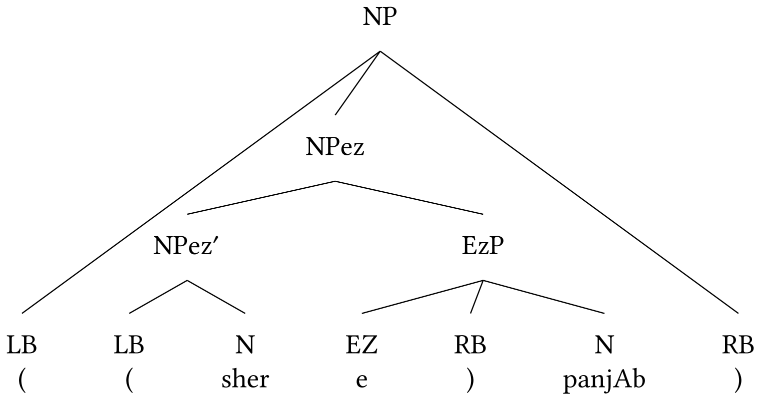

Figure 11: Urdu *ezafe* analysis as proposed in Bögel et al. (2009)

Another aspect discussed in Bögel et al. (2009) is the prosodic resolution of syntactically ambiguous structures. Consider the following example, where *old* can either modify only the first noun ((12a)) or scope over the whole coordination ((12b)). Each possibility is accompanied by a distinct prosodic grouping.

(12) a. [old men] and [women]
(old men) and (women)

b. [old [men and women]]
(old (men and women))

The paper postulates a 'Principle of Prosodic Preference', according to which the syntactic component disprefers syntactic structures whose constituent boundaries do not coincide with prosodic boundaries. For the implementation, Bögel et al. (2009) use a metarule, which systematically transforms the rules of the syntactic component. In the following metarule, CAT is a nonterminal category, and RHS denotes the regular language over categories which are annotated with co-describing constraints.

(13) CAT ⟶ RHS

In Bögel et al.'s metarule in (14), the top part of the rule will match a (recursive) sequence of CAT surrounded by prosodic brackets (LB and RB). The bottom part will match the RHS regular expression if all occurrences of LB or RB are ignored, thus preventing the inserted prosodic brackets from ruling out a valid syntactic analysis.[15]

(14) CAT → LB CAT RB
| RHS / [LB | RB]
Disprefer

The Principle of Prosodic Preference is enforced via the 'Disprefer' optimality mark,[16] which assigns a dispreference mark to the construction every time the bottom part of the metarule in (14) is applied. In the case of several possible syntactic analyses (as in (12)), this extension effectively ranks the analyses: The top half of the rule only applies if the prosodic brackets match the syntactic structure, while the syntactic analyses with no matching prosodic brackets will be parsed by the bottom half of the rule, but will receive a 'Disprefer' mark. This allows for constructions with matching prosodic and syntactic brackets to be preferred, while constructions with non-matching brackets will only be valid if a preferred solution (with matching brackets) is not available.

This first approach to the interface was extended in Bögel et al. (2010) which discusses second position (2P) clitics in Russian and Serbian/Croation/Bosnian (SCB). It is concerned with examples like (15), where a clitic cluster (CCL) disrupts the NP *Taj čovek*.

(15) [Taj *joj* *ga* *je* čovek] poklonio.
that her it AUX man presented
'That man presented her with it.' (Schütze 1994)

These clitics appear in the second position after a first prosodic word without regard to syntactic requirements ((16)).

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[15] The 'Ignore operator' / was first introduced in Kaplan & Kay (1994).

[16] See Forst & King 2023: section 1.5 [this volume] for a description of optimality marks and relevant references.

(16) (((Taj)$_{\omega}$ (*joj ga je*)$_{cl}$)$_{\omega}$ (čovek)$_{\omega}$)$_{\varphi}$ (poklonio)$_{\varphi}$
That her it AUX man presented
'That man presented her with it.'

Such a structure is problematic for traditional LFG accounts, because it is difficult to account for the clitics' appearance within an NP and to furthermore retrieve the clitics' functional contribution to the clausal f-structure. With a purely syntactic account, this information is locked into the NP's f-structure.

Bögel et al. (2010) resolve this issue by assuming a shared responsibility between the syntactic and the prosodic component: While the syntactic component ensures the availability of the functional information by placing the clitic in the (linear) first position, the prosodic component ensures the correct position of the clitics within the clause and places the clitics following the first prosodic word. This prosodic repair mechanism has been shown to apply crosslinguistically and was dubbed 'prosodic inversion' by Halpern (1995).[17]

In order for the clitic to appear in the correct syntactic position, Bögel et al. (2010) define the rule in (17), where RHS$_S$ denotes the possible expansion of the clausal S node with left and right brackets (as discussed above). LB$_S$ is a preterminal node that marks the left edge of a clause and allows syntactic/prosodic constraints to be aligned with respect to clause boundaries. CCL can optionally appear as a prefix to the S expansion; the ↑=↓ annotation ensures the processing of the clitics' clause-level functional information.

(17) $\mathrm{S} \longrightarrow \mathrm{LB}_S \quad \underset{\uparrow=\downarrow}{(\mathrm{CCL})} \quad \mathrm{RHS}_S$

To account for the prosodic placement, Bögel et al. (2010) distinguish between a prosodic and a syntactic (c-structure terminal) string which includes the lexical formatives discussed above. The interface between these (usually aligned) strings is a regular relation, where the syntactic string is the 'upper language' and the prosodic string is represented by the 'lower language'. In the simplified illustration in (18), the upper language/syntactic string clitic sequence (CS:0) immediately following the clause boundary ($(_S$ is placed after the first prosodic word ω in the prosodic string in the lower language/prosodic string (0:CS).

(18)

s(yntactic)-string ('upper'):	$(_S$	CS	ω	0
p(rosodic)-string ('lower'):	$(_S$	0	ω	CS

---

[17] For further work in LFG, see an account of prosodically determined second position clitics in Vafsi in Bögel et al. (2018).

The regular relation has the effect that strings with syntactically clause-initial clitic sequences are related to strings where those clusters appear on the other side of an adjacent prosodic word. The sentence-initial position allows for the functional information to be made available to syntax, but violates the prosodically dependent clitic's need for a preceding host. The second position in the prosodic string satisfies this prosodic constraint in that the clitic is placed following a valid prosodic host.

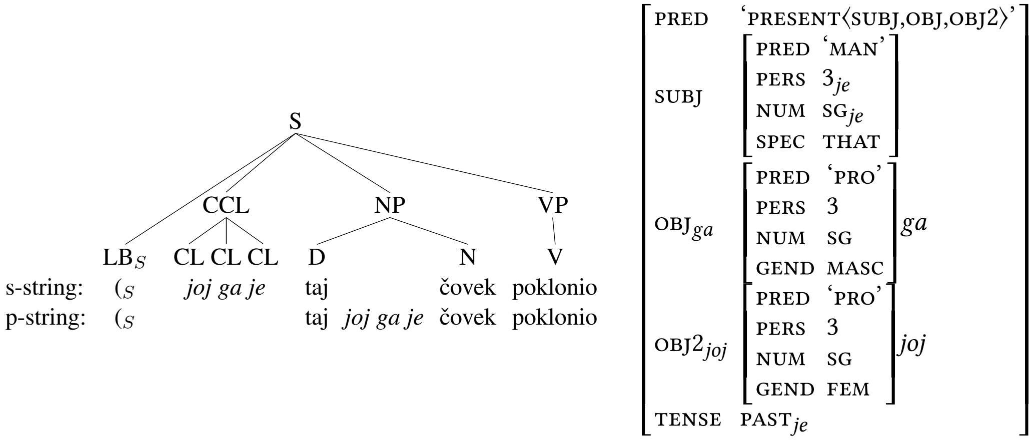

Figure 12: 2P clitics and the syntax-prosody interface (Bögel et al. 2010: 13)

In conclusion, Bögel et al. (2009) set up a directional architecture where they assume an independent prosodic component to process information related to prosody. Information on prosodic constituency is only entered into the terminal syntactic string in the form of lexical formatives, that is, the approach pursues a softer version of the parallel approach discussed above in Section 2.2. This allows for an account of general prosody-syntax misalignment, but also for a prosodic resolution of syntactically ambiguous structures. The approach was furthermore extended to account for second position clitics as well.

There are also several problems with this approach. For one, no further prosodic information can be transmitted via the string. However, information on pitch patterns, accent types or other prosodic features can be crucial for a correct interpretation of meaning.

Another factor is the relatively coarse-grained representation of prosody. Prosodic units can be relevant down to the syllable, a granularity that becomes difficult to represent by interspersing brackets with the terminal c-structure string. And finally, integrating the prosodic structures into the c-structure analysis makes the representation not only difficult to process, but is also questionable in terms of modularity.

4.4 A stricly parallel approach: Dalrymple & Mycock (2011), Mycock & Lowe (2013)

Dalrymple, Mycock, and Lowe base their approaches[18] on the assumption that the prosodic and the syntactic component are parallel but separate components, which goes beyond the distinction between direct and indirect approaches to prosody and its interfaces as briefly discussed in Section 2.2. In the parallel approach, syntactic structure has no influence on the formation of prosodic structure (and vice versa).[19] Instead, each structure is built up independently: syntactic structure as traditionally assumed, and prosodic structure based on rhythmic principles, more specifically, the trochaic foot. In constrast, the indirect reference approach assumes that rhythmic structure is only one factor among many which contribute to the formation of prosodic structure.

The approach represents prosodic constituency in a tree-like structure, assuming the constituents proposed by Selkirk (1995) (see Section 2.1). Similar to the proposal made in Bögel et al. (2010), the interface between the syntactic and prosodic components is the interface between a s(yntactic)-string and a p(honological)-string. The "linguistic signal" (Dalrymple et al. (2019: 407), the nature of which is not further defined) is parsed into minimal syntactic units in the s-string, and into minimal prosodic units (i.e., syllables) in the p-string. A (very simplified) representation of the example sentence *Anna was studying at the university* is shown in Figure 13 (see Figure 15 for a complete picture).

Figure 13 displays the syntactic component (s-string and c-structure) in the top part. The bottom part represents p-structure: the p-string and the prosodic tree. The p-string is parsed into syllables (but see below for further specifications) which are grouped into prosodic words. Following Lahiri & Plank (2010), prosodic structure is built based on rhythmic principles, specifically on the trochaic foot (see Section 2.2). The representation omits the foot structure, but the underlying formation algorithm is still visible in the fact that the left edge of each prosodic word is placed with the syllable carrying primary stress in a lexical, (syntactic) word; e.g., u.ni.(VER.si.ty)$_{\omega}$. Function words and feet built on secondary stress (e.g., (ˌu.ni)$_{ft}$) seem to generally be phrased with the preceding

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[18] The approach to the interface described in this section was developed in a number of works, namely Mycock (2006), Dalrymple & Mycock (2011), Mycock & Lowe (2013) (see also Lowe 2016 and Jones 2016 for further discussion); the version described here is part of the prosody chapter in Dalrymple et al. 2019.

[19] Dalrymple et al. (2019: 398) classify their approach as indirect reference. However, all indirect reference approaches include syntactic structure as a main factor for building up prosodic structure (mostly from the perspective of production). This is not the case here.

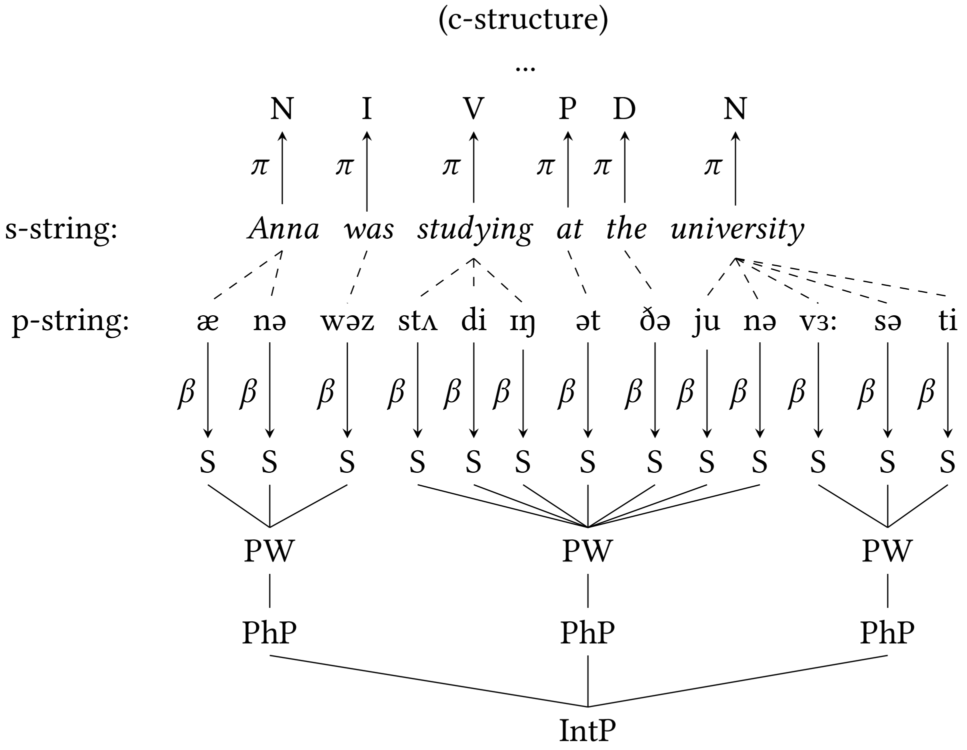

Figure 13: Simplified interface for *Anna was studying at the university* (Dalrymple et al. 2019: 408, showing only c-structure terminal nodes)

prosodic word.[20] The following example shows the prosodic phrasing according to a trochaic foot structure, with primarily stressed syllables in capital letters.

(19) (Anna was) (STUdying at the uni) (VERsity)

The formation of prosodic words based on rhythmic principles naturally leads to regular mismatches between syntactic and prosodic units. However, the approach raises the question whether these units are indeed prosodic words or whether they should rather be defined as phonological phrases. If these units are prosodic words, then the question arises how phonological phrases are defined under this approach. In Figure 13, each phonological phrase is identical with a prosodic word, which is a crosslinguistically very unusual 1-1 relationship.[21]

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[20] It would be interesting to see how this approach can be applied to cases where the first syllable of a prosodic unit is unstressed as in a modified version of example (19), *Anna or Ravi and Karla* ... (Anna ∨ (Ravi ∧ Karla)), where the prosodic boundary is realised directly after *Anna* (Wagner 2010), while the rhythmic approach would predict the prosodic boundary to occur after *or*.

[21] See, for example, the family of BinMin-constraints, which require for a higher prosodic domain to contain more than one unit of a lower prosodic domain (a.o., Ghini 1993, Inkelas & Zec 1995).

Mycock & Lowe (2013) extend the string interface by assuming that the string-units are not atomic but should rather be seen as feature bundles, represented as AVMs. The relation between the two strings and their units is regulated through information stored in the lexicon. While the lexical s(yntactic)-form contains the traditional morphosyntactic information, the p(honological)-form contains information on segments and syllable structure as well as the feature SYLLSTRESS which indicates the primary lexical stress position.

In addition to the lexical information, the feature structures at the interface also include information on the edges of constituents in the respective modules. These 'edge features' are necessary to allow for the matching of prosodic and syntactic constituents, e.g., in order to prosodically disambiguate syntactically ambiguous structures. Mycock and Lowe define a number of mechanisms to make the edges available to the strings: ⇙ and ⇘ for the left and right edges of syntactic nodes, and ↙ and ↘ for the left and right edges of prosodic nodes.[22] Figure 14 shows the AVMs for the first syntactic and the first prosodic unit of example (19), where the values of L(eft) and R(ight) consist of a set of syntactic and prosodic nodes whose edges are represented by this particular form.

$$
\begin{array}{cc}
\text{s-string unit } \textit{Anna} & \text{p-string unit } \textit{æ} \\
\begin{bmatrix} \textsc{fm} & \textsc{Anna} \\ \text{L} & \{\text{IP, NP, N}\} \\ \text{R} & \{\text{NP, N}\} \end{bmatrix}
&
\begin{bmatrix} \textsc{fm} & \text{æ} \\ \textsc{syllstress} & \text{P} \\ \text{L} & \{\text{I}\textsc{nt}\text{P, P}\textsc{h}\text{P, PW}\} \\ \text{R} & \{\} \end{bmatrix}
\end{array}
$$

Figure 14: Feature structure for first unit of the p-string and the s-string (Dalrymple et al. 2019: 412)

At the interface, a "Principle of Interface Harmony" ensures that the best-matching parses between the p-string and the s-string are preferred. Note, however, that the approach does not explain how this preference is implemented.[23]

Furthermore, the question of which syntactic and prosodic constituent edges should be matched, that is, which prosodic boundary type is important to syntax and vice versa, is left for future research (Dalrymple et al. 2019: 419). This is surprising, given the extensive existing literature on the topic, but in a sense it is a necessary consequence of assuming strictly parallel modules as has been discussed in Section 2.2.

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[22] See Dalrymple et al. (2019) for the exact definitions.

[23] Lowe (2016) presents a possible implementation of the Principle of Interface Harmony using additional formal power in form of OT contraints (see also Lowe & Belyaev 2015). A critical discussion of this approach can be found in Bögel (2015: Ch.6).

Apart from the interface to syntax, the string interface also serves as an interface between prosody and semantics and i-structure.[24] The semantics-prosody interface is demonstrated by means of declaratives, where the intonational contour distinguishes between declarative statements and questions. In order to make the semantic information available at the string interface, the c-structure receives a "label" PolarIntSem along with the meaning constructor [PolarInt]. Similar to the edge values, this label is handed down to the s-string where it is placed in the rightmost AVM.

For the prosodic interpretation of a declarative question, information on pitch is required. This information is included in the form of H and L pitch accents and boundary tones.

Dalrymple et al. (2019) assume that in English declarative questions, a nuclear L tone is associated with the stressed syllable of the first prosodic word in the last phonological phrase, and an H boundary tone at the right edge of the Intonational Phrase.[25] Similar to O'Connor (2005) above (Section 4.2), they annotate prosodic structure by means of prosodic phrase structure rules. In addition, a label *PolarInt* appears at the rightmost AVM of the p-string. The rule in (20) can then be read as follows: In this phonological phrase, assign a nuclear tone L to the leftmost syllable with primary stress ($\swarrow^{s}$) and a right boundary tone to the rightmost unit;[26] if these constraints are satisfied, create a label *PolarInt* which appears as a set member of the rightmost unit's right edge.

(20)
$$\begin{array}{llll} \text{IntP} & \longrightarrow & \text{PhP}^{*} & \text{PhP} \\ & & & ((\swarrow^{s}\ \textsc{n\_tone}) = \text{L}) \\ & & & (\searrow\ \textsc{rb\_tone}) = \text{H} \Rightarrow \\ & & & \textit{PolarInt} \in (\searrow\ \textsc{r}) \end{array}$$

Figure 15 shows part of the full analysis for example (19), the PP *at the university*. In addition to the edge features, both labels, PolarIntSem and *PolarInt* appear at the right edge of the string interface. The Principle of Interface Harmony requires both labels to co-occur for the overall structure to be grammatical, but the matching process is not further detailed here.

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[24] As the description of the interface to i-structure is similar to the one provided for the prosody-semantics interface, the interested reader is referred to Dalrymple et al. (2019) for details.

[25] The prosodic expression of declarative questions in English shows much more variability than assumed here, see, e.g., Gunlogson (2003) for discussion of different contours.

[26] The assignment of a right boundary tone here does not distinguish between 'boundary tones', e.g. H%, which appear as boundary tones of intonational phrases, and 'phrase accents', e.g., H⁻, which appear at the edges of phonological phrases. If both edges fall together, these tones form combinations, e.g. H-H%, which can be crucial for an interpretation. The use of a boundary tone with a phonological phrase unfortunately collapses this distinction.

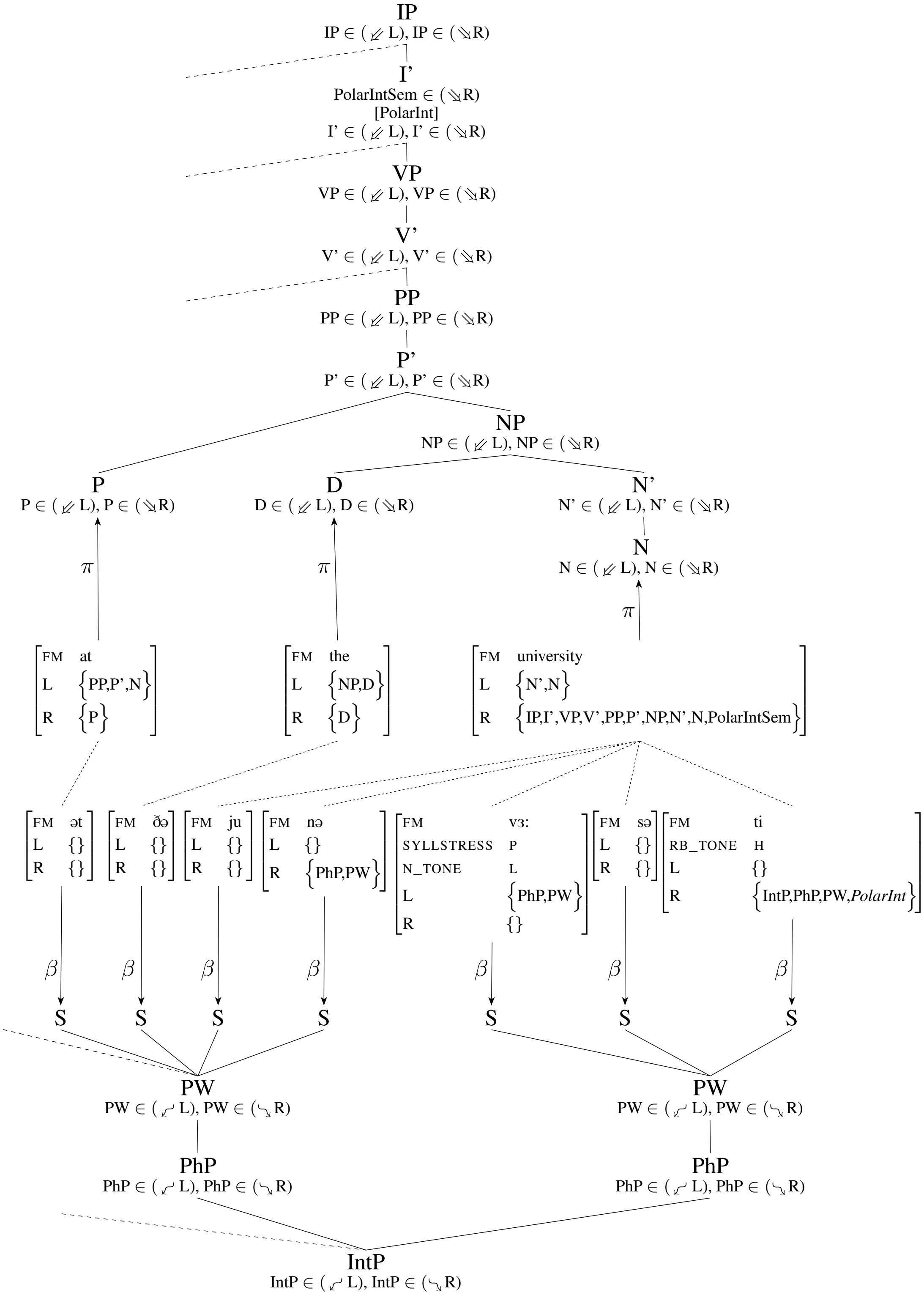

Figure 15: Analysis of the PP in the declarative question *Anna was studying at the university?*

In conclusion, the non-directional model proposed by Dalrymple et al. (2019) pursues the idea of modularity in the extreme: the syntactic and the prosodic component are taken to be completely independent structures which do not allow for any co-description mechanisms as commonly found in LFG (see Belyaev 2023a [this volume]). Instead, information about (at least) syntactic and prosodic constituency, semantics, i-structure, and intonational contours is handed to the respective strings. The interface between the syntactic and the prosodic component is then situated between the s-string and the p-string, where matching edges and 'labels' are preferred according to the Principle of Interface Harmony.

Apart from initial suggestions involving OT-constraints in Lowe (2016) and Lowe & Belyaev (2015), the formal implementation of the Principle of Interface Harmony is not further detailed. Given that there are numerous combinatorial possibilities of prosodic constituents, pitch accents, phrase accents, and boundary tones, and hardly any of them can be mapped to one particular interpretation, but are always co-dependent on other modules of the grammar, the matching of labels at the string interface will most likely prove to be difficult. The introduction of these labels and the mingling of information from different modules is, however, a necessary consequence of the parallel approach. The reduction of the interface to the strings implies that *all* potentially relevant information from other modules has to be duplicated and appear as part of the string where it might or might not be matched against the material in the parallel string. As it was the case in Bögel et al. (2009, 2010) (Section 4.3), this is also problematic with respect to modularity.

The extensive duplication and blending of structures can be avoided by assuming a more traditional co-descriptive approach, while at the same time acknowledging modularity in that each module only processes information related (i.e., 'native') to its module. This indirect reference approach was first pursued in Butt & King (1998), and was further developed in Bögel (2015) and subsequent work as discussed in the next section.

4.5 Production and comprehension: Bögel (2015)

Starting with her dissertation in 2015, Bögel developed a directional indirect reference model of the prosody-syntax interface that enables the integration of a speech signal into LFG and can account for a vast variety of phenomena from both perspectives, production and comprehension. In this approach, illustrated in Figure 16, the interface between c-structure and p-structure is regulated via two transfer processes, the 'transfer of vocabulary' (ρ), which exchanges phonological and morphosyntactic information of lexical elements via the multidimensional lexicon, and the 'transfer of structure' (♮), which exchanges information on syntactic and prosodic phrasing, and on intonation.

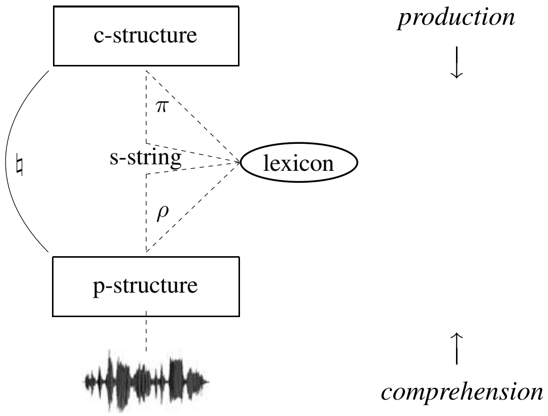

Figure 16: Abstract overview of the prosody-syntax interface (Bögel 2015)

The transfer of vocabulary requires a lexical entry to contain detailed information on (at least) the morphosyntactic as well as the phonological form (s-form and p-form, Dalrymple & Mycock 2011). Following Levelt et al. (1999), Bögel (2015) develops a multidimensional lexicon where the s-form encodes the traditional morphosyntactic information, and the p-form contains information on segments, the metrical frame and prosodic word status.[27] Figure 17 shows the (shortened) lexical entries for *čovek* ('man'), *taj* ('that'), and *joj* ('her') from example (15) (repeated in (21)) from SCB, where the clitic cluster (*joj ga je*) is placed in the prosodic second position, syntactically 'interrupting' the NP *taj čovek*.

(21) [Taj *joj* *ga je* čovek] poklonio.
that her it AUX man presented
'That man presented her with it.' (Schütze 1994)

The lexical p-form entries of *čovek* and *taj* are both marked as full prosodic words (ω). In contrast, the p-form of *joj* is marked as a prosodically deficient enclitic (=σ), that is, it is prosodically dependent on a preceding host. Following the concept of modularity, each dimension can only be accessed by the related module: c-structure can access the s-form and p-structure the p-form. However, during the transfer of vocabulary, the lexicon also assumes a 'transducer function' between s-form and p-form: If a particular dimension is accessed (e.g., s-form from

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[27] A third dimension, 'concept', which includes semantic information is assumed as well, but not discussed further here.

s(yntactic)-form				**p(honological)-form**	
čovek	N	(↑ PRED)	= ‘čovek’	P-FORM	[tʃovek]
		(↑ PERS)	= 3	SEGMENTS	/tʃ o ʋ e k/
		…		METR. FRAME	$(ˈ\sigma\sigma)_{\omega}$
taj	PRON	(↑ PRED)	= ‘pro’	P-FORM	[taj]
		(↑ PRON-TYPE)	= demon	SEGMENTS	/t a j/
		…		METR. FRAME	$(ˈ\sigma)_{\omega}$
joj	PRON	(↑ PRED)	= ‘pro’	P-FORM	[joj]
		(↑ PRON-TYPE)	= pers	SEGMENTS	/j o j/
		…		METR. FRAME	$=\sigma$

Figure 17: Lexical entries for SCB *čovek* ‘man’, *taj* ‘that’, and *joj* ‘her’

c-structure), the associated dimensions become available as well and the information stored in them is projected to their respective structures (e.g., p-form information becomes available to p-structure).

P-structure itself is represented by the p-diagram, a compact linear representation of the utterance. The p-diagram is structured syllablewise, where each syllable is part of a vector (V(ECTOR) INDEX) which associates the syllable with relevant segmental and suprasegmental phonological information.[28] During the transfer of vocabulary, the information stored with each lexical item’s p-form is stored in the p-diagram. Figure 18 illustrates this process for example (21).

PHRASING	$=\sigma$	$=\sigma$	$=\sigma$	$(\sigma)_{\omega}$	$(\sigma$	$\sigma)_{\omega}$	…
LEX.STRESS	–	–	–	prim	prim	–	…
SEGMENTS	/joj/	/ga/	/je/	/taj/	/tʃo/	/ʋek/	…
V. INDEX	S_1	S_2	S_3	S_4	S_5	S_6	…

Figure 18: The p-diagram with material from the transfer of vocabulary from example (21) (production)

The p-diagram’s content in Figure 18 is identical with the lexical p-form information in Figure 17: *tʃovek*, for example, consists of two syllables, each of which contains a number of segments. The first syllable has primary stress and the complete word forms a prosodic word. These attributes and their values are stored

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[28] The choice of the underlying prosodic or phonological unit and of the different attributes is up to the researcher.

for each syllable, thus creating a linear representation of the phonological string, with a vertical representation of the different values associated with each part of the phonological string.

In addition to the lexical information, p-structure receives information on syntactic constituency through the transfer of structure. This approach assumes match theory[29] (see Section 2.2), where each syntactic clause is mapped to an intonational phrase and each XP is mapped to a phonological phrase. The c-structure annotation in (22) models this approach to the mapping between syntactic and prosodic constituents for the clausal node S.

(22) S

$(\natural(T(*))\ \mathrm{S}_{min}\ \textsc{phrasing}) = {}_{\iota}($

$(\natural(T(*))\ \mathrm{S}_{max}\ \textsc{phrasing}) =)_{\iota}$

This annotation can be read as follows: Take all terminal nodes (T) of the current node (*, here S), for the attribute PHRASING assign a left IntP boundary (${}_{\iota}($) to the leftmost syllable (S_{min}) and a right IntP boundary to the rightmost syllable (S_{max}) in p-structure. The transfer of structure thus encodes information on larger prosodic domains in p-structure. Taken together, the transfer of vocabulary and the transfer of structure thus provide an initial input to p-structure based on lexical phonological information on the one hand, and on syntactic constituency in form of larger prosodic domains on the other hand (see Figure 19).

As discussed above in Section 4.3, the syntactic analysis of example (21) positions the clitic cluster in the sentence-initial position: *[joj ga je]*$_{CCL}$ *[taj čovek]*$_{NP}$ *[poklonio]*$_{VP}$. As information is accumulated, a prosodic constraint violation becomes apparent (which, in line with modularity, syntax neither recognized nor cared about): The clitics are placed in the initial position of the intonational phrase ι, where they cannot attach to a preceding prosodic host: ${}_{\iota}(=\sigma$. This issue is resolved by positing that p-structure is organised according to its own principles and constraints. One of these constraints is prosodic inversion (Halpern 1995), which allows for the clitics to be placed after the first valid prosodic host – in this case (/taj/)$_{\omega}$. As a consequence, the initial linear order of the phonological string as depicted in Figure 19 will be adjusted to satisfy the prosodic constraints. The result is the (final) p-string (taj)$_{\omega}$ =joj =ga =je (t͜ʃoʋek)$_{\omega}$ … which in turn forms the basis for the phonetic representation.

This approach to the interface allows for a clear separation of syntactic and prosodic analyses and can account for a number of other phenomena as well,

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[29] Which approach is chosen for the mapping between syntactic and prosodic constituency is up to the researcher. In this case, the end-based approach would not lead to a different outcome with respect to the clitic placement.

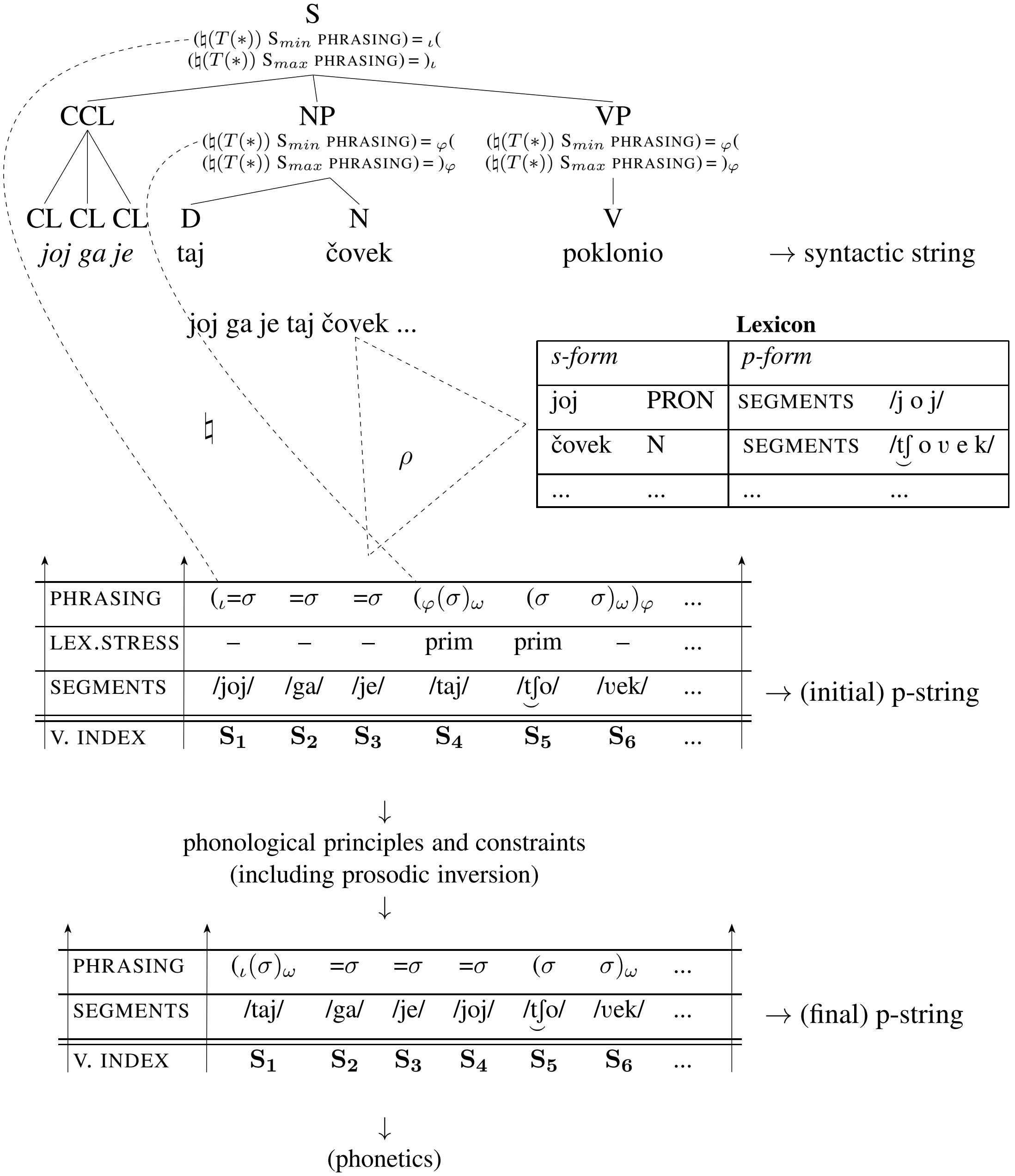


Figure 19: The syntax–prosody interface and the p-structure analysis for example (21)

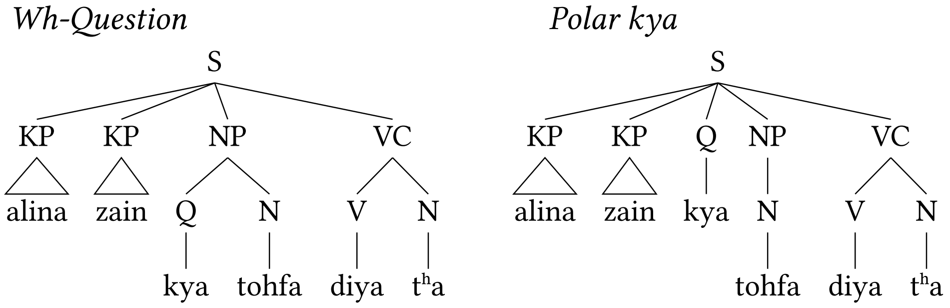
including notorious problems where the concept of lexical integrity (Bresnan & Mchombo 1995) is seemingly at stake. Such phenomena, among them Pashto endoclitics (Bögel 2015: Ch. 6) and Vafsi mesoclitics (Bögel et al. 2018), are difficult to explain from a purely syntactic perspective, but can be explained in a straightforward fashion with the proposal made here, as prosodic restructuring is based on prosodic constraints alone and is not concerned with syntactic constraints like word integrity.

The 2P clitic analysis just discussed was an example for production, i.e., the analysis first considers syntactic structure and then builds prosodic structure. The framework proposed in Bögel (2015) also allows for comprehension as is demonstrated in the following with an example from Butt et al. (2017, 2020) on Urdu polar *kya*. Consider example (23), where the sentence can be understood either as a polar question or as a wh-constituent question.

(23)	alina=ne	zain=ko	kya	tohfa	di-ya	t^h-a?
	Alina=Erg	Zain=Acc	what	present.M.Sg	give-Perf.M.Sg	be.Past-M.Sg

Constituent Question: ‘What gift did Alina give to Zain?’
Polar Question: ‘Did Alina give a gift to Zain?’

This ambiguity corresponds to two different possible syntactic analyses, as shown in Figure 20. In the wh-constituent interpretation, *kya* is phrased together with the following noun *tohfa*. In contrast, in the polar interpretation, *kya* is analyzed as an immediate daughter of S.


Wh-Question

Polar kya

Figure 20: C-structures for the *wh*-reading and for *polar kya*

Prosody is essential to the disambiguation of this structure: *kya* carries an H* accent if it is part of a constituent question while it has a flat pitch in the polar interpretation. In order for the grammar to make use of this disambiguation possibility, the information on pitch accents thus has to be available at the interface to p-structure.

The categorical interpretation of pitch accents is dependent on a number of attributes in a given speech signal; for a H* pitch accent, there needs to be a sudden rise followed by a relatively abrupt drop in the fundamental frequency F_0. The p-diagram in Figure 21 allows for the integration of this (and additional) speech signal information on the 'signal' level (here: medium F_0 and duration for each syllable) with a categorical interpretation of the relevant acoustic cues given on the 'interpretation' level in form of a ToBI annotation: H*.[30]

Phras.	$(_\iota$	...	...	...	...	...	...	...	...	...	...	$)_\iota$	interpret.
ToBI	...	...	...	...	...	...	**H***	...	...	...	...	L%	↓
Dur.	0,08	0,16	0,14	0,17	0,28	0,23	0,21	0,20	0,16	0,13	0,11	0,22	signal
F_0	164	211	239	243	228	229	**247**	229	162	147	136	(83)	↓
Value	[ə]	[li]	[na]	[ne]	[zæn]	[ko]	**[kja]**	[t̪oh]	[fa]	[d̪i]	[ja]	[tʰa]	
Index	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	

Figure 21: P-diagram for the speech signal corresponding to the constituent question in (23)

This effectively provides for an interface between phonetics (i.e., a concrete speech signal) and phonology/prosody and allows for the integration of information given in a speech signal into an LFG grammar. The relevant information on the H* accent again becomes available at the interface to c-structure via the transfer of structure and the transfer of vocabulary.

As shown in Figure 22, the transfer of vocabulary identifies the correct p-forms in the multidimensional lexicon and makes the associated s-forms available to c-structure. The transfer of structure then 'checks' whether the syllable associated with the c-structure node Q carries an H* accent – in which case the attribute-value pair [QUESTION-TYPE = constituent] is projected to f-structure. This approach also allows for the disambiguation of syntactically ambiguous structures where the boundary domains are the crucial indicators (Bögel 2020) and has also been applied to more complex pitch accent phenomena (Bögel & Raach 2020).

Summing up, the directional indirect reference approach proposed in Bögel (2015) allows for a differentiation of production and comprehension and has been

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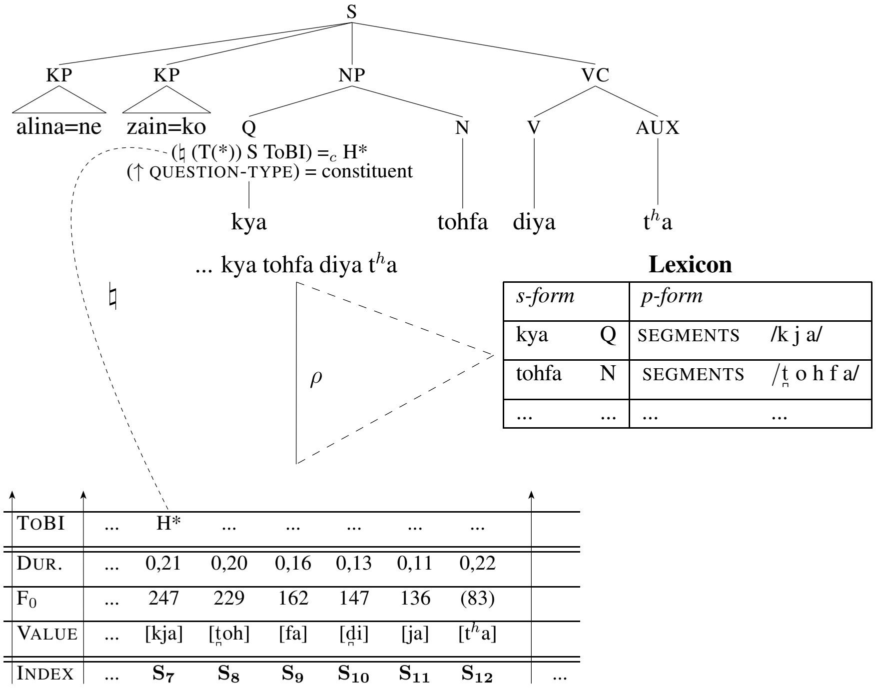
[30] The annotation on the interpretation level is greatly reduced on purpose. There is not yet a fully developed 'UrduToBI' or a clear conception of possible prosodic domains and how these are defined (but see Urooj et al. 2019 for discussion) – an interpretation in terms of the English/German annotation system might thus be misleading.



s-form		*p-form*	
kya	Q	SEGMENTS	/k j a/
tohfa	N	SEGMENTS	/t̪ o h f a/
...	...	...	...

TOBI	...	H*	...	...	...	...	...	
DUR.	...	0,21	0,20	0,16	0,13	0,11	0,22	
F_0	...	247	229	162	147	136	(83)	
VALUE	...	[kja]	[t̪oh]	[fa]	[d̪i]	[ja]	[t^ha]	
INDEX	...	**S_7**	**S_8**	**S_9**	**S_{10}**	**S_{11}**	**S_{12}**	...

Figure 22: *kya* as part of a constituent question (Butt et al. 2020)

applied to a large variety of different linguistic phenomena. It is the first approach in LFG which integrates spoken language in the form of concrete speech signal data and which pushes LFG towards a more psycholinguistic model of language as discussed in Section 3.

5 Conclusion

This chapter gave a chronological overview of the different approaches to prosody and its interfaces in LFG. As the different proposals show, work at this particular interface always requires a discussion of grammar architecture in general and of module interaction in particular. In general, two schools of thought can be distinguished in the LFG literature: the indirect reference approach and the parallel approach. The indirect reference approach assumes that p-structure is influenced by information from different modules, for example syntactic constituency. In addition, p-structure is assumed to be subject to its own principles and constraints, among them rhythmic principles, prosodic inversion, or constraints on the size of prosodic domains. The indirect reference approach was pursued in Butt & King (1998), O’Connor (2005), and Bögel (2015) and subsequent papers. While these proposals show differences with respect to the overall architecture, the interfaces between modules in all of these approaches are organised according to the traditional co-descriptive LFG annotations.

The second school of thought, the parallel approach, assumes that modules are built up in parallel. Under this view, each module is built on its own principles and constraints without 'input' from the other modules. P-structure is assumed to be formed on rhythmic principles, thus accounting for the mismatches found between prosodic and syntactic constituency. The interface between c- and p-structure is reduced to the interface between the syntactic and the phonological string, which are extended to include prosodic and syntactic/semantic information. The information present in both strings is then 'matched'. This approach is most prominently pursued in Dalrymple & Mycock (2011), Mycock & Lowe (2013), and subsequent work. Bögel et al. (2009, 2010) also fall into this second group. However, the exact nature of p-structure is never defined under this approach and it is thus harder to demarcate.

A second main point of this chapter was that the majority of the proposals presented here assume a certain directionality, which is also in line with psycholinguistic and computational approaches (Forst & King 2023 [this volume]): 'production' in the case of Butt & King (1998), 'comprehension' in Bögel et al. (2009, 2010), O'Connor (2005), and an open discussion of both in Bögel (2015). This distinction is not evident in the proposals by Dalrymple & Mycock (2011) and Mycock & Lowe (2013), which represent a perspective where each module builds structure independently of the other modules. The discrepancy between these views of the grammar architecture and of the analysis of language in general has, to my knowledge, not yet been openly debated. This chapter hopefully contributes to a more general discussion of grammar architectures in that it aims to show in a very concrete way what each school of thought pursues and how these ideas can be realised.

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Chapter 18

Information structure

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The first section of this chapter gives an overview of the conceptual discussions in information structure (IS), and the second section describes the LFG work in the area. The third section intends to be an exhaustive overview of the LFG work on IS.

1 Introduction

In LFG, attention to information structure has led to many interesting language-specific studies but, contrary to the situation in, for instance, syntax, there is no generally accepted view of either the distinctions needed or the terminology to be adopted. Given this situation, we start with a general, non-LFG-specific overview of conceptual discussions in IS (Section 2). The hope is that this will alert the reader to check which notion of say, topic, focus or contrast, is used in the LFG contribution they happen to be reading. In Section 3, we describe the general lines of the LFG work, highlighting some of the concepts that are often appealed to and the major proposals that have been made about how IS should be integrated in the LFG architecture. Section 4 gives exhaustive thumbnails of the LFG work on IS. The overview in this chapter does not include historical studies. These will be covered in Booth & Butt 2023 [this volume].

2 What is Information Structure?

Information Structure looks at how a producer of an utterance presents linguistically encoded information to the audience. It studies the sentence-internal aspects of this organization, while Discourse Structure (DS) studies the overall organization of bigger units of a text. The term INFORMATION STRUCTURE (IS)

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was coined by Halliday (1967); Chafe (1976) introduced the term INFORMATION PACKAGING, which is also used by Vallduví (1992). Recently it has been generally accepted that it is desirable to keep DS and IS separate, but it is often not possible to describe IS without making some assumptions about DS: for instance, the notion of sentence topic and discourse topic are related and often not kept clearly separated. Both DS and IS are generally considered to be part of pragmatics and different from semantics, which is mainly concerned with INFORMATION CONTENT, while DS and IS are concerned with INFORMATION MANAGEMENT (cf. Krifka 2008). But, again, certain aspects of information content and information management are closely intertwined, e.g. scope phenomena, the notion of predication, and pronoun interpretation (see e.g. Reinhart 1981 and King & Zaenen 2004).

IS distinctions can be realized through *prosody*, *word order* and/or *morphology*. In this section we mainly discuss word order and morphology; for prosody, see Bögel 2023 [this volume].

IS entities can be talked about as being linguistic in nature, e.g. NPs, VPs, etc., or they can be thought of as psychological. In most cases the only thing we can access and study are the linguistic reflexes of psychological states. This leads to terminological confusion. For example, is a topic a textual entity in the sentence, or is it the entity/state of affairs which the producer of this utterance intends to talk about, the denotation? Reinhart's discussion, for instance, is very much in terms of linguistic entities: all the NPs in a sentence are possible topics, and new information will be added to the file card for the NP or a new file card will be created, in the sense of Heim (1982) or Kamp (1981).

In the discussion of topic, the ambiguity is often not too harmful. It leads to more confusion in the discussion of focus. Consider the sentence *John washed it* as an answer to *What happened to the car?* Here *John washed* is taken to be the focus, but in most syntactic theories this is not a constituent at any level, the exception being Steedman's Categorial Grammar framework (see e.g. Steedman 2000).

Lambrecht (1994) and Vallduví (1992) state explicitly that they see topic and focus as psychological, and that the linguistic entities should be termed TOPIC and FOCUS EXPRESSIONS. They appeal to a pragmatic notion of common ground[1]

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[1] The original notion comes from Stalnaker (1970), who defines it as the set of pragmatic presuppositions shared by interlocutors at the moment of the utterance of the sentence. For Stalnaker, a proposition is pragmatically presupposed when the participants in the discourse "take its truth for granted", and "assume that others involved in the context do the same". It is not totally clear that Lambrecht has the same idea. Lambrecht (1994: 44) states: "'To have knowledge of a proposition' is understood here in the sense of 'to have a mental picture of its denotatum', not in the sense of 'to know its truth'". See Dryer 1995 for an extensive discussion.

in which interlocutors' intentions play a role. This relates to the issue of how IS fits into a full-fledged formal representation of text, which is often left rather vague. The most common metaphor is that the IS gives instructions to update file cards. For Lambrecht (1994), the pragmatic presupposition and assertion are sets of propositions, and topic and focus structure is defined in relation to them. How all this is ultimately represented in the human mind is definitely outside of the scope of this overview. For convenience, I will assume that interlocutors have a structured representation of the discourse they are engaged in, and I will refer to this as the DENOTATION of the linguistic entities that encode IS.

IS, viewed as part of pragmatics, assumes that information transmission relies on the interlocutors having a common ground from which the interaction proceeds, with the producer of the utterance introducing information not yet known by the audience. The interlocutors are in a particular information state that they intend to change through the interaction. An utterance, then, can be divided into two parts, one that links it to what precedes and one that introduces new information. Under this bipartite subdivision, the TOPIC, THEME or BACKGROUND is the part that relates it to the preceding discourse and the COMMENT, RHEME or FOCUS advances the discourse by providing new information. Even ignoring the notion of DISCOURSE TOPIC and the existence of ALL FOCUS utterances, both sets of notions are unclear and defined differently by different authors. A useful way to get a grip on the main distinctions is to start from Dahl's (1974) observation (see also Jacobs 1984) that, assuming a context in which what John drinks is at issue, a sentence such as *John drinks beer* can simultaneously be analyzed as having *John* as its topic and *drinks beer* as the comment or *John drinks* as the background and *beer* as the (narrow) focus. The sentence is about *John* (the topic), so the rest is comment, but the new information, the focus, is *beer*, as we already know that John drank something. Researchers interested in focus often see the main division as BACKGROUND-FOCUS, whereas those interested in topic see it more often as TOPIC-COMMENT. The two views are combined in the tripartite proposal of Vallduví, who proposes LINK-FOCUS-TAIL, where LINK and TAIL together form the GROUND.

Apart from these discrete views, there are views that see information structure as gradient. For instance, the Prague school (e.g. Firbas 1975) describes topics as the material lowest in "communicative dynamism", where the latter is determined by three parameters: linear order, semantic considerations (e.g. the type of the verb), and the degree of context dependency. These views are not often referred to in the LFG literature, but some researchers have proposed hierarchical analyses with respect to the notions of activation/salience (see Andréasson 2009 and O'Connor 2006) or topic-worthiness (Dalrymple & Nikolaeva 2011)

Other authors have proposed to further analyze notions such as topic and focus as feature bundles, as we will discuss in Section 3.1. This allows for more fine-grained distinctions.

There is no accepted view of IS in LFG, but the views that have had the most influence are Lambrecht (1994), Vallduví (Vallduví 1992, Vallduví & Vilkuna 1998, Vallduví & Engdahl 1996), and Reinhart (1981). Only a few LFG proposals address the conceptual issues wholesale.

In what follows I will review some IS notions in more detail and then discuss the LFG work in the area.

2.1 Notions of topic

One of the most influential proposals is that of ABOUTNESS TOPIC, so named by Reinhart (1981), but the idea goes back at least as far as Kuno's early work, later published as Kuno (1987) (see also Dahl 1974). The link to the previous discourse that is assumed here is rather broad: the referent of a topic is presupposed to exist (based on Strawson 1964). Reinhart, following Kuno, uses locutions such as *X says about Y*, *Speaking of X*, *As for X* as tests to distinguish the topic from other NPs in the sentence. It is recognized that these tests do not work very well. *Speaking of X*, for instance, is an expression notoriously used to change the topic, so it cannot be used as a diagnostic for continuing topics.

Reinhart uses the file card metaphor (cf. Heim 1982) to explain what a topic does: it indicates where the hearer should store the information contained in the sentence. The proposal does not distinguish between continuing topics and switch topics (see below) and makes the explicit assumption that every sentence has only one topic. For instance, for the sentence *All crows are black*, the information provided is classified under crows and understood as an assertion about the set of all crows. (So, the natural way to assess it will be to check the members of the set of crows and see if any of them are not black, rather than checking the non-black things to see if any of them are a crow.) This view seems to be based on an overly literal conception of a file card. With a discourse fragment like *What about John and Mary? They got married but he doesn't love her* (adapted from Lambrecht 1994), it seems difficult to claim that this information is stored only under *John* rather than (also) under *Mary*.

The one-topic idea is explicitly rejected by Lambrecht (1994), who sees Reinhart's (1981) distinction between topics and non-topic definites as a difference in salience. This view has led to the proposal to distinguish between primary and secondary topics (see below). Lambrecht also rejects Reinhart's semantic notion of presupposition. For Reinhart, following Strawson (1964), topics are presupposed to exist. Lambrecht's notion of presupposition is pragmatic and does not require this. For him, the most important pragmatic articulation of a structured meaning is that between PRAGMATIC PRESUPPOSITION and PRAGMATIC ASSERTION (comment), where the pragmatic presupposition is assumed by the speaker to be equally assumed by the hearer and the pragmatic assertion is what the hearer is expected to assume after having heard the sentence. For Lambrecht, the negative quantifier *nobody* can be a topic. Most authors, however, confine the notion of topic to referents that can be expressed by definites or specific indefinites. However, not everybody agrees with this: see e.g. Endriss (2009) and Gécseg & Kiefer (2009).

Vallduví's (1992) notion of LINK is close to that of topic, but it is explicitly restricted to elements in first position. He sees this first position[2] in terms of a requirement for such elements to act as address pointer, instructing the hearer to go to an address or card in the sense of Heim (1982). When the elements in the sentence do not require a pointer to a new address, they are not LINKS (topics) but TAILS. Tails correspond more or less to what others have called SECONDARY or CONTINUING TOPICS. Vallduví's notion of link is restricted to what have been called SWITCH TOPICS: topics that are different from the topic of the previous sentence.[3]

As this short discussion shows, it is useful to distinguish topics depending on properties of the element in the previous discourse with which they are in an anaphoric relation. (The discussion tends to be restricted to consideration of elements in the previous sentence.) The antecedent can be a topic, in which case we have a CONTINUING TOPIC; or it can be a focus, in which case we have a SWITCH TOPIC (corresponding to Vallduví's LINK). It has been claimed that some constructions explicitly signal switch topics.[4] The notion of CONTINUING TOPIC comes close to that of DISCOURSE TOPIC. The two might be distinguished in the sense that a continuing topic has to be the topic of the immediately preceding discourse unit (e.g. sentence), whereas the discourse (or FAMILIAR) topic can be broader, but not all authors make that distinction. Some authors reserve the term ABOUTNESS TOPIC for SWITCH TOPIC and hence distinguish them from CONTINUING TOPICS (see e.g. Frascarelli & Hinterhölzl 2007, who show that in Italian and

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[2] He allows for two topics under the condition that they precede all other elements in the sentence.

[3] The discussion in section 5.1.1 of Vallduví & Engdahl (1996) shows that the alignment between switch topic and first position cannot be right for all languages. It also shows that restricting the notion of topic to switch topic is awkward, as Swedish examples show this is also a position of continuing topics.

[4] For example, first position elements in Catalan as analyzed in Vallduví (1992).

German these have a different linguistic realization). CONTINUING TOPICS are often not overtly expressed (e.g. in so-called pro-drop languages). Some authors consider these sentences as topicless, while others assume the understood topic to be part of the IS of the sentence.

A further distinction is invoked with the term CONTRASTIVE TOPIC. Contrast is most often invoked with respect to foci, and the concept will be discussed further in Section 2.2.1. Here we point out that topic expressions can contain elements that are new as well as old. For example, in the short discourse *What about cars? Which ones do you like? – Fast cars I like*, *cars* is topical, but *fast* is new information. Contrastive topics are seen as implying that a set of alternatives is active in the speaker's mind. They can be linked to the notion of D-LINKING (Pesetsky 2007). D-linked elements are defined (following Büring 2003) as related to the question under discussion (QUD). This, again, brings discourse topics into the discussion of sentence topics.

The types of topics mentioned above are typically expressed as NPs, but there is a kind of topic that is most often realized as a PP. It occurs in so-called "all focus" sentences such as *In California, there are often forest fires.* Here, the initial element restricts the range of the rest of the sentence. These elements were dubbed STAGE TOPICS by Erteschik-Shir (2007), but they have been discussed earlier, e.g. Gundel (1974). Erteschik-Shir claims there is a silent stage topic in all-focus sentences that do not have an overt topic. Some researchers seem to think the stage topic only occurs in sentences that have no other topic, but for others, stage topics can co-occur with ABOUTNESS topics. Bentley & Cruschina (2018) discuss the specific lexical-semantic restrictions on all-focus constructions in Romance languages. LFG researchers have not worked on stage topics, but Szűcs (2017) discusses English adverbials that could be considered as, in part, falling in that class.

2.1.1 Accessibility hierarchies

Apart from the aboutness tests proposed by Reinhart, some proposals in IS appeal to notions, such as salience or topic-worthiness, that distinguish among the entities that are assumed to be in the discourse participants' consciousness at the moment a new utterance is produced or heard. Following Chafe (1987), who introduced the idea, various hierarchies or, at least, classifications have been proposed (see e.g. Givón 1983, Ariel 1988, Lambrecht 1994, Erteschik-Shir 2007). Within LFG the ones that are referred to are Prince's (1981) notions of DISCOURSE OLD/NEW and HEARER OLD/NEW, EVOKED, and INFERRABLE (see also Ward & Birner 2001) and Gundel's GIVENNESS HIERARCHY (e.g. Gundel et al. 1993).

Prince's categories are about entities. If they have been mentioned in the discourse, they are discourse old; if not, they are discourse new (or inferrable). Referents may also be old/new with respect to (the speaker's beliefs about) the hearer's beliefs. In feature decomposition approaches in LFG, following Choi (1996), the +NEW feature corresponds to Prince's notion of discourse new. Lambrecht (1994) proposes a connection between Prince's notions and topics (his Topic Accessibility Scale) but notes that inherent semantic factors such as animacy may also play a role.

The GIVENNESS HIERARCHY of Gundel et al. (1993) proposes six ordered cognitive statuses: in focus > activated > familiar > uniquely identifiable > referential > type identifiable. These statuses determine the form of referring expressions and are assumed to correspond to the status of the referent in the memory of the discourse participants. For instance, for English:

- TYPE IDENTIFIABLE: necessary for the appropriate use of any nominal expression
- REFERENTIAL: speaker refers to a particular object, hearer needs to know the referent; necessary for appropriate use of definite expressions
- UNIQUELY IDENTIFIABLE: necessary for the appropriate use of *the*
- FAMILIAR: necessary for the uses of personal and definite demonstrative pronouns
- ACTIVATED: necessary for all pronominal forms and sufficient for demonstrative *that* and stressed personal pronouns
- IN FOCUS: necessary for the use of zero and unstressed pronouns.

Especially the last two items on the scale have been used to argue for differences in status between elements which are not treated equally: cognitive accessibility relates to how prominent the entity is in memory. This does not in itself determine whether it will be a topic or a focus. The accessible elements are all topic-worthy, but depending on their place on the scale, they will require different linguistic expression.

2.1.2 Other hierarchies

The topic-worthiness of a discourse element has also been claimed to be influenced by the prominence features that play a role in the REFERENTIAL HIERARCHY (Silverstein 1976, Dixon 1994), such as person, definiteness, and animacy. This hierarchy has played a more important role in studies about the alignment of grammatical functions but, as Simpson (2012) (following Bickel 2012) observes, a hierarchy with pronouns on one end and full NPs on the other is bound to have something to do with IS.

In recent literature, it is generally accepted that topic-worthiness or accessibility are not enough to guarantee topichood, and that ABOUTNESS is the crucial factor. It is, however, not clear how aboutness can be detected. The decision to construct a sentence/utterance about a particular sentence topic seems to be a decision that the speaker/writer makes which is constrained, but not uniquely determined, by the previous discourse. In some languages this choice must always be clearly marked, while in others that is not the case and a specific marking may be absent or optional.

2.2 Focus and related notions

The focus is (or is part of) what is informationally new in a sentence, what is not assumed to be common ground between the hearer and the speaker at the moment that the sentence is uttered. A common proposal is that the focus can be found by considering what question the sentence could be an answer to. The focus is what replaces the wh-term in the question.[5] A typical set of question-answer pairs is the following:

(1) Q: What did Mary do?
A: She [washed the car].

(2) Q: What did Mary wash?
A: She washed [the car].

(3) Q. Who washed the car?
A: [Mary] washed the car.

(4) Q: What happened to the car?
A: [Mary washed] it.

(5) Q: What happened?
A: [Mary washed the car].

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[5] This test runs into problems when a particular language has a special marking for answers to questions that distinguishes these from other arguable foci. Another more general problem with the test is that full answers to wh-questions are often unnatural. Most of the topical information would be silent. These versions are, however, rather uninformative when the test is used to probe word order constraints.

(6) Q: What did Mary do with the car?
A: She [washed] it.

The focus of each answer is the material in square brackets. Lambrecht (1994) distinguished three notions of focus structure: PREDICATE FOCUS (1 and, presumably, 4 and 6), ARGUMENT FOCUS (2 and 3) and SENTENCE FOCUS (5)

The question-answer approach tends to tie the IS notion of focus to alternative sets as used in semantics, as the meaning of wh-questions can be considered as the set of possible answers (Hamblin 1973), or one can think of the alternative sets of Rooth's (1992) view on focus and focus particles. The problem with appealing to these semantic notions is that one can get bogged down by the issue of how explicit these alternatives have to be. It is clear that, in a certain sense, every assertion is made against the background of all other possible assertions that could have been made at that particular moment in the discourse, but that does not mean that one can list/define a set of alternatives (see below).

It is often claimed that different types of foci are distinguished by the degree to which the set of alternatives has been made explicit. In the examples discussed so far, the syntax is unremarkable and the stress pattern is what would be found in normal narrative text. The foci in these examples are called INFORMATION or COMPLETIVE or IDENTIFICATION FOCI. They are often expressed in what is thought of as 'neutral' or 'default' syntax. In some languages, specific constructions allow the speaker to signal whether she has a particular set of alternatives in mind, or even whether she wants to convey that only one option is possible. This has led to the distinction between the foci above and CONTRASTIVE and/or EXHAUSTIVE FOCI. Moreover, EXCLUSIVE foci can be distinguished from EXHAUSTIVE foci: exclusive foci exclude some alternatives, while EXHAUSTIVE foci exclude all alternatives. Some researchers have proposed additional subdivisions of focus. Dik et al. (2008) distinguish COMPLETIVE focus, which is NON-CONTRASTIVE, from all other CONTRASTIVE forms: PARALLEL, SELECTIVE and three types of corrective foci: EXPANDING, RESTRICTING, and REPLACING. Most of these subtypes can be seen as specifying relations between the set of alternatives and the focus.[6]

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[6] Not all researchers distinguish clearly between the FOCUS DOMAIN and FOCUS EXPONENT. For instance, in the English examples (1-6), focus is normally indicated with pitch accent. As discussed at least since Jackendoff (1972), the nuclear stress rule assigns stress to the final constituent of a focus, while the focus itself can be projected up any higher constituent, so the answers in (1), (2), and (5) get the same stress assignment but have different foci. Even when phenomena such as FOCUS PROJECTION are recognized, researchers tend to concentrate their attention on FOCUS MARKERS and are often not very clear on what constitutes the FOCUS DOMAIN. For some it is actually the markers that deserve the term focus. In this overview I assume that the conceptual category can be distinguished from its realizations.

In running text, it is not always clear what the question is. Consider example (7) (adapted from Vallduví & Engdahl 1996).

(7) a. Mary bought a book yesterday morning.
b. She read it in the afternoon.

Sentence (7b) can be seen as an answer to the question *What did she do then?* as well as an answer to the question *What did she do with the book?* In the first case, (the denotation of) the VP is focal. In the second case, both *she* and *it* are topics and the rest of the material is focal. Written material, especially reduced by a window of at most two sentences, is prone to being pragmatically ambiguous. By turning the text into a set of questions and answers, an interpretation is imposed which reduces the ambiguity. Looking at larger pieces of text might also help in figuring out what the right question is in a particular context, but that leads to discourse analysis as distinct from information structure.

2.2.1 Contrast

Although there are many subdivisions of focus, the main dividing line seems to be between non-contrastive and contrastive focus. Once this line has been drawn, however, one realizes that contrast is not only relevant for focus but also for topic. Take, for instance, an exchange like the following:

(8)
- Q. Which foreign languages do your children speak?
- A. Anna speaks English and Maria speaks German.

In languages such as English there will be CONTRASTIVE STRESS on *Anna* and *Maria* as well as on *English* and *German*. Some researchers see this as a reason to adopt contrast as an independent notion and propose to distinguish between ±CONTRASTIVE topics and foci.

Here, again, a confusing factor is that contrast can be used to refer to an abstract category or to a linguistic signal, e.g. a particular stress pattern. Contrastive focus, then, can mean that the focus has some special stress or pitch pattern (dubbed Kontrast by Vallduví & Vilkuna 1998) or it can mean that the focus element contrasts with other elements that could fill the same position in the sentences by being an alternative to these elements. When seen as the latter, the notion is as confusing as that of focus and, in fact, it is difficult to see a difference between the two.

The various notions of contrast are discussed in Repp (2016). She distinguishes:

(9) a. Restricted, contextually clearly identifiable set of alternatives: *John* would be marked for contrast in an example like *John, Pete and Josie all offered help. I asked John.* (É. Kiss 1998).
b. Alternatives must be in the sentence.
c. Substitution of alternatives must create a false statement (Neeleman & Vermeulen 2013).
d. Alternatives always contrast, simply by being different (alternative semantics) (Vallduví & Vilkuna 1998, also Krifka 2008).
e. Interlocutors' belief systems: unexpected, remarkable (Frey 2006).

These are, by and large, the notions of the set of alternatives which have been proposed in discussions of focus. At the limit, we find notions such as *unexpected, remarkable* that seem to depend on the speaker's frame of mind without being independently detectable. Moreover, as we have seen above, contrast is not limited to foci: it can also occur with topics. Some researchers have bit the bullet and taken contrast as the correct notion, e.g. Kruijff-Korbayová & Steedman (2003). Under that view, contrast within the topic indicates that part of the topic is actually focal (Krifka 2008, Erteschik-Shir 2007). Others, however, see contrast as an additional distinction, and much work in LFG takes that approach. This is a view that has been argued for explicitly by, for example, Neeleman & Vermeulen (2013), who distinguish between contrastive and non-contrastive topics as well as contrastive and non-contrastive foci. They illustrate their approach with word order data in Dutch, but claim that in other languages it can be detected through prosodic marking. As noted above, their notion of contrast relies on the generalization that in contrastive contexts, the substitution of alternatives leads to false statements.

2.2.2 Relational newness

For researchers who treat CONTRAST as a feature that can belong to both topics and foci, the question remains: what is the characteristic that distinguishes focus from topic? Choi (1996), among others, proposes that foci must be DISCOURSE NEW in the sense of Prince (1981). This view is, however, contested by e.g. Lambrecht (1994) and Gundel (1974), who draw attention to examples such as (10) (adapted from Lambrecht 1994):

(10) a. Last night Anne and Paul were bored.
b. They hesitated between going to the neighborhood restaurant or going to the new movie at the Rex.
c. Finally they went to the movie.

(The denotation of) *last night* in (10a) can be considered to be a stage topic and the rest of the material in that sentence is focal. In (10b) and (10c), the aboutness topic is (the denotation of) *they* (=Anne and Paul). (10b) and (10c) (as well as (10a)) establish new relations between these referents and the rest of the sentence. In (10c), *the movie* and even *going to the movie* are as much old information as *they*. What is new is the relation between the elements. The referents of the NPs have become part of the common ground between speaker and hearer before the sentence is uttered. They are not DISCOURSE NEW in Prince's sense or REFERENTIALLY NEW in Gundel's terminology. Rather, they are RELATIONALLY NEW in Gundel's terminology. Once it is determined that the topic is (the denotation of) *they*, the choice between the restaurant and the movie is the relevant relationally new information. Thus, (the denotation of) *the movie* is the element about which a new relation is asserted, marked as +NEW. It is the alternative that is chosen in opposition to all other possible choices.[7]

Note that under this view of newness, it is not immediately clear that (the denotation of) *they* is the topic: the relation between (the denotation of) *they* and (the denotation of) the rest of the sentence is also new. To determine the focus, it is necessary to know already what the topic is and what we are adding information about. Here we are assuming that (10a) leads to the question *What were they going to do about being bored?* and (10b) to *Where did they go?*

A sentence can establish new relations between several different entities. In (11b), the *give* relation holds between three participants.

(11) a. Mary was wondering what she would give little Hansi: the candy bar or the chocolate chip cookie.
b. She gave him the chocolate chip cookie.

Assuming that *Mary* is the topic, (11b) can be analyzed as the answer to *What did Mary do?*, in which case the denotation of the whole VP is the focus, or as the answer to *What did she give to him?*[8], in which case the denotation of *the chocolate chip cookie* is the focus. The second question presupposes that both speaker and hearer already assume that Mary has given Hansi something, so the relational new information is that it is a chocolate chip cookie. What is the status of *him* under that analysis? Here it seems useful to remember the terminological

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[7] Some authors, most clearly Lambrecht (1994), see the relation itself as new, and hence as the focus. Still others, e.g. Erteschik-Shir (2007), see the focus as a complex structure that can contain topical material.

[8] There are other possibilities which we ignore here. Our point is not an exhaustive analysis of this stretch of text.

ambiguity remarked upon in the introduction: is focus seen as a synonym of comment, or is it to be opposed to background? When one assumes an opposition to background, it is reasonable to consider *him* to be part of the background and, possibly, as a special part of the background: a secondary topic.

The comment can also consist of more than just the focus. Consider the question-answer pair in (12):

(12) a. Q: Where was Mary?
b. A: She was cooking potatoes in the kitchen.

Here *in the kitchen* is the answer to question (12a) and presumably the focus, but *cooking potatoes* is also new information. Presumably it is part of the COMMENT. It can be seen as supplementary or COMPLETIVE information.[9]

3 The LFG approach

For LFG, there are two main issues related to IS: (1) what are the relevant distinctions to be made, and how are they encoded? and (2) how does IS interact with the LFG architecture? We discuss these in turn.

3.1 Feature decomposition

In the previous section we have seen that the notions of topic and focus, although generally accepted, are felt to be insufficient to encode all relevant IS distinctions. With respect to topic, there seems to be a need to further distinguish between different levels of salience and/or topic-worthiness of the entities which are accessible to the discourse participants. With respect to focus, there seems to be a need to distinguish between explicitly contrastive and not explicitly contrastive elements. Moreover, it has been observed that some topical information assumes the existence of subsets among which a choice has to be made. This has led many researchers, including many LFG researchers, to use features, most often binary

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[9] What has been analyzed in the literature as focus marking is very heterogeneous. This has led some researchers, most prominently Matić & Wedgwood (2013), to question the assumption that the linguistic processes that are described in the literature as marking foci indeed have a uniform function. Hedberg (2006) already argues that several proposals about the relation between pitch accent and IS in English are not mutually compatible, nor are the proposals about *wa* in Japanese or those about *nun* in Korean. Matić & Wedgwood (2013) go further and try to show that many proposals invoking focus marking in various languages actually isolate markers whose functions are quite different and whose effect on the focus is only a byproduct of these functions.

features, to describe the IS behavior of linguistic entities and to define notions such as topic and focus. There is at this point no closed set of such features. Descriptive studies in this vein would provide a good basis for more theoretical investigations if the terminology was constant and explicit. Unfortunately, this is not the case. The same labels are used for different concepts and often no clear definition is given that allows the reader to figure out which meaning of an ambiguous term is intended. There are, however, some general tendencies: many researchers follow Choi (1996) and Butt & King (1996) and decompose the notions of topic and focus with two binary features.

In the light of the preceding discussion, one might expect that the notion of contrast would be represented in these dichotomies. This is, however, not the case in the proposals of Choi (1996) and Butt & King (1996).

Choi proposes the features ±NEW and ±PROM, for 'prominence', as shown in Table 1. Her notion of NEW is Prince's (1981) discourse new. Above, we saw that that notion is based on what is mentioned in the discourse and, hence, is problematic for certain analyses of focus. Choi's notion of PROM collapses the distinction between contrastive and completive focus and that between tail and link in Vallduví's sense. She does not discuss explicitly what such a collapsed notion would correspond to intuitively.

Table 1: Choi's features

Discourse function	Topic	Contr Focus	Tail	Compl/Pres Focus
PROM	+	+	−	−
NEW	−	+	−	+

Table 2: Butt and King's features

Discourse function	Topic	Focus	Background	Completive Info
PROM	+	+	−	−
NEW	−	+	−	+

Butt & King (1996) adapt Choi's proposal, making the distinctions in Table 2. Butt & King (1996) do not use the PROM feature to distinguish between contrastive and non-contrastive focus, as they only discuss cases of what they consider non-contrastive focus in their paper. This, of course, leaves open the question of which distinctions need to be made to account for the cases that have been discussed as contrastive versus non-contrastive focus.

Another difference between the two feature systems seems to be whether IS should be a full representation of everything in the sentence, or just some important parts. Whereas Choi's version of the features suggests that only some parts of the sentence will be represented, Butt & King's (1996) labeling assumes a full representation of the sentence. This latter view is also espoused in more formal treatments (see Section 3.2).

Another version of the scheme is found in Gazdik & Komlósy (2011), who use the d-link distinction of Pesetsky (2007) instead of the ±NEW feature, as shown in Table 3. They consider continuing topics to be background, and discuss the difference between hocus and focus in Hungarian as well as the status of question words. This more recent proposal takes into account the most important distinctions discussed in the literature reviewed above. The notion of prominence seems to correspond to the notion of contrast, and d-linking is a way to distinguish between more and less salient elements. This proposal is, however, only worked out for Hungarian.

Table 3: Gazdik and Komlósy's features

Discourse function	Focus, Question word, Hocus	Contrastive Topic, Question word	Completive	Background
PROM	+	+	−	−
D-LINKED	−	+	−	+

The switch in interpretation between Choi (1996) and Butt & King (1996) and the further switch in interpretation in Gazdik & Komlósy (2011) shows that the features are not clearly enough defined to apply unambiguously. It might be just this vagueness that has allowed several other LFG accounts, e.g Marfo & Bodomo (2005), Dalrymple & Nikolaeva (2011), Mycock (2013), Mycock & Lowe (2013) and Otoguro & Snijders (2016) to adopt the approach of Choi (1996)/Butt & King (1996).

What these two-feature approaches suggest is that, on an abstract level, only four distinctions need to be made to account for the IS distinctions that natural languages encode, even if these distinctions are not exactly the same in all languages. This is not necessarily false, but it is not something that has been argued for in any detail.

With respect to TOPIC, we often find one further distinction, although some authors have proposed more subdivisions. Bresnan & Mchombo (1987) distinguish between CONTRASTIVE (new) topics and NON-CONTRASTIVE ones. Although they refer mainly to early work by Lambrecht, their distinction seems to be basically Vallduví's distinction between LINK and TAIL. The distinction between LINK and TAIL is also appealed to in Dalrymple & Nikolaeva (2011) as closely corresponding to their distinction between PRIMARY and SECONDARY topics. Based on an analysis and data treated in more detail in Nikolaeva (2000), Dalrymple & Nikolaeva (2005) argue explicitly for a distinction between PRIMARY and SECONDARY TOPIC in Ostyak: according to the *what about X?* test, the primary topic has to be a subject in this language, but agreeing objects are secondary topics. They are typical answers to questions such as *What did X* (= primary topic) *do to Y* (= secondary topic)? This analysis is further developed for several other languages by Dalrymple & Nikolaeva (2011) in the context of their discussion of differential object marking.

Abubakari's (2018) FAMILIARITY and CONTRASTIVE topics (in Kusaal) seem to be intended to capture the distinctions between SWITCH and CONTINUING topic, but he seems to assume that there could be more than two varieties of topic. Mchombo et al. (2005) use the feature ±CONTRASTIVE to make a distinction within the class of SWITCH TOPICS; switch topics themselves are distinguished from CONTINUING TOPICS. Kifle (2011) proposes three topics in certain sentences in Tigrinya. Szűcs (2014) sees the distinction between CONTRASTIVE and NON-CONTRASTIVE topics (= −NEW elements) as crucial for left-dislocation and 'topicalization' in English: the topic position can be occupied by a contrastive element, be it topic or focus, whereas left-dislocation requires a non-contrastive new element. His distinctions seem to be similar to the ones made in Mchombo et al. (2005), but similarities and dissimilarities are not discussed.

Early work on FOCUS often distinguishes between CONTRASTIVE and PRESENTATIONAL focus (e.g. King 1995). A distinction between CONTRASTIVE and NON-CONTRASTIVE FOCI is made in Abubakari (2018). Dahlstrom (2003) appeals to Lambrecht's (1994) three-way distinction among foci: PREDICATE FOCUS, ARGUMENT FOCUS, and SENTENCE FOCUS. Gazdik & Komlósy (2011) also distinguish between HOCUS and FOCUS in Hungarian.

When four distinctions are felt not to be enough, appeal is made to various hierarchies to introduce further distinctions. The GIVENNESS HIERARCHY is invoked to make distinctions among topical and/or focal elements: see e.g. O'Connor (2006) and Andréasson (2008, 2009, 2013), who appeal to the notion ±ACTV (activated). Andréasson's and Connor's analyses are based on the Gundel hierarchy, but similar ideas are found in Lambrecht (1994).

Morimoto (2000) appeals to an animacy hierarchy in her analysis of subject-object inversion; following Bresnan (2001), she treats subject as a grammaticalized discourse function, and shows that animacy plays a role in the determination of the subject function in Bantu. Other hierarchies proposed are the Silverstein hierarchy (e.g. Simpson 2012 and similar hierarchies of topic-worthiness: Dalrymple & Nikolaeva 2011), or appeal to animacy, definiteness and specificity as in Mayer (2006). Mycock (2013) adds a feature for questions that can co-occur with all other features. O'Connor (2006) adds the feature ±OPEN to capture representations with and without a variable. The most extensive feature taxonomy in LFG, to my knowledge, has been proposed by Cook & Payne (2006) (see Section 4).

In general, the LFG analyses would profit from more cross referencing and more discussion of the similarities and dissimilarities among the various proposals. An exception is Dalrymple & Nikolaeva (2011), who adopt the two-feature scheme of Butt & King (1996) and discuss how their notions of PRIMARY and SECONDARY TOPIC are different. The feature CONTRASTIVE is liberally used by various authors, but often not further defined. Given how problematic it is, it would profit from a systematic clarification.

In general, not much attention is spent on the question of how to identify topic or focus independently of their syntactic, prosodic or morphological characteristics. Thus, it is not always clear that the marking that is thought to be that of an IS unit might not mark another distinction.

3.2 Representation of IS in LFG

3.2.1 From f-structure functions to a separate IS representation

The first mention of IS notions in LFG can be found in the discussion of the TOPIC/FOCUS functions in Kaplan & Bresnan (1982) and Zaenen (1985). These are taken over from the phrase structure treatment of long distance dependencies in the grammatical frameworks that were then current. The discussion of what these discourse functions did was limited to the observation that they were "overlay" functions, requiring an extension of the coherence principle: topics or foci were not only topics or foci, but also had an argument function such as subject or object. The actual content of the notions topic and focus was not discussed. The discourse functions were treated in the f-structure, just like other functions. In the early nineties, several Stanford theses (e.g. Alsagoff 1992, Joshi 1993, Kroeger 1991) investigated the relation between SUBJECT and TOPIC in Asian languages in syntactic terms.

In the first studies to discuss IS as such, the grammaticalized discourse function approach is also used, e.g. by Bresnan & Mchombo (1987) and by King (1995), who investigates in detail the phrase structure configuration needed to account for the configurational encoding of Russian discourse relations.

King (1997) discusses the drawbacks of an approach that integrates IS notions into the c-structure and the f-structure. She illustrates in detail the potential mismatches between f-structure units and IS units, and proposes to handle IS as a separate projection. This is what most researchers have done in subsequent work. We will refer to this separate module as the *i-structure*.

As already indicated above, most researchers start from a two-feature analysis of topic and focus, in most cases augmented with background and completive roles. The representation given is generally an attribute-value matrix (AVM), with the roles as attributes. The nature of the values depends on the way the relation of the i-structure to the other projections is articulated.

3.2.2 How does the IS relate to the other components of the grammar?

As IS can be signaled in various ways, the flow of information from the different components to the separate i-structure has to be modeled. LFG has a modular structure which allows researchers to experiment with various approaches while keeping other aspects of the framework constant. One of two models is generally adopted. One is proposed in an early paper by Butt & King (1996) and King (1997) and discussed further in Butt & King (1997); a later, different one is proposed in Dalrymple & Nikolaeva (2011) and further work in glue semantics.

In Butt & King (1996, 1997), the c-structure feeds into the i-structure. The i-structure and the f-structure feed into the semantic structure and the i-structure is related to the f-structure, as every PRED appearing in the f-structure has to be linked to a discourse function. Butt & King's model is assumed in Sulger (2009), Dione (2012) and Andréasson (2007), but it has not been worked out in detail.

Dalrymple & Nikolaeva (2011) develop a structured meaning approach à la von Stechow (1982) and Krifka (2006). In their view, the semantic structure encodes how meaning constructors relate to each other. The i-structure adds further structure specifying the pragmatic relations. Every meaning constructor in a sentence has to have a role at i-structure. What this role is can be positionally determined, through a c-structure annotation, or morphologically or prosodically determined. The feeding relations are c-structure to f-structure to s-structure to i-structure. The Dalrymple & Nikolaeva model is worked out in detail in Dalrymple et al. (2019). For discussion of how the prosodic information fits in, see Dalrymple & Mycock (2011), Mycock & Lowe (2013), Mycock (2013) and Bögel 2023 [this volume]. Apart from these two proposals, there are proposals by individual researchers that draw attention to specific problems; for example, O'Connor (2006) stresses the importance of the i-structure (his d-structure) relation to prosody. For him, part of the goal is to link an AVM representation for i-structure (his discourse structure) to a tree representation for prosody. Otoguro (2003) discusses the relation to morphology. Dahlstrom (2003) draws attention to the necessity of allowing constructional information to distinguish the various types of focus, especially sentence focus, and tentatively proposes an i-structure organized as a set of propositions.

Several researchers (e.g. O'Connor 2006, Choi 1996, and Andréasson 2010) propose an Optimality-Theoretic calculation to determine what is topic or focus or what is reanalyzed in a particular way, but no precise proposals are made about how this OT part fits with the rest of the architecture.

4 Studies of IS phenomena in LFG

In the following, I list LFG contributions in IS in chronological order, with some short comments intended to inform the reader which language data can be found in the contribution and which issues are most prominent.

Bresnan & Mchombo (1987) *Topic, pronoun, and agreement in Chichewâ.* This early paper treats the IS concepts as part of the f-structure. It discusses mainly word order and the notions subject and object in Chichewâ and some other Bantu languages.

King (1995) *Configuring topic and focus in Russian.* A revised version of a PhD thesis. Discusses topic, contrastive and presentational focus and background in Russian, Serbo-Croatian and Bulgarian. The IS notions are encoded in c- and f-structure, and other possible architectures are discussed.

Choi (1996) *Optimising structure in context: scrambling and information structure.* This PhD thesis discusses scrambling in German and Korean and appeals to the notions of aboutness topic and contrastive and presentational focus. It influenced later research by introducing the feature decomposition ±NEW and ±PROM(inent) and by its use of Optimality Theory to calculate the results.

Butt & King (1996) *Structural topic and focus without movement.* The paper discusses word order and discourse configurationality in Urdu and Turkish and distinguishes topic, focus, background and completive information. It is influential in the new way it used the features ±NEW, ±PROM.

King (1997) *Focus domains and information-structure.* The paper explicitly discusses the problem created by representing IS in the c- and the f-structure on the basis of Russian data. It proposes an i-structure parallel to the f-structure.

Sharma (1999) *Nominal clitics and constructive morphology in Hindi.* The focus of this paper is the representation of focus clitics in Hindi via inside-out uncertainty.

Broadwell (1999) *The interaction of focus and constituent order in San Dionicio Zapotec.* The paper uses Optimality Theory to calculate the right word order for focused constituents in Zapotec.

Morimoto (2000) *Discourse configurationality in Bantu morphosyntax* (see also Morimoto 2009) This dissertation looks at Kirundi and Kinyarwanda and discusses subject-object inversion. Following Bresnan (2001) in analyzing SUBJECT as both an argument and a discourse function and using the features of Choi (1996), it argues for two notions of topic in Bantu: external and internal topic. The distinctions are encoded in the f-structure.

Butt & King (1997) *Null elements in discourse structure.* The paper discusses pro-drop in Hindi/Urdu. It adds the distinction between switch and continuing topic to the distinctions made in Butt & King (1996). It uses a separate i-structure projected mainly from the c-structure.

Otoguro (2003) *Focus clitics and discourse information spreading.* The paper studies focus clitics in Japanese and argues for an architecture in which the c-structure is the input to the i-structure as well as to the f-structure and both are input to the morphology. It uses Optimality Theory to calculate the outcomes.

Dahlstrom (2003) *Focus constructions in Meskwaki.* The paper starts from Lambrecht's (1994) three focus types and discusses the various constructions, exemplifying them in Meskwaki. Following Lambrecht (1994), it proposes an i-structure which is structured as a set of propositions.

Dalrymple & Nikolaeva (2005) *Non-subject agreement and discourse roles.* The paper makes an argument for the notion secondary topic based on agreement facts in Ostyak. It assumes a separate i-structure.

Marfo & Bodomo (2005) *Information structuring in Akan question word fronting and focus constructions.* Starting from Akan question word fronting, the paper studies the difference between focus and background. It assumes a separate i-structure.

Mchombo et al. (2005) *Partitioning discourse information: A case of Chichewa split constituents.* The paper argues that the topic in Chichewa can be split into a −PROM and a +PROM part. The +PROMINENT part can be in initial position or not, and it can be ±CONTRASTIVE.

Cook & Payne (2006) *Information structure and scope in German.* The paper examines the interaction between word order and scope in German and claims we need to distinguish between ±TOPIC, ±NEW and ±CONTRASTIVE. The facts discussed relate to what others have called topic-within-focus. The account uses a separate i-structure, glue semantics and Optimality Theory.

Mayer (2006) *Optional direct object clitic doubling in Limeño Spanish.* The paper discusses clitic doubling in Limeño Spanish. It contains an extensive discussion of the factors that are usually associated with differential object marking (DOM): animacy, definiteness and specificity. It proposes that some of the objects discussed might be secondary topics.

O'Connor (2006) *Information structure in lexical-functional grammar: The discourse-prosody correspondence.* This dissertation discusses prosody and pitch accent in Serbo-Croatian and their link to IS notions. It is based on Lambrecht's (1994) distinction between presupposition and assertion and the distinction between active and non-active referents. In O'Connor's terminology, discourse structure corresponds to what is called i-structure in this paper. O'Connor represents discourse structure as an AVM and discusses how it should be linked to the prosodic structure that is represented as a tree.

Simpson (2007) *Expressing pragmatic constraints on word order in Warlpiri.* The paper discusses word order in Warlpiri, arguing for a distinction between prominent and non-prominent information as well as the distinction between new and not new. The AUX marks the transition from prominent to less prominent information. New information precedes the verb. Both prominence and newness are seen as relational notions. The separate IS is intended to be capable of representing hierarchies of newness and prominence.

Kifle (2007) *Differential object marking and topicality in Tigrinya.* See also Kifle (2011). The discussion is based on Dalrymple & Nikolaeva (2005), but it is claimed that for Tigrinya further distinctions are needed. The topic is represented at f-structure in the implementation.

Andréasson (2007) *The architecture of i-structure.* The paper argues for a function SCENE distinct from GROUND and RHEME and from STAGE TOPIC. The data come from Scandinavian languages, mainly Swedish, where the SCENE is placed between the GROUND and the RHEME. A separate i-structure is assumed, but it is not clear how it relates to the rest of the grammar.

Andréasson (2008) *Not all objects are born alike.*
Andréasson (2009) *Pronominal object shift — not just a matter of shifting or not.*
Andréasson (2010), *Object shift or object placement in general?*
Andréasson (2013) *Object shift in Scandinavian languages: the impact of contrasted elements.* This series of papers studies the different factors that influence Object Shift in Scandinavian, especially in Danish and Swedish. Andréasson (2008) argues for an accessibility hierarchy a la Gundel et al. (1993); Andréasson (2009) argues for the importance of factivity when clausal antecedents are involved; and Andréasson (2013) explores the role of contrastive focus. They assume a separate i-structure and discuss its link to the c-structure.

Sulger (2009) *Irish clefting and information-structure.* The paper argues for the distinction between GROUND and FOCUS in Irish clefts. It assumes a separate i-structure projected from the c-structure.

Gazdik (2010) *Multiple questions in French and in Hungarian: An LFG account.* The paper studies questions in French and Hungarian, making a distinction between FOCUS, TOPIC and BACKGROUND using a separate i-structure.

Dalrymple & Nikolaeva (2011) *Objects and information structure.* This book discusses (differential) object marking and agreement in several languages (Uralic languages including Ostyak, Tundra Nenets, Vogul; Iranian languages; Indo-Aryan languages) with a typological and historical perspective. It mainly discusses primary and secondary topics and distinguishes the notion of topic from that of topic-worthiness, which is based on prominence features such as animacy, definiteness, and specificity. It uses Lambrecht's (1994) notions of assertion and presupposition. It proposes a separate i-structure and provides a structured meaning representation for topic and focus projected from the semantic structure.

Gazdik & Komlósy (2011) *On the syntax-discourse interface in Hungarian.* The paper discusses word order and prosody in the Hungarian preverbal field. It distinguishes between the hocus (an element that highlights an unusual feature of a otherwise usual event) and the focus, and proposes a revision of Butt & King's (1996) schema appealing to the notion of d-linking (Pesetsky 2007). It uses a separate i-structure.

Simpson (2012) *Information structure, variation and the referential hierarchy.* The paper discusses agreement and word order in Warlpiri and Arrernte and points out the importance of the Silverstein hierarchy to account for the data. It does not address architectural issues.

Dione (2012) *An LFG approach to Wolof cleft constructions.* The paper mainly discusses clefts in Wolof. It argues that the i-structure can be part of the f-structure when it has been syntactized.

Mycock (2013) *Discourse functions of question words.* The paper discusses questions in English and Urdu/Hindi. It follows Butt & King's (1996) proposal but adds a Q mark to all distinctions. It assumes a separate i-structure.

Mycock & Lowe (2013) *The prosodic marking of discourse functions.* The paper discusses the prosody of broad and narrow focus in English. The IS distinctions are based on Dalrymple & Nikolaeva (2011). It addresses the relation between c-structure, i-structure and p-structure.

Butt (2014) *Questions and information structure in Urdu/Hindi.* The paper develops the distinctions made in Butt & King (1996), proposing more subdivisions to account for questions in Urdu/Hindi. It assumes a separate i-structure, but does not discuss the relation between projections.

Szűcs (2014) *Information structure and the English left periphery.*
Szűcs (2017) *English left-peripheral constructions from an LFG perspective.* These papers discuss the English left periphery based on insights from Prince (1981) and Ward & Birner (2001). They argue for a distinction between ±NEW and ±D-LINKED which is further subdivided into ±CONTRASTIVE. The IS notions are represented in the f- and the c-structure.

Zymla et al. (2015) *Modeling the common ground for discourse particles.* The paper discusses discourse particles in German in the context of the PARGRAM AKR (Abstract Knowledge Representation).

Otoguro & Snijders (2016) *Focus clitics and discourse information spreading.* The paper discusses quantifier float in Dutch, English and Japanese. Based on Butt & King's (1996) distinctions, it argues that quantified NPs are topics and the floated quantifer is part of the focus.

Belyaev (2017) *Information structure conditions on agreement controller in Dargwa.* The paper argues for the importance of the notion PIVOT as defined in Falk (2006) to account for agreement in Dargwa. The notions used are syntactically encoded.

Abubakari (2018) *Information structure and the Lexical-Functional framework.* The paper argues for a subdivision of focus in contrastive and completive based on data from the morphological markings on focus and topic in Kusaal. The morphological markers themselves are retained in the i-structure.

Szűcs (2019) *Left-dislocation in Hungarian.* The paper argues for a distinction between topic left-dislocation and clitic topicalization in Hungarian. It mainly discusses the f- and the c-structure.

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Chapter 19

Morphology in LFG

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Lexical-Functional Grammar has been consistent over the past 4+ decades about its conception of syntactic structure and the sorts of rules that license it. However, despite being a highly lexicalist model of grammar, LFG has not developed a similarly consistent model of morphology. LFG has in fact assumed a variety of different models of morphology and interfaces with distinct 'morphological' modules and theories in this time. This is perhaps because LFG early on solved the problem of how morphology and syntax can communicate in a common formal language — the language of functional descriptions, which can be both associated with words and their parts and with syntactic elements. We first introduce some important concepts from morphological theory. We then look at some early LFG analyses which treated morphology *incrementally*. Subsequently, we review work on the syntax–morphology interface in LFG. We end with a discussion of *realizational* approaches to morphology in LFG.

1 Introduction

Lexical-Functional Grammar has been fairly consistent over the past more than four decades about its conception of syntactic structure and the sorts of rules that license it. However, despite being a highly lexicalist model of grammar, LFG has not developed a similarly consistent model of word-formation. LFG has in fact assumed a variety of different models of word-formation and interfaces with distinct 'morphological' modules and theories in this time. This is perhaps because

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LFG early on solved the problem of how morphology and syntax can communicate in a common formal language — the language of *functional descriptions*, which can be both associated with words and their parts and with syntactic elements. Together with the Lexicalist Hypothesis (Lapointe 1980, Chomsky 1970, Bresnan et al. 2016: 92), this entailed that syntactic terminals are morphologically complete words, with possibly complex associated f-descriptions, but the theory did not have to really say anything about the exact mechanism for word formation or how contributions were made to complex f-descriptions by specific parts of words. In addition, LFG has distributed what might be considered aspects of word-formation to various components besides a lexicon, including for example prosodic or phonological structures (Dalrymple & Mycock 2011, Bögel 2015).

In this context, it is perhaps better to start this chapter with a brief overview of some of the range of variation in morphological theory so that we can better situate LFG in the landscape of morphological possibilities (Section 2). We then look at early LFG analyses which treated morphology incrementally (Section 3). Then we review work on the syntax–morphology interface in LFG (Section 4). This sets the stage for a look at current approaches to morphology in LFG, which are realizational (Section 5). We will not have anything to say about the interactions of morphology, syntax, and prosody in LFG, because that is covered by another chapter in this volume, Bögel 2023 [this volume].

2 Morphological theory and terminology

The landscape of morphological theory is defined by many key ‘decision points’ that we summarize here for subsequent use. These decision points are pretheoretically distinct from each other, but they have a tendency to cluster together in ways that will be reflected in morphological theories interfacing with LFG. We attempt to be neutral for each decision point, and also as brief as possible. We leave the detailed description of these distinctions to sources like Hockett (1954), Beard (1995), and Stump (2001), but also textbooks like Haspelmath & Sims (2010), which does an especially good job of describing these decisions.

2.1 Morphemes vs. words

The first of these is also the most basic. What are the ‘atoms’ of morphological theory? What are the inputs to morphological rules? What are the elements that morphology manipulates? Morphological theories fall into two basic classes:

those that subscribe to the *morpheme hypothesis* and those that do not. The former are typically called *morpheme-based* theories (or *morphemic* theories). The latter are typically called *word-based* theories (or *lexemic* theories).

In morpheme-based models, the inputs to morphological operations are idealized as one-to-one pairings of sound and meaning called *morphemes*. Later morpheme-based models, such as Distributed Morphology (Halle & Marantz 1993), have redefined 'morpheme' to mean 'abstract morphological feature'. In these models, the sound-meaning pairing is better considered a *listeme* (Di Sciullo & Williams 1987) but is often called a *vocabulary item*. Historically, a 'word' is the morphological domain above morphemes. In most contemporary models of this kind, the 'word' is mostly epiphenomenal or refers to an extra-morphological domain (typically prosodic/phonological). In this context, a so-called 'simplex word' is nothing more than a domain containing only a single morpheme, while a so-called 'complex word' is a domain containing more than one morpheme.

In word-based models (Aronoff 1976), words are the atoms of the grammar. Morphological operations have words as their input and words as their outputs. In contemporary instantiations of word-based models, the *input* and *output* are not really the appropriate terms. Rather, 'words' have both abstract representations and phonological representations. The abstract form of a word is called a *lexeme*.[1] A lexeme is the basic representation of a word (often analogized to a dictionary entry). A lexeme may be derived from another lexeme via derivational morphology or compounding (and thus can be complex) but is never inflected. The phonological form of a word, which is fully inflected, is called a *word-form*, which can be conceptualized as a particular, (grammatically) context-sensitive, instantiation of a word. The word-forms of a lexeme are typically organized into paradigms.

There are many reasons why a theory might choose to assume words or morphemes — more than we could possibly summarize in this space. We posit the following as an oversimplified summary. The basic tendency observed in the crosslinguistic state of affairs is that morphology is affixal and morpheme boundaries are clearly identifiable. This is tautologically true in isolating and agglutinative languages, but even fusional languages, which almost always have *portmanteau* (many-to-one) morphemes, tend to have clear morpheme boundaries. On the other hand, divergences from this tendency are legion and likely exist in

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[1] Word-based and lexeme-based models are not strictly the same (Aronoff 1994: 7). For example, not all word-based models assume lexemes, and some lexeme-based models are actually not word-based in the strict sense (lexemes are taken to be atoms of morphological descriptions, but words are not). For the purposes of this overview this simplification suffices. We thank an anonymous reviewer for helping us sharpen this point.

every language. *Templatic* (or root-and-pattern) morphology, such as found in Semitic languages, is not easily accounted for as affixation. *Stem allomorphy* and *suppletion*, especially in high frequency words, often involves a morphological alternation without clear morpheme boundaries. Furthermore, complex words frequently have lexicalized meaning, i.e. non-compositional meaning that is more than the sum of the contained meanings. These exceptional data are usually given exceptional explanations, such as diachronic ones. Put simply: the morpheme hypothesis captures the basic concatenative cross-linguistic tendency of morphology, but lacks synchronic empirical coverage of seemingly exceptional data. The word hypothesis is its opposite, capturing all the data, but needing to attribute the basic concatenative tendency to something else, such as diachronic pressures like grammaticalization.

2.2 Arrangement vs. Process vs. Paradigm

The second decision point is the types of rules that operate on the atoms. This distinction is originally described by Hockett (1954) as the contrast between *item-and-arrangement* (IA), *item-and-process* (IP), and *word-and-paradigm* (WP) models. The names for these models reflect their workings. In an IA model, morphology is simply the set of morphemes in a word and the arrangement of those morphemes. Thus, the arrangement itself (which is essentially simple concatenation) is the only 'morphological process'. In an IP model, rules (such as *affixation*, *reduplication*, *juxtaposition*, *suppletion*, etc.) are applied to a *base* (or *stem*), which may be complex or simplex, to generate a new complex form. IP models are compatible with both morphemes or words being the 'base'. Finally, WP models assume the morphology is the process through which all the word-forms in a word's paradigm are inferable from each other via some mechanism that generates a paradigm.

The reasons for adopting any of these three are similar to the reasons in Section 2.1. IA models have two strengths. Firstly, they capture the basic cross-linguistic generalization: the vast majority of morphology can be explained with simple concatenation. Secondly, many practitioners of IA models find such a simple operation to have an elegance and restriction that are laudable metatheoretical goals. Because of this, IA would be preferred by those theorists for whom such theoretical elegance is a high-ranking concern. Again, we find that such practitioners are satisfied that putatively non-concatenative processes have potential diachronic explanations.

There are familiar reasons to assume IP models, which again, as in Section 2.1 appear to be the opposing reasons. Chief among them is that IA models under-describe the data. IA models end up accounting for everything with affixation, including apparently non-affixal morphology like *functional shift*, *back-formation*, *stem allomorphy*, *suppletion*, *stress shift*, *truncation*, and *reduplication*. Affixal explanations for these phenomena tend to be fairly stipulative and lead to a proliferation of null morphemes that condition these changes (which are themselves a violation of theoretical parsimony, despite this concern being a primary motivation of such approaches). IP practitioners point out that there is also a ready-made counter-explanation from diachrony for the prevalence of concatenation: the chief source of morphology is grammaticalization, which (ultimately) leads to affixes. Furthermore, although rule-based morphological models are undoubtedly much more powerful than IA models, that power comes with significant empirical coverage, which is arguably worth the trade-off. In many varieties of both WP and IP models, in the idealized case, any two word-forms can be mutually predictive. This allows rules to apply 'backwards', capturing phenomena such as *backformation* or *cross-formation* (see, e.g., Becker 1993). These types of morphological alternations are difficult to capture in an IA model.

The appeal of WP models over the other two is the ability to make reference to the paradigm as an abstract entity. In the domain of inflection, many generalizations, especially *morphomic* ones, can be captured by referring to the paradigm itself. A *morphome*, as described in Aronoff (1994) and Luís & Bermúdez-Otero (2016), among others, is a purely morphological pattern. The existences of morphomes is controversial (a debate captured well in Luís & Bermúdez-Otero 2016). The most salient of proposed morphomes in this debate are root allomorphy patterns like the 'L pattern' and the 'N pattern' (see Maiden 2018), which are literally described as patterns in a paradigm (e.g., cells arranged in an L or an N). Thus WP models are uniquely well-situated to account for these. On the other hand, arrangement accounts usually deny the existence of morphomes as paradigm effects and instead account for them via some other mechanism (see Trommer 2016).

Similarly, patterns of syncretism lend themselves to paradigmatic explanations. Paradigmatic explanations are especially well suited to highly fusional languages as are common in Indo-European. They also lend themselves easily to complex agreement patterns that are cross-linguistically ubiquitous. Furthermore, because a paradigm cell can contain multiple forms or even no forms, WP models allow explanations for both *optionality* and *defectiveness*/*ineffability*. The tradeoff here is paradoxical: on the one hand, paradigmatic models tend to have little to say about derivation[2] and compounding, so they under-describe the data;

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[2] There are some notable exceptions, though, such as Booij (2010) and Spencer (2013).

on the other hand, paradigms are much more powerful than needed for most of the world's languages, so in another respect, they over-describe the data.[3]

2.3 What is the lexicon?

The third decision point is the nature of the word-storage component of the grammar. For example: Is the lexicon a productive component of the grammar or simply a passive list of memorized forms? While the terminology here is far from consistent in the literature, for the purposes of this chapter we will use *lexicon* to denote a generative/productive component of the grammar responsible for word-formation. We will use *vocabulary* for a passive component which is simply a list of memorized items. There is nothing inherently contradictory about a model having both a lexicon and a vocabulary. It just happens that most models with a productive component typically assume that that component is also the one responsible for word-storage. Indeed, this dual role is central to many models of *blocking*, such as the original one developed by Aronoff (1976). On the other hand, Di Sciullo & Williams (1987) argue for both a lexicon and a vocabulary (without using those terms).

There are some downstream effects of the decision to have a component dedicated to word-formation. If it is assumed that the lexicon is productive, a decision must be made on how much it is responsible for. The *Single Component Hypothesis* claims that all three distinct types of morphology (derivation, inflection, and compounding) are handled by the same generative component. On the other hand, the *Split Morphology Hypothesis* claims that derivation and inflection are handled by separate components. Thus, it is not uncommon to have two distinct word-formation components, one for derivation and one for inflection, depending on a particular model's definition of *lexeme*. This is made explicit in the WP model of Anderson (1982, 1992), where the paradigms are only responsible for inflection.[4]

Provided you assume that morphology is not its own domain, there seem to be two obvious non-morphological components involved in ordering morphological elements. One of these is prosody/phonology, as seen in models such as Optimality Theory (Prince & Smolensky 2004). The other, more common, account for ordering morphological elements outside of a lexicon is the syntactic component. The *Morphosyntax Hypothesis* — this is not its common name but will suit our purposes — assumes that all of morphology and syntax are handled

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[3] Word and Paradigm models encompass more than just what is described here, including adaptive discriminative models such as Blevins et al. (2016), but these have not yet been meaningfully interfaced with LFG, so we set them aside here.

[4] Split morphology theories are properly ambivalent about the place of compounding; we do not address compounding in this chapter.

by the same component of the grammar. This entails the strong claim that autonomous morphological phenomena do not exist, and are instead attributable to the morphological interfaces with phonology and syntax. The *Weak Lexicalist Hypothesis* separates derivation from inflection: Derivation is handled by a lexicon while inflection is part of the syntactic structure. By contrast, the *Strong Lexicalist Hypothesis* assumes that all of word-formation is Lexical/non-syntactic.

We won't get into the reasons why a syntax model might adopt variations on the Lexicalist Hypothesis. We leave that to elsewhere in this handbook. From the point of view of morphological theory, there are distinct reasons to consider breaking the class of things called 'word-formation' into distinct components. Data on morphological structure suggests compounding and derivation are of a kind that is distinct from inflection. In the domain of derivation and compounding, fully productive morpheme ordering overwhelmingly generalizes as *headed hierarchical structure* (the type of structure usually represented by trees in syntactic theory). In inflection, on the other hand, to the extent that morpheme boundaries are even identifiable, they tend to be arranged in ordered flat structure (i.e., a *list*). Constituency tests that show hierarchical structure tend to fail, despite strict ordering. Alternatively, when boundaries are less identifiable, the morphology appears to be arranged *paradigmatically*. This difference is mostly captured by the distinction between an agglutinative and a fusional inflectional system. A key reason for treating inflection as different from other kinds of morphology is precisely because of the apparent structural distinction between a linear structure (inflection) and a hierarchical structure (derivation). Conversely, while inflection is overwhelmingly productive and expresses compositional meaning, derivation and compounding have a much greater (but still small) likelihood of having non-compositional meaning and being less than fully productive. This is yet another reason to partition morphology into distinct classes.

Finally, and perhaps most importantly, to the extent that we can today justify that derivation is a distinct empirical category from inflection, following Anderson (1982), the chief generally observed distinction (outside of the hierarchical/ linear/paradigmatic ones above) is that inflection is relevant to the syntax. Inflection comes in two varieties. The first empirical category is those inflections that express grammatical configurations (*contextual inflection;* Booij 1996). For example, case and subject/object agreement on verbs express the relationship between verbs and their dependents. Similarly, nominal concord expresses the relationship between nouns and their dependents. Importantly, languages appear to have the option of expressing these relationships either via morphology or through a fixed word order (or both). The other empirical category of inflection is those morphological reflexes of so-called 'morphosyntactic' or 'morphosemantic' categories (*inherent inflection;* Booij 1996). These are such properties as tense, aspect, voice, mood, number, definiteness, etc. Again, languages appear to have the choice of expressing these properties morphologically or syntactically (through separate categories such as auxiliaries, clitics, prepositions, etc).

Given these differences, it makes sense to split a *lexicon* into two pieces: one that handles so-called *lexeme-formation* and another that handles inflection (but see Booij 1996 for counter-arguments). These two components can then have fundamentally different types of processes and can have different relationships with the syntactic component. And indeed, this division of labor is common in Word-and-Paradigm models today. For a review of the history and state-of-the-art of WP models, see Blevins (2018).

Since syntax is also naturally represented, at least in part, by headed hierarchical structures, the parsimonious approach to grammar is to identify the extent to which all such structure can be done with the same component — in other words, to assume a single component that generates headed hierarchical structure, whether the structure represents 'syntax' or 'morphology'. Compounding and derivation can similarly easily be accommodated to a component that generates headed hierarchical structure, especially if we restrict the model to only the most productive processes and we are willing to assume that non-compositional morphological meaning is fundamentally the same as non-compositional idiomatic syntactic constructions. We would have to then be willing to postulate vacuous hierarchical structure in inflection, but this postulation is arguably worth the trade-off for overall parsimony. The call of parsimony is heightened by the definitional interdependence of syntax and inflection. In fact, an Item-and-Arrangement model has already made certain empirical sacrifices for parsimony and restriction goals. It seems that no further sacrifices are needed to assume a single morphosyntactic component. The gain in parsimony is even further support for Item-and-Arrangement from this point of view, so it is not surprising that most models today that assume an Item-and-Arrangement model reject the Lexicalist Hypothesis and adopt a passive *vocabulary*. But deciding to approach morphology by reducing it to syntactic (and/or phonological) operations is not restricted to Item-and-Arrangement approaches. Similarly, *construction-based* approaches to morphology (Booij 2010, Masini & Audring 2018) generally assume that the *construction* is both a morphological and syntactic mechanism. This property of having a shared mechanism is often summarized as 'X all the way down', where X is *constructions* in construction-based approaches, *syntax* in standard Distributed Morphology, and *constraints* in Lexical-Realizational Functional Grammar.

Approaching morphology via a single morphosyntactic component has significant empirical justifications as well. There are several commonplace phenomena that blur the lines between word and phrase, suggesting that distinction is more one of convenience than a justifiable categorical contrast. Such phenomena include for example: clitics, phrasal affixes, phrasal compounds, valence changing devices, separable prefixes (of the Germanic variety; e.g., Booij 2002), object incorporation (of the Mohawk variety; e.g., Baker 1988). Because these phenomena appear to be both syntactic and morphological, it is appealing to these practitioners to find unitary explanations, which ultimately rest on not positing a syntax/morphology distinction.

2.4 Lexical vs. inferential

While not strictly distinct from our classification above, it is worth taking a moment to describe a distinction that is common in the literature, especially within models that interface with LFG. Stump's (2001) typology of morphological theories of inflection includes a distinction between two types of theory: *Lexical* and *Inferential.* In a lexical model, the lexicon (or vocabulary) stores associations of inflectional properties and phonological properties. A complex word is an ordered set of these associations. Conversely, in an inferential model, the systematic associations are between a lexeme and its word-forms. Word-forms are inferred from their stems by rules (not restricted to concatenation) that associate aspects of form with aspects of grammatical content. In sum, lexical models are concerned with listed lexical objects (words or morphemes), whereas inferential ones are concerned with rules.

In the typology that we are describing here, these distinctions are not basic. Instead, they are composites of the distinctions above. While it may not be the case that Stump (2001) intends "lexical" to comprise these four properties, the examples of *lexical* models that Stump (2001) lists all share in common that they are *morpheme-based*, *Item-and-Arrangement*, and *morphosyntactic* with a passive *vocabulary*. In contrast, an *inferential* model is *word-based*, and assumes *Strong Lexicalism* (at least for inflection, which is what Stump 2001 is concerned with).

2.5 Incremental vs. realizational

The final distinction that we describe here concerns the relationship between information and morphology. In an incremental model, morphology is *information-adding*. That is, a word gains grammatical complexity (i.e., morphosyntactic properties) at the same time, or as a function of, gaining complex morphology. For example, on this conception, adding the plural morpheme to the word is what makes it plural. In opposition to this stand *realizational* models. In a realizational model, morphology is *information-expressing*. Some aspect of grammar that is external to the morphology supplies a set of morphosyntactic properties (which may or may not include a *root*). What we conceptualize as morphology then expresses that set of morphosyntactic features. Depending on other choices made, this expression might be a passive mapping to phonology or the application of a realizational rule. In these models, morphology provides the *exponence* of morphological properties (the *exponenda*).

This distinction is not so much an active distinction today since most contemporary morphologists assume *some* variety of realizational morphology. This can be achieved via paradigms (Paradigm Function Morphology; Stump 2001, 2016, Spencer 2013), morpheme-insertion (Distributed Morphology; Halle & Marantz 1993), or constructions (Construction Morphology; Booij 2010, Masini & Audring 2018; Optimal Construction Morphology; Inkelas et al. 2006, Caballero & Inkelas 2013, Inkelas 2016). The simple reason for this is that morphology, especially inflection, both under- and overdetermines its featural content.

The underdetermination part has always been well-known. For example, a fundamental property of inflection and primary explanandum of morphological theory is the fact that the morphosyntactic features overtly expressed by an inflected form are often a subset of those properties that are associated with the word. For example, it is common for gender to be unexpressed in combination with participant persons (1^{st} and 2^{nd}). Similarly, it is also common for person features to be unexpressed in combination with past tense or plural number (see, for example, Bjorkman et al. 2021).

Interestingly, the reverse is true as well, which demonstrates the case of overdetermination. Morphosyntactic properties are often expressed *multiply* without additive meanings; this is usually called *multiple exponence*. For example, *children* is not 'multiply plural' despite having three distinct reflexes of plural (vowel change, historic *-r* plural, historic *-en* plural). What is noteworthy here is that the multiple expression of plurality is *grammatical*. One wouldn't expect this of an iterated plural function, which is what multiple applications of a plural morpheme might lead one to expect (see, for example, Harris 2016).

3 Incremental morphology and LFG

3.1 Phrase structure rules as word-formation rules

An obvious approach to concatenative morphology is to capture morphological well-formedness using similar (annotated) phrase structure rules to the ones that license c-structures (Selkirk 1982). The difference is that the morphological ones use morphological categories. However, standard LFG assumes *Strong Lexicalism*, so it is important to note that this is happening in different combinatorial components of the grammar — morphology versus syntax. Pedagogical presentations, such as Bresnan et al. (2016), out of necessity simplify representations in such a way that this important distinction is masked. In the problem set on West Greenlandic (Bresnan et al. 2016: 364–369), we find the example in (1) below, analyzed with the assistance of the morphological rule in (2), and the sketch of an analysis for (1) in (3).[5]

(1) West Greenlandic
Angisuu-mik qimmeq-arpoq.
big-INS dog-have.IND.3.SG
'He has a big dog.'

(2)
$$\begin{array}{llcc} \text{V} & \longrightarrow & \text{N}_{\text{stem}} & \text{V}_{\text{suff}} \\ & & (\uparrow \textsc{obl}) = \downarrow & \uparrow=\downarrow \end{array}$$

Note that this rule looks just like a c-structure rule, except with a c-structure category on the lefthand side of the rule and morphological categories on the righthand side. In other words, it is the *outputs* of these morphological rules that form the *inputs* to the c-structure rules.

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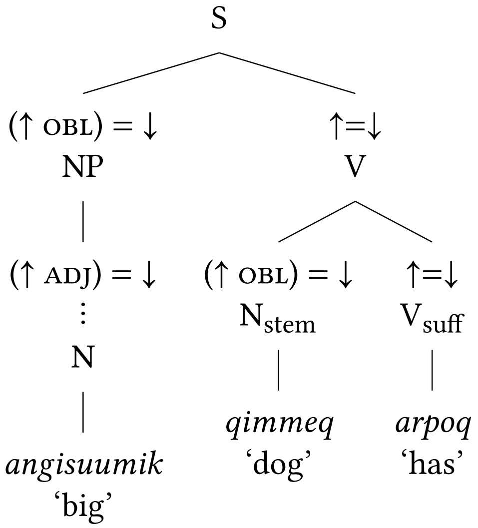
[5] We have left the morphological glosses off the free English translation in (3), which is not present in Bresnan et al. (2016: 446); this is just a rough approximation of the glossing in (1). We have also elided some annotations from the original.

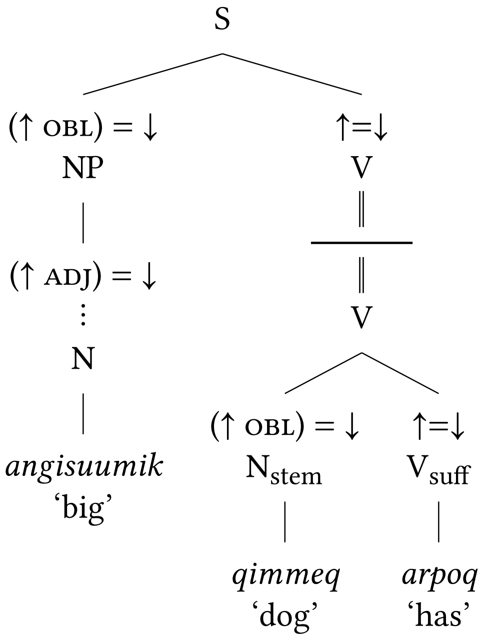
(3)



However, notice that the node labelled V in this tree is actually licensed by the *morphological* rule in (2). In another sense, this very same V is also licensed by the c-structure rule for S, which is easily inferable from (3).

However, if morphology and syntax are distinct grammatical modules, per Strong Lexicalism, then it can't actually be a single rule set that captures both aspects of V, as implied by (3), even if the mechanisms involved are the very same for both syntax and morphology (annotated phrase structure rules) in this incremental approach to LFG morphology. Thus, a more transparent way to represent (3) may be something like the following (based on Ishikawa 1985: 285):

(4)



The horizontal line represents the syntax/morphology ‘boundary’ and we see that V has a foot on each side. This representation is arguably more transparent about the full set of theoretical claims behind (3). But it also highlights that the licensing mechanisms for c-structure and morphology are redundant in this sort of incremental morphology for LFG.

It is important to realize, though, that in early LFG, incremental morphology through phrase structure rules was not merely a pedagogical simplification. There were proposals in early LFG research on morphologically rich languages that involved phrase-structural incremental morphology, such as Baker (2006 [1983]), Ishikawa (1985: ch. 3)[6] and Nordlinger (1997, 1998). For example, Nordlinger (1997: 107) proposes the following morphological rule for case affixation in various dependent-marking languages of Australia (including, e.g., Kayardild, Martuthunira, Thalanyji, Wambaya):

$$\begin{array}{llll} \text{(5)} & \text{N} \longrightarrow & \text{N} & \text{Aff} \\ & & \uparrow=\downarrow & \uparrow=\downarrow \end{array}$$

Nordlinger subsequently revised this incremental analysis in favour of a realizational approach (Sadler & Nordlinger 2004, 2006), which will be discussed further in Section 5.1.

In sum, the early incremental approach to morphology that was commonly assumed by LFG was a straightforward, even traditional, *morpheme-based*, *item-and-arrangement* approach.

3.2 Finite-state morphology

Another question that arises with incremental phrase-structural morphology is one of computational complexity/power. One way of expressing the intuition that morphology is generally concatenative is to observe that regular languages/ finite state automata, which are the Type 3 grammars in the Chomsky Hierarchy (Chomsky 1957, 1965, Partee et al. 1990: part E), are computationally sufficient for generating concatenative morphology. One can make an even stronger claim, which is that almost all of morphology requires no more than finite-state power, except for total reduplication (Beesley & Karttunen 2003, Roark & Sproat 2007: 25, 53–60), which is beyond finite-state power, since it requires exactly matching a preceding string of potentially unlimited length.[7]

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[6] See Bresnan et al. (2016: 396) for a simplified presentation of some of Ishikawa’s proposals.

[7] Note that Beesley & Karttunen (2003) build their system around the operation of *concatenation*, whereas Roark & Sproat (2007) argue that the operation of *composition* is more general and is to be preferred. Among other considerations, *composition* gives a more natural finite-state solution to templatic (root-and-pattern) morphology (Kiraz 2001, Roark & Sproat 2007: 41–44).

Let's now turn back to the particular kinds of proposals for phrase-structural morphology that we saw in Section 3.1. The computational power of phrase-structural morphology is at least context-free, which is more powerful than required and corresponds to a higher level in the hierarchy. In other words, representing concatenative morphology in a phrase structure format gives the morphological component more potential power than seems justified by linguistic data. Moreover, once we add f-structure annotations to morphological phrase structure rules, we are potentially in the yet more powerful class of mildly context-sensitive languages (Joshi et al. 1991), since we would have the full power of LFG. This seems too powerful.

For example, if morphology were mildly context-sensitive, we might expect to see *morphological* long-distance dependencies or cross-serial dependencies, but we are not aware of any morphological phenomena that straightforwardly demand such analyses. It might seem that phenomena such as circumfixion or vowel harmony are candidates for morphological long-distance dependencies, but these can in fact be handled by finite-state means (Beesley & Karttunen 2003). Some agreement phenomena, like the Ojibwe PERSON discontinuity in (35) below, might similarly seem long-distance, but are in fact clause-bounded, so we expect that finite-state morphology (FSM) could handle them. We are aware of so-called 'long-distance agreement' (Butt 1993, Bhatt 2005), but we are not aware of any such case for which there is no viable non-long-distance solution. Lastly, it might seem that templatic morphology shows a morphological need for an indexed language (mildly context-sensitive) to line up consonants and vowels properly. However, it has been shown that a composition-based finite-state approach can indeed handle templatic morphology (Kiraz 2001, Roark & Sproat 2007).

It should be noted that actual computational work on LFG, in the context of the Parallel Grammars (ParGram) project (Butt et al. 1999; Forst & King 2023 [this volume]), uses finite-state morphology, rather than incremental phrase-structure morphology. Indonesian is among the languages in the ParGram project and does have productive total reduplication. The ParGram Indonesian grammar only allows for reduplication of words already in the dictionary/lexicon. This means that the FSM can extract the morphological feature encoded by the reduplication (because there is a finite vocabulary). However, on encountering a word for the first time, such a system cannot recognize the reduplication and so cannot extract the morphological feature encoded.[8] Thus, the full productivity of Indonesian reduplication is not modelled in the ParGram grammar.

In sum, the FSM approach is a restrictive approach that also yields broad coverage of morphological phenomena; for example, see the many case studies in

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[8] We thank Ron Kaplan (p.c.) for discussion of this point. Any remaining errors are our own.

Roark & Sproat (2007). The restrictiveness of the FSM approach makes it very attractive, even more so when coupled with the fact that FSM approaches have revolutionized applications that require morphological analysis, such as spell-checkers, part-of-speech taggers, and speech recognition and production systems (Kaplan & Kay 1994, Beesley & Karttunen 2003, Roark & Sproat 2007). Nevertheless, this does not mean that we should conflate theories with their formal or computational bases. Using an analogy from syntax, the mildly context-sensitive formalisms of Lexicalized Tree-Adjoining Grammar, Categorial Grammar, and LFG form a computational equivalence class but nevertheless underpin distinct theories. As Roark & Sproat (2007) themselves emphasize, theoretical distinctions may matter even if the options are computationally equivalent. For example, they consider Tagalog *-um-* infixation, as in *tawag* ('call') versus *tumawag* ('call (perfective)'). They note that it is computationally "immaterial" from an FSM perspective whether we conceive of the infix as attaching to *t-* or to *-awag* (Roark & Sproat 2007: 30–31). However, from a theoretical perspective, these two solutions are clearly not equivalent. In particular, Tagalog *um* is an infix in consonant-initial words (with some exceptions, where it cannot appear at all), but is a *prefix* in vowel-initial words, such as *abot*, which becomes *umabot* ('reach for (perfective)') (Orgun & Sprouse 1999: 204). On theoretical grounds, it therefore seems preferable to think of *um* as attaching to the element to its right, as McCarthy & Prince (1993) and Orgun & Sprouse (1999) conclude, but to FSM the two options (dependency on the preceding or following element) are equivalent and the distinction immaterial.

3.3 Lexical rules

Throughout the early history of LFG, theorists made crucial use of *lexical rules*, such as found in Bresnan (1982). These lexical rules were almost always employed to capture argument structure alternations, like passivization. Another way to think about the effect of lexical rules is that they concern the remapping of grammatical functions. These rules frequently had morphological reflexes in addition to their argument-structure-changing properties, but they also frequently did not (see the example lexical rules for gerundives in Bresnan et al. 2016: 316–317). In fairness, these rules were not normally postulated from the point of view of morphological theory, so the emphasis was not on their morphological reflexes or how to use them to capture morphological generalizations. Moreover, lexical rules were not systematically codified into a model that we could discuss explicitly here.

Nevertheless, it was clear that these rules are explicitly non-syntactic. For example, in Falk's textbook they are described thus (Falk 2001: 93):

> [A] lexical rule of this kind is not monotonic: it takes existing information and changes it. This is ruled out in principle in the syntax on grounds of processing: syntactic information cannot be changed. But a lexical rule is not a syntactic rule. Lexical rules do not represent on-line processing, but rather regularities relating stored lexical items. When a lexical rule is applied productively, the result is stored as a new lexical item. For this reason, the usual LFG constraint against changing information is inapplicable here.

Falk's pedagogical point is revealing of an important foundational tenet of LFG: syntax is monotonic, so no non-monotonicity can be syntactic. It therefore follows that argument alternations are non-syntactic, since they are non-monotonic. In other words, allowing the lexical rules to behave non-monotonically shields the syntax.

On the other hand, Baker (1985) explicitly considers lexical rules from the point of view of morphological theory, arguing precisely that because GF-rules (argument structure rules) and word-formation rules align on the same element in LFG (i.e., the lexical rule as developed in Bresnan 1982), LFG was especially well equipped to capture the "lexicalist approach" to the Mirror Principle (Baker 1985: 409). To the extent that these lexical rules were codifiable in the categories we have laid out, these rules often generated affixation as in the types described by Baker (1985), but most frequently required the power and mechanisms of an *Item-and-Process* approach to morphology, especially because they were often expressed with non-concatenative (frequently null) morphology and were explicitly both information-adding and information-destroying, the latter of which cannot be done with concatenation alone.

4 The syntax–morphology interface

Some work on morphologically conditioned syntactic order (e.g., restrictions on verbal sequences, as found in English 'affix hopping'; Chomsky 1957) has proposed a structure called m(orphological)-structure to shield f-structure from features that are morphological in nature (Butt et al. 1996, Frank & Zaenen 2002). This unfortunately gives the impression that m-structure is the morphological component of LFG, but this is not really the case, as we'll see in Section 4.2. First, though, we turn to a general framework for the interface between an LFG syntax and a realizational morphology (Dalrymple 2015). This better sets the context for the discussion of m-structure.

4.1 A general framework

Dalrymple (2015) presented a new, systematic approach to realizational morphology for LFG (see also Dalrymple et al. 2019: ch. 12). It is clear, though, that the morphological output is intended to be something similar or identical to Paradigm Function Morphology (Stump 2001, 2016). We return to that aspect of the Dalrymple analysis in Section 5.1, where we discuss it along with other approaches to a PFM interface with LFG (Ackerman & Stump 2004, Sadler & Nordlinger 2004, Spencer 2013, Thomas 2021).

Dalrymple (2015) assumes, following Dalrymple & Mycock (2011), Mycock & Lowe (2013), that the traditional lexical phonological string is comprised of two aspects, the *s-string* which interfaces with c-structure via the π correspondence function and the *p-string* which interfaces with prosodic structure (via the β correspondence function; Dalrymple et al. 2019: 409). This is illustrated explicitly in Figure 1.

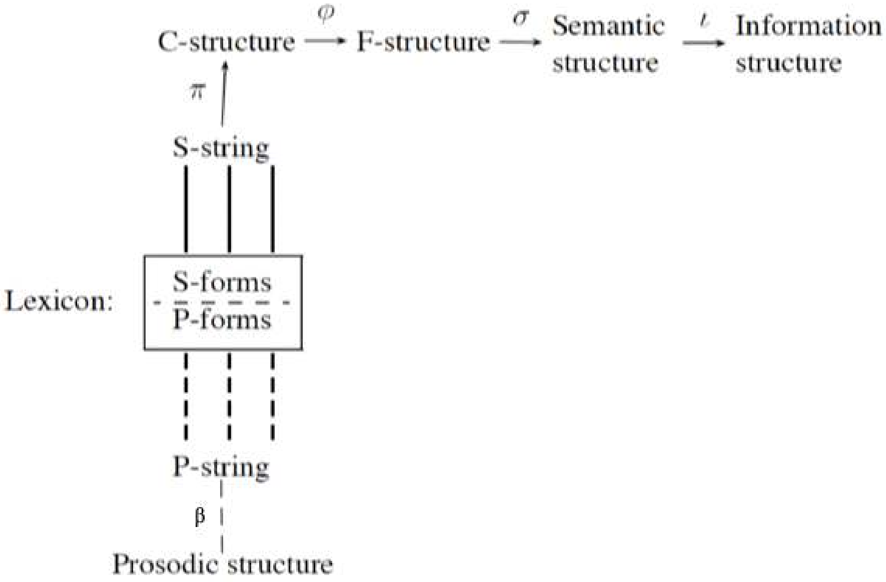

Figure 1: Proposed LFG Correspondence Architecture. From Dalrymple & Mycock (2011: 178, (5); see also Dalrymple et al. 2019: 409); used with permission.

A sample lexical entry for *dogs* from Dalrymple (2015: 67, (3)) is shown here:[9]

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[9] This simplified lexical entry sets information structure aside; see Dalrymple (2015: 66).

(6)

s-form	(• FM) = dogs
c-structure category	$\lambda(\pi(\bullet))$ = N
f-description	(↑ PRED) = DOG
	(↑ NUM) = PL
p-form	/dɔgz/

It is convenient to represent the information in lexical entries as a relation (Dalrymple 2015: 67 (4)):

(7) $\mathcal{L}\langle$s-form, p-form, category, f-description$\rangle$

The particular information in (6) can therefore compactly be represented as (Dalrymple 2015: 67 (5)):

(8) $\mathcal{L}\langle$dogs, /dɔgz/, N, {(↑ PRED) = DOG, (↑ NUM) = PL}$\rangle$

This lexical entry generates the structures and correspondences in Figure 2.

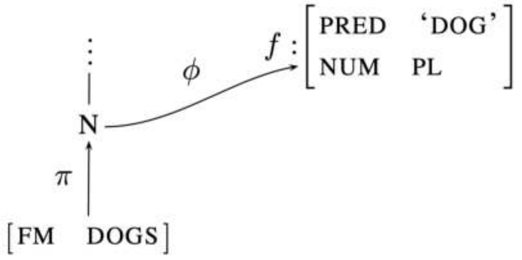

Figure 2: *Dogs*, contributions to the s-string, c-structure, and f-structure. Adapted from Dalrymple (2015: 66, (2)); used with permission.

Dalrymple (2015: 68) assumes, following Spencer (2013), that a *lexemic entry* consists of information about the form of the root (and any non-predictable alternations), any syntactic information and requirements, a representation of the semantics of the lexeme, and an arbitrary unique lexemic index. Dalrymple (2015: 68, (7)) therefore defines a lexemic entry as follows:

(9) *Lexemic entry*
⟨root & idiosyncratic stem forms, f-description, lexemic index⟩

She gives the following particular examples (Dalrymple 2015: 68 (8–9)):

(10) a. ⟨{ROOT: dog}, {(↑ PRED) = DOG}, DOG1⟩
b. ⟨{ROOT: child; STEM1: children}, {(↑ PRED) = CHILD}, CHILD1⟩

The question is how these lexemic entries interact with the morphological component to produce complete lexical entries. For example, how does the lexemic entry for DOG1 produce the lexical entry (8)?

The answer is illustrated in the diagram in Figure 3. The realization of the s-string form (*s-form*) and the p-string form (*p-form*) are handled by the morphological realization function, *R*, which also contributes morphological features (*m-features*) based on the ID of the lexemic entry (LI). The morphosyntactic description function, *D*, uses the m-features to represent the syntactic category and morphologically contributed f-description. The final lexical entry has the s-form and p-form that are computed by the realization function *R* (based on the m-features), the syntactic category that is computed by the description function *D* (again based on the m-features), and the f-description that is the union of the lexically contributed f-description from *LE* and the morphologically contributed f-description from *D*.

The relations between the different elements can be illustrated in a logic-programming-style representation, as in Figure 4. This representation reveals some redundancy. In particular, it's not clear why *R* and *D* each need access to both the lexemic index (LI) and the set of m-features (M), especially given that M must be computed based on LI. A more streamlined representation would eliminate LI from *D*. It would certainly be theoretically elegant if the set of m-features was sufficient to determine the category C and the morphologically contributed f-description G. However, there are empirical cases that show that *D* must be directly conditioned on LI, such as the syntactically singular but morphologically plural *measles* (Dalrymple 2015: 75).

As we mentioned above, Dalrymple's (2015) model is not a theory of morphology, but rather a theory of the interface between syntax and morphology. Nevertheless, it is most compatible with a morphological theory that is *lexemic*, is *Word-and-Paradigm*, and assumes *Strong Lexicalism*.

4.2 M-structure

As noted above, Dalrymple (2015) sees her framework as a general framework for realizational morphology and it is a feature of the approach that it is very much backwards-compatible with existing LFG proposals about morphological conditioning of syntax, such as the proposals for adding a m(orphological)-structure to the Correspondence Architecture proposed by Butt et al. (1996) and Frank & Zaenen (2002), which are both LFG accounts of affix ordering restrictions (e.g., English 'affix hopping'). The main distinction between the two proposals is that the first holds that m-structure is projected from c-structure (Butt et al. 1996),

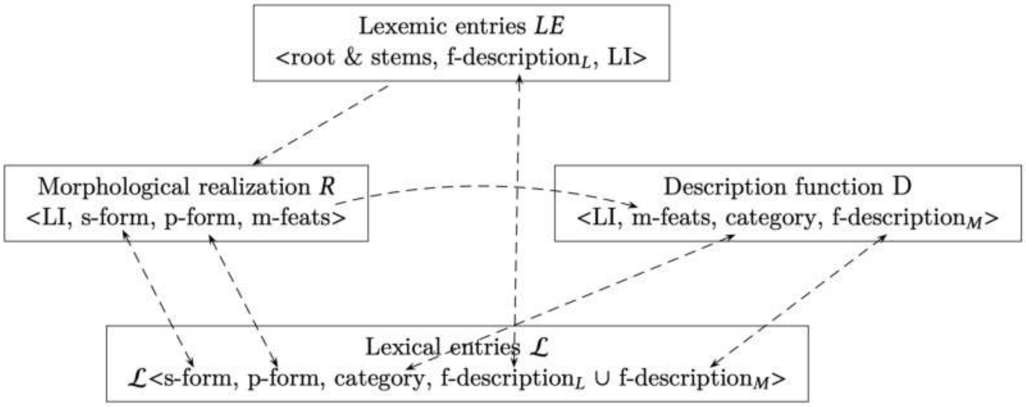

Figure 3: How the set of lexical entries, $\mathcal{L}$, is computed from the set of lexemic entries, *LE*, using a morphological realization function, *R*, and a description function, *D* (Dalrymple 2015: 70 (15); used with permission)

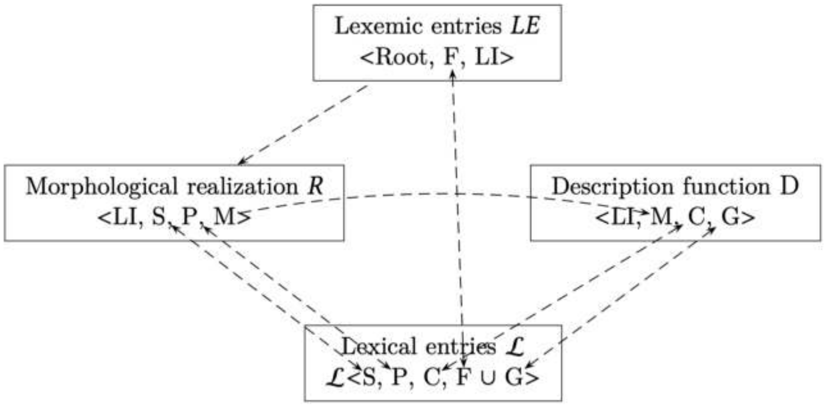

Figure 4: Logic-programming-style representation of the relations between $\mathcal{L}$, *LE*, *R*, and *D*

whereas the second holds that m-structure is projected from f-structure (Frank & Zaenen 2002).

The *morphological entry* (m-entry), i.e. instance of *R*, based on Butt et al. for *swimming* is shown here:

(11) *R*⟨SWIM1, swimming, /swɪmɪŋ/, {M-CAT:VERB, M-VFORM:PRESPART}⟩

The relevant *D* mapping would then be:

(12) M-VFORM:PRESPART $\overset{D}{\Rightarrow}$ {($\hat{*}_\mu$ VFORM) = PRESPART, (↑ ASPECT) = PROG)}

Given the same m-entry in (11), the relevant *D* mapping based on Frank & Zaenen would instead be:

(13) $\textsc{m-vform:prespart} \overset{D}{\Rightarrow} \{(\phi(\hat{*})_{\mu}\ \textsc{vform}) = \textsc{prespart}, (\uparrow \textsc{aspect}) = \textsc{prog})\}$

We have represented things this way for maximum comparability with (12), but $\phi(\hat{*})$ is just ↑, so we could have written $\uparrow_{\mu}$ instead:

(14) $\textsc{m-vform:prespart} \overset{D}{\Rightarrow} \{(\uparrow_{\mu}\ \textsc{vform}) = \textsc{prespart}, (\uparrow \textsc{aspect}) = \textsc{prog})\}$

Note that there are other differences between the Butt et al. theory and the Frank & Zaenen theory, but we've kept things as simple as possible for direct comparison. See Dalrymple (2015) for further details regarding both of these approaches to m-structure. It's important to realize, though, that m-structure concerns morphological conditioning on syntactic order and is not a theory of morphology per se. However, we have seen that the Dalrymple (2015) framework, which *can* provide the foundation for a theory of morphology, accommodates both approaches. This demonstrates the Dalrymple framework's generality. M-structure is most compatible with a morphological theory that is *lexemic*, is *Word-and-Paradigm*, and assumes *Strong Lexicalism.*

5 Realizational morphology and LFG

As noted in Section 2.5, realizational morphology is done today in three major ways:

1. The word-based approach, such as Paradigm Function Morphology (Stump 2001, 2016, Spencer 2013).
2. The morpheme-based approach, such as Distributed Morphology (Halle & Marantz 1993) and Nanosyntax (Starke 2009, Caha 2009)
3. The construction-based approach, such as Construction Morphology (Booij 2010) or Optimal Construction Morphology (Caballero 2008)

To our knowledge, neither Construction Morphology nor Optimal Construction Morphology has been interfaced with LFG, so we set them aside here. We focus in particular on PFM and DM interfaces to LFG. PFM and LFG have a history going back at least to Sadler & Spencer (2004). There has also been renewed interest in PFM+LFG (Dalrymple 2015, Dalrymple et al. 2019), as well as recent interest in DM+LFG (Melchin et al. 2020, Asudeh et al. 2021, Everdell et al. 2021, Asudeh & Siddiqi 2022).

5.1 LFG interfaced with PFM

The first attempts to interface LFG with Paradigm Function Morphology (Stump 2001, 2016, Spencer 2013) were undertaken by Sadler & Nordlinger (2004, 2006) to account for highly complex case-stacking in certain Australian languages and by Ackerman & Stump (2004) to deal with the general problem of *periphrasis*. However, the complexity of the data and phenomena involved precluded either of these collaborations from simultaneously providing a general theory of realizational morphology for LFG. As we have seen, steps in that direction were taken by Dalrymple (2015) and Dalrymple et al. (2019). Although the Dalrymple framework is general and not specifically geared towards PFM, there is a deep compatibility between LFG's version of Strong Lexicalism, the Lexical Integrity Principle (see (38) below), and PFM. As Dalrymple (2015) presumably wishes to preserve Lexical Integrity/Strong Lexicalism — the traditional/default stance in LFG theory — then it is natural that she envisages a word-based morphology. Thomas (2021: 22) aptly sums up this underlying compatibility as follows:

> Unlike many other theories of morphology, the concept of a 'morpheme' is irrelevant to PFM: there is no conception of a form-meaning pair below the level of the word, as only fully inflected forms are associated with morphosyntactic property sets. This aligns with the Lexical Integrity Principle of LFG, by which terminal nodes must correspond to fully inflected words, rather than to morphemes or other sub-word elements.

If one wishes to retain LFG's Strong Lexicalism, such that the fundamental building blocks of syntax are words, then it makes sense to interface the syntax with a word-based theory of morphology. And PFM is arguably the most formally well-developed realizational, word-based morphological theory, making it a natural choice. Indeed Thomas (2021: 23) notes in passing that PFM's rigorous formalization offers another natural point of compatibility between PFM and LFG: "PFM also shares with LFG a commitment to being formally explicit and rigorously testable, as well as computationally implementable."

PFM's fundamental claim is that lexemes are represented as pairs of a form and a set of morphological properties (captured as features). Thus, in $\langle X,\sigma\rangle$, X is the form and σ is the set of properties. A paradigm function relates the lexeme to its inflectional realizations, by mapping the input form to an output form given the morphological properties:

(15) $\langle X,\sigma\rangle \xrightarrow{f} \langle Y,\sigma\rangle$

These paradigm functions are defined in terms of realization rules, which consist of *rules of exponence* and *rules of referral.* Rules of exponence realize the property set directly. Rules of referral instead refer the realization of their property sets to one or more other realization rules. There is a limited number of additional rule types; furthermore Stump's (2001) notion of paradigm has been refined in Stump (2016), which is typically called PFM2. However, this simple account will have to serve our purposes.

The realization rules in PFM are arranged into ordered rule *blocks*; however, there is no ordering within blocks. Given Panini's principle, the effect of block ordering mimics concatenation, but allows a morphologically synthetic form (*portmanteau*[10]) to block a morphologically analytic form. Selection of the correct rule in any given block is governed by Paninian blocking: the most specific rule that can apply in any given rule block must apply. PFM also assumes a principle called the Identity Function Default (IFD), which states that the identity function is a member of every rule block: If no other rule applies, the output is identical to the input.

This is exemplified by the following rules for Swahili future and past tenses (Stewart & Stump 2007: 402–403), which Thomas (2021: 22) presents in simplified form.[11] We have adapted the representation for maximal consistency with (15) above.

(16) Block A ⟨X,σ:{CAT:verb,TNS:fut}⟩ ⟶ ⟨*ta*X,σ⟩
⟨X,σ:{CAT:verb,TNS:past}⟩ ⟶ ⟨*li*X,σ⟩
⟨X,σ:{CAT:verb,POL:neg,TNS:past}⟩ ⟶ ⟨*ku*X,σ⟩

Block B ⟨X,σ:{CAT:verb,AGR(su):{PERS:1,NUM:sg}}⟩ ⟶ ⟨*ni*X,σ⟩
⟨X,σ:{CAT:verb,AGR(su):{PERS:2,NUM:sg}}⟩ ⟶ ⟨*u*X,σ⟩
⟨X,σ:{CAT:verb,AGR(su):{PERS:3,NUM:sg},GEN:{1,2}}⟩ ⟶ ⟨*a*X,σ⟩
⟨X,σ:{CAT:verb,AGR(su):{PERS:1,NUM:pl}}⟩ ⟶ ⟨*tu*X,σ⟩
⟨X,σ:{CAT:verb,AGR(su):{PERS:2,NUM:pl}}⟩ ⟶ ⟨*m*X,σ⟩
⟨X,σ:{CAT:verb,AGR(su):{PERS:3,NUM:pl},GEN:{1,2}}⟩ ⟶ ⟨*wa*X,σ⟩

Block C ⟨X,{CAT:verb, POL:neg}⟩ ⟶ ⟨*ha*X,σ⟩

Recall that the identity function, ⟨X,σ⟩ ⟶ ⟨X,σ⟩, is a member of every rule block, according to the IFD. Thus, we see for example, that the negated third singular past tense form is correctly predicted to be *ha-a-ku*-ROOT and not **ha-a-li*-ROOT,

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[10] Note that, in this literature, the term *portmanteau* has a more restrictive use than how we use it here. What we have been calling a portmanteau would be called *cumulative exponence.*

[11] The simplification does not account for all the nuances of the paradigms that are captured by the rules in Stewart & Stump (2007).

because the portmanteau form *ku* expresses both the past tense and the negation. From Block A, then, the third rule must be chosen. From Block B, the third rule best expresses the features. Lastly, the rule in Block C can apply, given the input features. The result is the well-formed *ha-a-ku*-ROOT, which undergoes phonological shortening to *ha-ku*-ROOT.

Sadler & Nordlinger (2004) presented an LFG interface to PFM for case-stacking in Australian languages that display that phenomenon (e.g., Kayardild, Martuthunira, Thalanyji, Wambaya). Sadler & Nordlinger (2006) subsequently presented the actual PFM morphology, i.e. realization, of case-stacking morphology. The two papers together constitute an instance of LFG interfaced with PFM. Sadler & Nordlinger (2004: 172–180) provide a detailed analysis of the following example from Martuthunira (Dench 1995: 60, (3.15)):

(17) Martuthunira
Ngayu nhawu-lha ngurnu tharnta-a mirtily-marta-a
I saw-PST that.ACC euro-ACC joey-PROP-ACC
thara-ngka-marta-a.
pouch-LOC-PROP-ACC
1 saw the euro with a joey in (its) pouch.

Sadler & Nordlinger (2004: 174, (28)) provide the following lexemic entry[12] for the word *tharangkamartaa* in (17):

(18) ⟨*thara*, {Case$_C$: LOC, {Case$_C$: PROP, {Case$_C$: ACC}}}⟩

Sadler & Nordlinger (2004: 174, (25)) provide the following interpretations of these case features:[13]

(19)

M-feature	F-description
Case$_C$: LOC	$(\uparrow \text{CASE}) = \text{LOC}$
	$(\text{ADJ}_{loc} \in \uparrow)$
Case$_C$: PROP	$(\uparrow \text{CASE}) = \text{PROP}$
	$(\text{ADJ}_{prop} \in \uparrow)$
Case$_C$: ACC	$(\uparrow \text{CASE}) = \text{ACC}$
	$(\text{OBJ} \uparrow)$

---

[12] We use the terminology of Dalrymple 2015; see Section 4 above.

[13] Their table does not include ACC but what its entry should be is clear from their (30) (Sadler & Nordlinger 2004: 175). Also, we have adjusted for the feature ADJ being set-valued by using the symbol $\in$.

In the Dalrymple (2015) notation this would be:[14]

(20) *LE*⟨{ROOT: pouch}, {(↑ PRED) = POUCH}, POUCH1⟩

R⟨POUCH1, tharangkamartaa, /t̪araŋkamaʈaa/,
m-features:{M-CAT:N, M-CASE: LOC, {M-CASE: PROP, {M-CASE: ACC}}}⟩

D⟨POUCH1, m-features, N, (↑ NUM) = SG
(↑ CASE) = LOC
(ADJ$_{loc}$ ∈ ↑)
((ADJ$_{loc}$ ∈ ↑) CASE) = PROP
(ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)
(((ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)) CASE) = ACC
(OBJ ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)⟩

$\mathcal{L}$⟨tharangkamartaa, /t̪araŋkamaʈaa/,
N, {(↑ PRED) = POUCH
(↑ NUM) = SG
(↑ CASE) = LOC
(ADJ$_{loc}$ ∈ ↑)
((ADJ$_{loc}$ ∈ ↑) CASE) = PROP
(ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)
(((ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)) CASE) = ACC
(OBJ ADJ$_{prop}$ ∈ ADJ$_{loc}$ ∈ ↑)}⟩

This complex lexical entry $\mathcal{L}_{tharangkamartaa}$ licenses the following f-structure:

(21)
$$\left[\begin{array}{ll} \text{OBJ} & \left[\begin{array}{ll} \text{CASE} & \text{ACC} \\ \text{ADJ}_{prop} & \left\{\left[\begin{array}{ll} \text{CASE} & \text{PROP} \\ \text{ADJ}_{loc} & \left\{\left[\begin{array}{ll} \text{PRED} & \text{POUCH} \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{LOC} \end{array}\right]\right\} \end{array}\right]\right\} \end{array}\right] \end{array}\right]$$

Thus, we can observe that the Dalrymple (2015) notation accurately reconstructs the intended f-structure from Sadler & Nordlinger (2004: 178, (36)).[15]

However, some work remains to be done. How is the realization of *tharangkamartaa* determined based on the root, lexemic ID, and the m-features? The Dalrymple (2015) framework is silent on this issue, because it is meant to be a *general*

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[14] The (↑ NUM) = SG part of the f-description occurs by default, following the assumption in Dalrymple (2015: 76) that singular number is the default for nouns (i.e., M-CAT:N in the absence of M-NUM introduces the f-description {(↑ NUM) = SG}).

[15] Modulo our use of ∈, which they simplify away, and the [NUM SG], which comes from Dalrymple's default; see footnote 14 above.

interface between LFG syntax and realizational morphology. In order to preserve its generality, the framework remains silent on the question of exponence. As mentioned above, Sadler & Nordlinger (2006) provide a PFM account, which we can plug into the Dalrymple framework. Adapting their proposal (Sadler & Nordlinger 2004: 471, 23) — which in any case is for Kayardild, not Martuthunira — we get the following case rule block, using the Dalrymple (2015) *R* function:

(22) a. *R*⟨POUCH1, tharangka, /t̪araŋka/,
{M-CAT:N, M-CASE: LOC}⟩
b. *R*⟨POUCH1, tharangkamarta, /t̪araŋkamaʈa/,
{M-CAT:N, M-CASE: PROP}⟩
c. *R*⟨POUCH1, tharangkamartaa, /t̪araŋkamaʈaa/,
{M-CAT:N, M-CASE: ACC}⟩

The effect of these functions on the s-form can be captured in the following simplified PFM representation, based on (15).[16]

(23) ⟨X,σ:{M-CAT:N, M-CASE:LOC}⟩ ⟶ ⟨X*ngka*,σ⟩
⟨X,σ:{M-CAT:N, M-CASE:PROP}⟩ ⟶ ⟨X*marta*,σ⟩
⟨X,σ:{M-CAT:N, M-CASE:ACC}⟩ ⟶ ⟨X*a*,σ⟩

In other words, in the context of the features M-CAT:N and M-CASE:LOC, the input exponent becomes extended with additional morphological information, the suffix *ngka*. In the context of the features M-CAT:N and M-CASE:PROP, the input exponent becomes extended with additional morphological information, the suffix *marta*. And, in the context of the features M-CAT:N and M-CASE:ACC, the input exponent becomes extended with additional morphological information, the suffix *a*.

In sum, much work in LFG has adopted Paradigm Function Morphology as its morphological theory. PFM is an *inferential-realizational* theory of morphology. It is *lexemic*, it is *Word-and-Paradigm*, and it assumes *Strong Lexicalism*.

5.2 The targets of exponence

What realizational theories have in common is that morphology realizes things; what they don't have in common is what those things are. In a paradigm model, like PFM, morphology realizes a lexeme and a valuation of a fixed set of attributes.

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[16] Note that the simplified formalization in (23) does not account for the set-based embedding in (17) above. But it should be easy enough to replace the second coordinate of the input to their function with **contains**(f), where **contains** is a function that recursively searches σ for its argument, f, a feature, e.g. M-CASE:LOC.

It must be a *fixed* set of attributes, by definition of a paradigm. As Spencer (2013) notes:

> On this […] conception we abstract away from actual word forms and just consider the set of oppositions or contrasts that are available in principle to a lexeme. (Spencer 2013: 9)

"The set of cells embodying the set of oppositions open to a lexeme" is what Spencer (2013: 9) calls the *property paradigm*. It's *this* abstraction, the property paradigm, that is realized by word forms (the *form paradigm*) in what Spencer calls the *form-property paradigm* (Spencer 2013: 9). In this kind of conception, in order to preserve Strong Lexicalism one must simply have an intervening function that maps a lexeme to a syntactic word:

(24) form-property paradigm $\xrightarrow{f}$ set of instantiated lexical entries for syntax

The mapping f can be a structured mapping, if there are features of the mapping itself that the grammar needs to refer to. This could be represented as an attribute-value matrix. In other words, m-structure (see above) is one possible characterization of the structured mapping f. And an AVM is also indeed how Spencer (2013) models the structured mapping f; see Figure 5. This paradigm shows the lexeme DELAT′ ('make') from Russian, which has stem alternants in the present (*delaj-*), infinitive (*dela-*), and predicative adjective (*delal-*).

Ackerman & Stump (2004) make an antecedent proposal to that of Spencer (2013) which is very similar, although not as well-developed (as a consequence of the former being a paper and the latter a monograph). However, it is worth reading the following passage from Ackerman & Stump (2004) to get a different perspective on the form-property paradigm of Spencer (2013), especially because it refers more directly to LFG structures:

> In distinguishing a lexeme's content-theoretic aspects from its form-theoretic aspects, we will pursue an innovative conception of the lexicon and its relation to c-structure, f-structure, and morphological realization. On this conception, a language's lexicon is bipartite with respect to content and form: one part of its lexicon is its LEXEMICON, whose individual entries are lexemes bearing lexical meanings: the complementary part is its RADICON, whose individual entries are roots, i.e. elements of form. Every member L of a language's lexemicon has an associated CONTENT-PARADIGM C-P(L) such that each cell in C-P(L) consists of the pairing of L with a complete set of morphosyntactic properties; we refer to any such pairing as a

> content-cell. Crucially, content-cells represent ensembles of semantically interpretable information. In contrast, every member r of a language's radicon has an associated form-paradigm F-P(r) such that each cell in F-P(r) consists of the pairing of r with a set of differentiating morphosyntactic property labels; we refer to any such pairing as a form-cell. A language's paradigms of form-cells house the information necessary to deduce the morphological realization of the cells in that language's content-paradigms. (Ackerman & Stump 2004: 117–118)

Although their terminology is different, there are obvious correspondences with Spencer (2013). Ackerman & Stump (2004) assume that a lexicon consists of two parts. The first part is the lexemicon, which "has an associated content-paradigm". Their content-paradigm corresponds to Spencer's property paradigm. The second part of the lexicon for Ackerman & Stump (2004) is

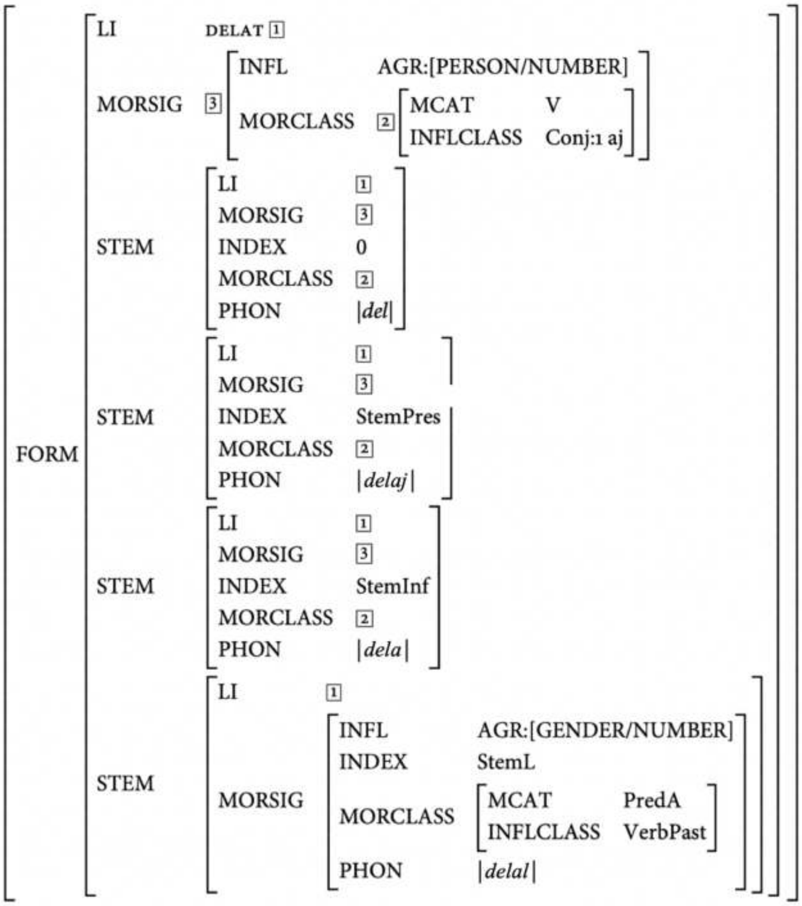

Figure 5: The form-property paradigm for Russian delat′ ('make'). From Spencer (2013: 263, (56)); used with permission.

the RADICON, which “has an associated FORM-PARADIGM”. Their form-paradigm corresponds to Spencer’s form paradigm. Taken together, then, Ackerman & Stump’s (2004) lexicon is equivalent to a set of Spencer’s (2013) form-property paradigms. As a consequence, the mapping in (24) above also accurately characterizes the Ackerman & Stump (2004) proposal, which is about periphrasis — when a paradigm cell is filled by more than one word. Further work in this vein can be found in, e.g., Ackerman et al. (2011) and Spencer (2015). We have chosen to describe the Spencer (2013) and Ackerman & Stump (2004) work because of their close connection to LFG, but PFM2 (Stump 2016) incorporates similar principles.

The important takeaway here is that in lexemic morphology there is a mapping (structured or not) from an abstract property paradigm — whose features are purely morphological — to syntax. One could imagine instead having morphology realize the syntactic representation(s) directly, which is the approach taken in Distributed Morphology (DM; Halle & Marantz 1993), and theories like it (e.g., Nanosyntax; Starke 2009, Caha 2009). This comes at the expense of (at least some of) Strong Lexicalism, as discussed below in reference to (38), but it does away with the abstraction of the property paradigm. In a morphemic model, like DM, morphology realizes the information in the terminals of some syntactic representation. There will necessarily be information about syntax, but also possibly about semantics and other aspects of grammar (if they are modelled separately).

5.3 LFG interfaced with DM

In Section 5.1, we explored LFG paired with PFM, an inferential-realizational framework for morphology. In this section, we see LFG paired with Distributed Morphology, a lexical-realizational framework. This combination is called Lexical-Realizational Functional Grammar ($\mathrm{L_RFG}$; Asudeh & Siddiqi 2016, Melchin et al. 2020, Everdell et al. 2021, Asudeh & Siddiqi forthcoming). $\mathrm{L_RFG}$ accomplishes this synthesis of LFG and DM by mapping information from the c-structure to a realization, or *exponent*, called *vocabulary structure*.

Importantly, $\mathrm{L_RFG}$ assumes that c-structure terminals are not *words*, but just grammatical and semantic information, with no associated information about the form (e.g., *s-form*; see Section 4.1) included in the c-structure. This fact, together with the fact that $\mathrm{L_RFG}$ follows DM in postulating highly articulated morphological structure, differentiates $\mathrm{L_RFG}$ c-structures from LFG c-structures. However, $\mathrm{L_RFG}$ uses the LFG formal machinery and assumes the same kinds of annotated c-structure rules. In $\mathrm{L_RFG}$, the categorial information in c-structure *preterminals* and the other information in c-structure *terminals* are realized by L$_{\text{R}}$FG's *v* correspondence function as v(ocabulary)-structures. Since L$_{\text{R}}$FG assumes a version of LFG's Correspondence Architecture (Kaplan 1989, 1995), the information that v-structures express is not *purely* syntactic. V-structures also express information about semantics (encoded in Glue Semantics *meaning constructors*: see Asudeh 2023 [this volume]) and can indeed express information structure or any other aspect of grammar that is encoded in distinct modules in the Correspondence Architecture.

L$_{\text{R}}$FG seeks to add to LFG's strengths in accounting for *nonconfigurationality* by adding DM's strengths in accounting for *polysynthesis.* These two properties co-occur with some frequency in non-European languages. L$_{\text{R}}$FG also seeks to account for highly agglutinative languages like Finnish and Turkish. Additionally, because the realizational module, v-structure, interfaces with prosodic structure, L$_{\text{R}}$FG draws on existing LFG work, especially Bögel (2015), on clitic ordering and extends it to affixation. Asudeh et al. (2022) develops the interface between v-structure and p(rosodic)-structure (by the ρ correspondence function) and the mapping from p-structure to the p(honological)-string (by the *o* correspondence function).

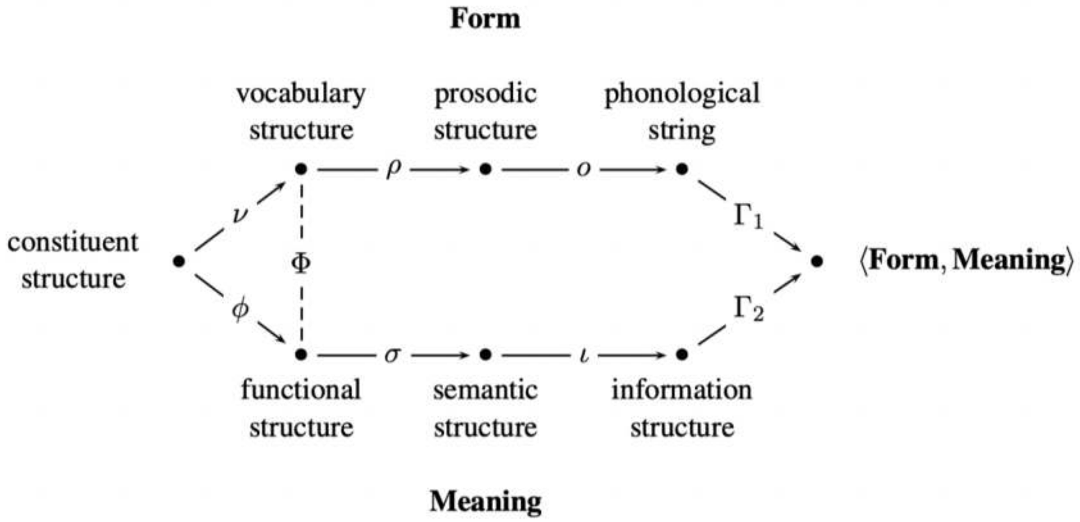

Figure 6: L$_{\text{R}}$FG's version of LFG's Correspondence Architecture. From Melchin et al. (2020: 271); used with permission.

L$_{\text{R}}$FG's version of LFG's Correspondence Architecture is shown in Figure 6, which shows that there is a lot shared between L$_{\text{R}}$FG and LFG. However, there is no lexicon feeding the c-structure in L$_{\text{R}}$FG. Rather, there is a Vocabulary in L$_{\text{R}}$FG that consists of a set of mappings from n-tuples that contain categorial information and an f-description to vocabulary structures that realize the content of the input. In recent L$_{\text{R}}$FG work on morphosemantics (Asudeh & Siddiqi 2022), we suggest that, for the purposes of the ν-mapping, the f-description could be usefully partitioned into a set consisting of information about non-f-structural aspects of the grammar (in particular, Glue meaning constructors for compositional semantics) and the set consisting of the rest of the f-description, which is information about f-structure.[17] The following example shows Vocabulary Items (VIs) for Ojibwe and English roots for *see* (Asudeh & Siddiqi 2022):[18]

(25) Ojibwe

$$\langle\ [\sqrt{}], \Phi\{(\uparrow \textsc{pred}) = \textsc{see}\}, \{\textbf{see} : (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap {\uparrow_\sigma}\}\ \rangle \xrightarrow{\nu} \textit{waab}$$

(26) English

$$\langle\ [\sqrt{}], \Phi\{(\uparrow \textsc{pred}) = \textsc{see}\}, \{\textbf{see} : (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap {\uparrow_\sigma}\}\ \rangle \xrightarrow{\nu} \textit{see}$$

The first coordinate of the input is a list of c-structure categories, typically of length 1. However, it is actually an ordered list of preterminals from the c-structure, such that the list can be longer in cases of *spanning* (Ramchand 2008, Haugen & Siddiqi 2016, Svenonius 2016, Merchant 2015), which is used in some versions of DM for *portmanteau* phenomena. The result is similar to the Lexical Sharing model proposed for LFG by Wescoat (2002, 2005, 2007), but maintains, like DM, that the complex internal structures of words are part of syntax.

In the cases above, the list is of length 1 and has the sole category $\sqrt{}$, the category of all roots. The second coordinate uses the *bridging function*, Φ, to map the f-description to the set of f-structures that it describes. The third coordinate is not subject to Φ and contains semantic information modelled in Glue meaning constructors.

Meaning constructors are pairs of terms from two logics (the colon is an uninterpreted pairing symbol):

(27) $\mathcal{M} : G$

$\mathcal{M}$ is an expression of the *meaning language* — anything that supports the lambda calculus. G is an expression of *linear logic* (Girard 1987), which specifies semantic composition based on a syntactic parse that instantiates the general terms in G to a specific syntactic structure.

The meaning constructors serve as premises in a linear logic proof of the *compositional semantics.* Consider example (28).

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[17] The new third coordinate could potentially also include i-structural information; or perhaps this would be better captured in a separate fourth coordinate. We plan to explore this in future work.

[18] We will present the *bridging function*, Φ, shortly.

(28) Alex likes Blake.

We obtain the following meaning constructors from the relevant VIs.

(29) Meaning constructors:
$$\begin{aligned}&\textbf{alex} : a\\ &\textbf{blake} : b\\ &\lambda y.\lambda x.\textbf{like}(y)(x) : b \multimap a \multimap l\end{aligned}$$

Note that $\lambda y.\lambda x.\textbf{like}(y)(x)$ is η-equivalent to just **like**, but it is useful to use the expanded form to make the structure of the following proof more obvious.

(30)
$$\dfrac{\boxed{\textbf{alex} : a} \qquad \dfrac{\boxed{\lambda y.\lambda x.\textbf{like}(y)(x) : b \multimap a \multimap l} \qquad \boxed{\textbf{blake} : b}}{\lambda x.\textbf{like}(\textbf{blake})(x) : a \multimap l}}{\textbf{like}(\textbf{blake})(\textbf{alex}) : l}$$

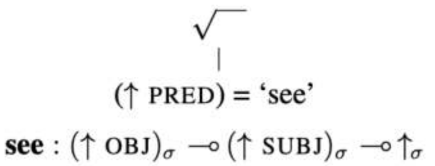
In the proof, the meaning constructors in (29) are shown in boxes to aid the reader less familiar with Glue; this is not a part of the proof as such. It highlights the meaning constructors versus the compositionally derived meanings. For brief overviews of Glue Semantics, see Asudeh (2022); Asudeh 2023 [this volume].

Recall the Vocabulary Item for Ojibwe *waab* in (25):

(31) $\langle\ [\sqrt{\ }],\ \Phi\{(\uparrow \textsc{pred}) = \textsc{see}\}, \{\textbf{see} : (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap \uparrow_\sigma\}\ \rangle \xrightarrow{v} \textit{waab}$

This information can be represented as follows in a c-structure:

(32)



The c-structure is licensed by c-structure rules of the usual kind, but containing categories like $\sqrt{\ }$, which are less familiar in LFG. Thus, the annotated c-structure rule for licensing (32) in a c-structure would be as follows, leaving the mother category underspecified and similarly the sister of $\sqrt{\ }$:

(33)
$$\begin{array}{lccc} \mathrm{X}^n & \longrightarrow & \sqrt{\ } & \mathrm{X}^{m,\ m\leq n}\\ & & \uparrow=\downarrow & \uparrow=\downarrow \end{array}$$

Note that it is X^m that projects the c-structure mother X^n in a co-head structure with $\sqrt{\ }$. Thus, X is necessarily a functional category (Bresnan et al. 2016: ch. 6).

In short, we can think of the lefthand side of a Vocabulary Item as a tree admissibility condition (McCawley 1968) on a subtree whose preterminal yield is the list of categories in the first coordinate of the v function such that the f-description in the second coordinate and the meaning constructors in the third are the union of its terminal yield. Alternatively, we can think of it in terms of terminal expansions, such as:

(34) $$\sqrt{} \longrightarrow \left\{ \begin{matrix} \{(\uparrow \textsc{pred}) = \textsc{see}, \textbf{see} : (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap \uparrow_\sigma\}, \\ \vdots \end{matrix} \right\}$$

We prefer the tree admissibility route, but observe that whether we go that route or the terminal expansion route, there is no information about form in the input side of the Vocabulary Item. That is the job of the *ν* correspondence function. Recall that *ν* maps the information in c-structure terminals and c-structure categorial information to v-structures, as shown in (25–26).

Here is an example from Ojibwe (*Anishinaabemowin*, Algonquian; Melchin et al. 2020: 288):

(35) Ojibwe

gi-	gii-	waab	-am	-igw	-naan	-ag
2	PST	see	VTA	INV	1PL	3PL

‘They saw us(incl).’

The L_RFG c-structure and f-structure and the *ν* correspondence from c-structure to v-structure are shown in Figure 7 (Melchin et al. 2020: 288). Note that we have only shown the form part of each v-structure, and only using an orthographic rather than phonemic representation. V-structures also minimally contain prosodic information — such as information about phonological dependency (e.g., for *clisis*) and the identity of the host (e.g., for *affixation*) — and any purely morphological information (e.g., *inflectional class*). Asudeh et al. (2022) propose the v-structure representation that is schematized in (36).

(36) $$\left[\begin{array}{ll} \begin{array}{l}\textsc{phon(ological)} \\ \textsc{rep(resentation)}\end{array} & \textit{phonological realization \& conditions} \\ \textsc{p(rosodic)frame} & \textit{prosodic unit} \\ \textsc{p(rosodic)level} & 1|2 \\ \textsc{dep(endence)} & \{\textsc{left},\textsc{right}\} \\ \textsc{class} & \{\textit{inflectional classes}\} \\ \textsc{type} & \textsc{verbal}|\textsc{nominal}|\textsc{adjectival} \\ \textsc{host} & \left[\begin{array}{l} \textsc{identity}\ \ \textsc{aunt}|\textsc{niece} \\ \left\{ \left[\begin{array}{ll} \textsc{phon.rep} & \ldots \\ \textsc{pframe} & \ldots \\ \textsc{plevel} & \ldots \\ \textsc{class} & \ldots \\ \textsc{type} & \ldots \end{array} \right] \right\} \end{array} \right] \end{array} \right]$$

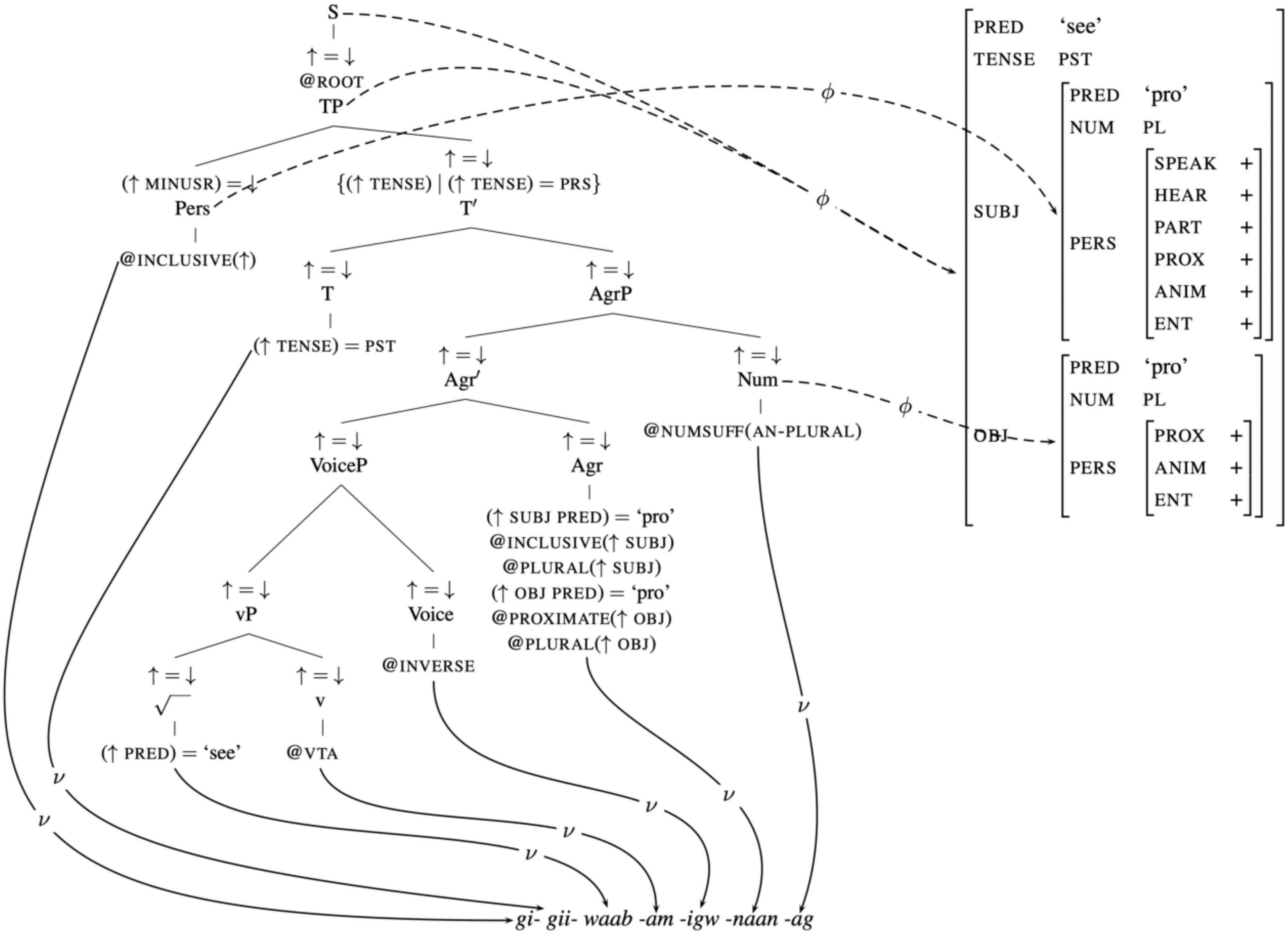


Figure 7: L$_{\text{R}}$FG c-structure, f-structure, and (simplified) v-structure for Ojibwe *gigiiwaabamigwnaanag* ('They saw us(incl)')

A v-structure is thus a feature structure that minimally contains information about form and morphophonology (PHON.REP, PFRAME, PLEVEL, and DEP), properly morphological information (CLASS, TYPE), and morphosyntactic information about its HOST, where relevant. All features can be left underspecified (i.e., when they are not mentioned in the description that defines the v-structure).

The obvious point of contrast between L_RFG and LFG concerns the Lexicalist Hypothesis (Chomsky 1970, Lapointe 1980):

(37) *Lexicalist Hypothesis*
No syntactic rule can refer to elements of morphological structure.
(Lapointe 1980: 8)

In LFG, this is captured in the *Lexical Integrity Principle*, through formulations like the following:

(38) *Lexical Integrity*
Morphologically complete words are leaves of the c-structure tree, and each leaf corresponds to one and only one c-structure node.
(Bresnan et al. 2016: 92)

This statement has two parts:

1. L_RFG *upholds* the part that states that "each leaf corresponds to one and only one c-structure node".
2. L_RFG *rejects* the part that states that "morphologically complete words are leaves of the c-structure tree".

Clearly, the c-structure leaves/terminals in L_RFG are not "morphologically complete words". The c-structure leaves/terminals are feature bundles that *map* to form, but the form itself is not part of the terminal node; hence 2. Yet there is never multidominance in an L_RFG c-structure; hence 1.

However, notice that the notion *morphologically complete word* is left unanalyzed in the definition in (38). In fact, it is far from clear that "morphologically complete word" is a coherent notion (for discussion, see e.g., Anderson 1982). The essential problem is that there are multiple relevant notions of wordhood, and they don't align on a single type of object that we can point to and unambiguously and confidently call a word (Di Sciullo & Williams 1987).[19] In fact, there can be mismatches between the phonological, syntactic, and semantic aspects of words (Marantz 1997). Of course, the LFG Correspondence Architecture is designed around the notion of mismatches between modules, which is carried over into L_RFG.

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[19] This is a long and broad discussion that we cannot possibly do justice to here.

5.3.1 Conditions on exponence

Recall that the exponence function $(\overset{v}{\rightarrow})$ maps a triple to a v-structure. The first argument of the triple is a list of preterminal categories, typically of length 1, which are taken in the linear order they appear in the tree. The second argument is itself a function, Φ, which maps an f-description to the set of f-structures that satisfy the description; i.e. $\Phi(d \in D) = \{f \in F \mid f \vDash d\}$, where D is the set of valid f-descriptions and F is the set of f-structures.[20] The third argument is a set that includes *meaning constructors* from Glue Semantics (Glue; Dalrymple 1999, 2001, Dalrymple et al. 2019, Asudeh 2012, 2022).

Let V^i be the domain of the exponence function v in some language L, i.e. the set of inputs to Vocabulary Items in L. We write $V^i(\alpha)$ to indicate the domain of some particular Vocabulary Item, α. We write $\pi_n(V^i(\alpha))$ to indicate the nth projection of $V^i(\alpha)$. For example, $\pi_1(V^i(\alpha))$ returns the c-structure list in the first projection of the input to Vocabulary Item α.[21] The following conditions on exponence hold based on the input side of the v correspondence function (Asudeh & Siddiqi 2022).[22]

(39) **MostInformative**$_c(\alpha, \beta)$ returns whichever of α,β has the longest list of overlapping c-structure categories.

Intuition. Prefer portmanteau forms, whenever possible, on c-structural grounds. Choose the VI that realizes the greater list of categories.

Formalization. We define a function **span** that compares two lists for overlap.[23]

Given two Vocabulary Items, α and β,

$$\textbf{MostInformative}_c(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \pi_1(V^i(\alpha)) = f \wedge \pi_1(V^i(\beta)) = g \wedge \textbf{span}(f, g) \\ \beta \textbf{ if } \pi_1(V^i(\alpha)) = f \wedge \pi_1(V^i(\beta)) = g \wedge \textbf{span}(g, f) \\ \bot \textbf{ otherwise} \end{cases}$$

(40) **MostInformative**$_f(\alpha, \beta)$ returns whichever of α,β has the most specific f-structure in the set of f-structures returned by Φ applied to α/β's collected f-description.

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[20] We thank Ron Kaplan (p.c.) for discussion of this point. Any remaining errors are our own.

[21] This π is just standard notation for retrieving arguments to functions and should not be mistaken for a correspondence function.

[22] Note that all these conditions are Paninian, as is typical in morphological analysis. The analog in PFM is actually called Panini's Principle (Stump 2001) and in DM it is called the Subset Principle (Halle & Marantz 1993).

[23] Asudeh & Siddiqi (2022) define **span** as follows:

$$\textbf{span}(list_1, list_2) = \begin{cases} \mathsf{first}(list_1) = \mathsf{first}(list_2) \wedge \textbf{span}(\mathsf{rest}(list_1), \mathsf{rest}(list_2)) \\ list_1 \neq elist \wedge list_2 = elist \end{cases}$$

Intuition. Prefer portmanteau forms, whenever possible, on f-structural grounds. Choose the VI that defines an f-structure that contains the greater set of features.

Formalization. The proper subsumption relation on f-structures (Bresnan et al. 2016: ch. 5) is used to capture the intuition.
Given two VIs, α and β,

$$\textbf{MostInformative}_f(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } \exists f \forall g. f \in \pi_2(V^i(\alpha)) \land g \in \pi_2(V^i(\beta)) \land g \sqsubset f \\ \beta \textbf{ if } \exists f \forall g. f \in \pi_2(V^i(\beta)) \land g \in \pi_2(V^i(\alpha)) \land g \sqsubset f \\ \bot \textbf{ otherwise} \end{cases}$$

(41) **MostInformative**$_s(\alpha,\beta)$ returns whichever Vocabulary Item has the more specific meaning.
Intuition. Prefer portmanteau forms, wherever possible, on semantic grounds. Choose the VI whose denotation is more semantically contentful.
Formalization. The proper subset relation on set-denoting expressions is used to capture the intuition.
Given two Vocabulary Items, α and β,

$$\textbf{MostInformative}_s(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } f = \pi_3(V^i(\alpha)) \land g = \pi_3(V^i(\beta)) \land [\![f]\!] \subset [\![g]\!] \\ \beta \textbf{ if } f = \pi_3(V^i(\alpha)) \land g = \pi_3(V^i(\beta)) \land [\![g]\!] \subset [\![f]\!] \\ \bot \textbf{ otherwise} \end{cases}$$

In addition, there is a constraint on exponence that concerns the output of the ν correspondence function (Asudeh & Siddiqi 2022), i.e. the expression of prosodic and phonological information. Let V^o be the co-domain of the exponence function ν in some language L, i.e. the set of outputs of Vocabulary Items in L. We write $V^o(\alpha)$ to indicate the co-domain of some particular Vocabulary Item, α (i.e., the output vocabulary structure).

(42) **MostSpecific**(α,β) returns whichever Vocabulary Item has the most restrictions on its phonological context.

Intuition. Prefer affixes whenever possible.

Formalization. The proper subsumption relation on feature structures — i.e., v-structures — is used to capture the intuition.
Given two Vocabulary Items, α and β,

$$\textbf{MostSpecific}(\alpha,\beta) = \begin{cases} \alpha \textbf{ if } (V^o(\beta)\ \textsc{host}) \sqsubset (V^o(\alpha)\ \textsc{host}) \\ \beta \textbf{ if } (V^o(\alpha)\ \textsc{host}) \sqsubset (V^o(\beta)\ \textsc{host}) \\ \bot \textbf{ otherwise} \end{cases}$$

The upshot is that **MostSpecific** chooses the VI whose output v-structure has more specific content in the HOST feature.[24]

Note that **MostInformative**$_c$ and **MostInformative**$_f$ are *morphosyntactic* constraints, **MostInformative**$_s$ is a *morphosemantic* constraint, and **MostSpecific** is a *morphophonological* constraint. Note also that each constraint can result in a tie, represented by ⊥. However, there are regularities in the mappings/interfaces between structures, so it would be unlikely for all four constraints to yield ⊥. We are not currently aware of any empirical case that would merit such an analysis. Lastly, it is important to note that these constraints apply simultaneously and universally (whenever they can), much like standard constraints and equations in LFG. There is no constraint-ordering and the constraints are not soft constraints.[25]

In sum, L$_\text{R}$FG is a daughter framework of LFG that uses the LFG formalism in a conservative fashion. However, L$_\text{R}$FG theory makes some different assumptions from traditional LFG theory. Namely, it rearranges the Correspondence Architecture, adds a new structure with new properties (v-structure), upholds only part of the Lexical Integrity Principle, and has a more articulated c-structure than standard LFG, in order to provide a morphemic theory of morphology. These theoretical distinctions are due to the influence of DM, since L$_\text{R}$FG is also a daughter framework of DM.

As its name states, Lexical-Realizational Functional Grammar is a *lexical-realizational* theory of morphology. It is *morphemic*, *Item-and-Arrangement*, and *morphosyntactic.*

6 Conclusion

A feature of LFG is its f-descriptions, which can occur in both lexical entries and on c-structure nodes. The result is that both morphology and syntax can contribute information to f-structure. This ‘common language’ between morphology and syntax has allowed LFG to remain agnostic about the precise nature of

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[24] Note that if (f FEAT) does not exist, (f FEAT) resolves to the empty feature structure, notated ⊥ (not to be confused with the ⊥ explicitly mentioned in the constraints above). as it’s the bottom of the f-structure lattice. The empty f-structure subsumes all f-structures. Therefore, if (v HOST) does not exist, but (v' HOST) does exist, then (v HOST) $\sqsubset$ (v' HOST) returns true. If (v' HOST) also does not exist, then (v HOST) $\sqsubset$ (v' HOST) returns false, since it is false that ⊥ *properly* subsumes ⊥.

[25] An anonymous reviewer wonders what the system would do if one constraint picks α and another picks β. This is an interesting point that deserves further investigation and we thank the reviewer for highlighting it.

morphology. In its initial construal as just a theory of syntax, based around c-structure and f-structure, this was pretty harmless. But once a general grammatical architecture, the Correspondence Architecture, was proposed (Kaplan 1989, 1995), LFG began to owe a better account of how it interfaces with morphology.

In early LFG, morphology was generally done incrementally, using annotated phrase structure rules of the same kind that license c-structures, but whose categories are morphological instead of syntactic. Morphological theory in general, though, has been converging on the idea that morphology is realizational, not incremental. Therefore, more recent work has focused on exploring the syntax–morphology interface (Dalrymple 2015, Dalrymple et al. 2019: ch. 12) in light of an interface with realizational morphology. This work can be thought of as providing a universal adapter between LFG syntax and some kind of realizational morphology. Much of the theoretical work on morphology for LFG over the last couple of decades has focused on interfacing LFG with Paradigm Function Morphology. Other recent work has presented an alternative in the guise of L$_{\mathrm{R}}$FG, a framework that instead interfaces LFG with Distributed Morphology.

The existence of two different approaches to morphological realization in LFG, i.e. PFM and L$_{\mathrm{R}}$FG, mirrors two different interpretations of 'morphological complexity' as a set of phenomena requiring explanation. *Paradigmatic* morphological complexity (see, e.g., Baerman et al. 2017) concerns complex patterns of syncretism, root allomorphy, and templatic morphology. *Syntagmatic* morphological complexity concerns concatenative morphology whose structures seem to encode syntactic structure, in other words structure *within* what we pretheoretically call words. PFM addresses the former kind of morphological complexity, while L$_{\mathrm{R}}$FG addresses the latter.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

INV	inverse voice	VTA	verb transitive animate object
PROP	proprietive case		

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Part IV

Linguistic disciplines

Chapter 20

LFG and historical linguistics

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This chapter looks at the opportunities and perspectives that LFG offers for the study of language change, surveying existing LFG approaches within historical linguistics and providing examples of sample phenomena. We discuss how reanalysis, a major driver of language change, can be accounted for elegantly within LFG's parallel architecture thanks to its crucial separation of form from function and, moreover, how different types of reanalysis can be understood, whether they involve rebracketing, recategorization, or changes at the lexical level commonly discussed in terms of grammaticalization. As we also discuss, LFG's fundamental design principles and resulting flexibility of c-structure allow for complex, nuanced accounts of word order change. Furthermore, we survey the opportunities that LFG offers for exploring the complex relationship between variation and change, and in particular frequency effects and gradual change which proceeds via competition. Finally, we signpost future possibilities for work in this relatively underexplored but promising area.

1 Introduction

This discussion of historical linguistic work in LFG builds on two previous meta-discussions.[1] One is Vincent's (2001) wide-ranging and satisfyingly deep, comparative look at the possibilities which LFG's particular projection architecture

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[1] An additional discussion of previous diachronic LFG accounts relating specifically to the history of English is Allen (2012).

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and its combination of both functionalist and generative perspectives offer for an analysis of various different types of language change. The other is a recent handbook article by Börjars & Vincent (2017), which offers more detail on c-structural analyses of language change in several Germanic languages that have emerged since the seminal *Time Over Matter* book. The *Time Over Matter* book (Butt & King 2001) represents the first collection of historical linguistic work within LFG, in which Vincent's (2001) contribution represents more of a position paper than a mere introduction to a collected volume.

In this chapter, we provide a discussion of architectural issues and perspectives on language change in Section 2. However, our intention is not to reproduce the in-depth discussions already found in Vincent (2001) and Börjars & Vincent (2017), so we keep this section comparatively brief and proceed on to discussing examples of lexical and functional change in Section 3. This includes phenomena generally dealt with under the rubric of "grammaticalization", but also an understanding of complex predication, passives and case. Section 4 provides a discussion of language change at c-structure, which includes "growing" functional categories, understanding changes in word order and the syntactic configuration of a language and the development of mixed categories. Finally, we address the possibilities for modelling the complex relationship between variation and change within LFG in Section 5.

2 The LFG Architecture and mechanisms of language change

As Vincent (2001) and Börjars & Vincent (2017) point out, LFG is like most theories in the generative tradition in that it was not specifically designed with diachrony in mind. There is no paper tackling language change in the landmark Bresnan (1982) volume. Serious historical work within LFG mainly began in the 1990s, with an early exception represented by Allen (1986): see Section 3.2. However, as demonstrated by Vincent (2001), LFG's fundamental design principles and its parallel projections are particularly well-suited to modelling diachronic change (see also the discussion of paradigms in Börjars et al. 1997).

In their textbook on language change, Harris & Campbell (1995) articulate a position whereby reanalysis, along with extension and borrowing, is seen as a key mechanism of language change. Reanalysis in their terms covers quite a broad range of phenomena, involving morphophonological and morphosyntactic changes.[2] A relevant touchstone here is Langacker's (1977: 59) classic definition of reanalysis, which Vincent (2001: 11) notes is most useful in an LFG setting, namely that reanalysis concerns "[a] change in the structure of an expression or class of expressions that does not involve any immediate or intrinsic modification of its surface manifestation". Because LFG does not conflate syntactic position and syntactic functions and, thus, by extension, is able to cleanly separate out surface appearance (at c-structure) from functional and semantic import (at f-structure, a(rgument)-structure and s(emantic)-structure), it is particularly well-suited to help understand different types of reanalysis, whether they concern simple syntactic rebracketing, morphosyntactic change of the type where a dative argument or object is reanalyzed as a subject (Allen 1995, Schätzle 2018), the rise of a recipient passive (Allen 1995, 2001) or the development of complex predication (Börjars & Vincent 2017). Other changes may involve the reanalysis of one syntactic category as another (Börjars & Burridge 2011), also leading to the existence of mixed category phenomena (Nikitina 2008), for example, again with attendant functional changes. Van Gelderen (2011) discusses such diachronic developments in terms of "Linguistic Cycles" and works with changes in feature specifications that are attached to lexical items and categories. The analyses are couched within Minimalism and work with a very restricted set of features — we would argue that LFG is much better poised to account for changes in feature systems in relation to phrase structure (see Section 4.1).

Cases of classic reanalysis at a lexical level, many of which have been prominently discussed as instances of grammaticalization (Hopper & Traugott 2003, Narrog & Heine 2017, but also see Roberts & Roussou 2003 within Minimalism) are also easily modelled and predicted by an architecture which separates surface syntactic form (c-structure) from function (f-structure). As we discuss in Section 3.1, a verb can retain its surface form but begin functioning as a perception raising verb, an auxiliary or a light verb (Barron 2001, Butt & Lahiri 2013). Over time, these functional changes may also result in a change in the surface form of the relevant item – typically some kind of morphophonological reduction, but also changes in the paradigmatic behaviour. The design of the LFG architecture allows for this associated process to be captured distinctly from the actual strict process of reanalysis as per Langacker's definition. In fact, it can also predict which types of functional and semantic elements are more prone to change than

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[2] While phonological change has been overall a central topic in historical linguistics, the focus in this chapter is on morphosyntactic change, reflecting the centrality of syntax in the LFG architecture and the fact that diachronic work within LFG has focused on morphosyntax. A natural framework to work within from an LFG perspective with respect to sound change would be Lexical Phonology (Kiparsky 1982a,b, Mohanan 1986), for example as in Lahiri (2000a).

others and in what way. For instance, in terms of lexical or semantic bleaching one would predict that a verb loses its predicational power (the PRED feature) at f-structure, but retains certain functional information. Or, with respect to originally spatial terms being drawn into the case-marking system of a language, one can imagine working with underspecification and/or the loss of particular features characterizing the spatial terms, e.g., the PLACE and/or PATH specifications (Ahmed Khan 2009).

On the other hand, some instances of language change concern changes at the c-structural level, without necessarily resulting in attendant functional change. Examples are changes with respect to word order and constituent structure such as those found in Germanic and Romance languages, where a previously freer distribution and "discourse-configurational" organization (É. Kiss 1995) yields to a system where grammatical relations are increasingly licensed by position (Kiparsky 1995, 1997, Hinterhölzl & Petrova 2010, Luraghi 2010, Ledgeway 2012, Ponti & Luraghi 2018, Booth et al. 2017, Booth & Schätzle 2019, Booth & Beck 2021). Given that LFG's c-structure represents actual linear order, constituency and hierarchical relations, is not dogmatic about binary branching, and allows for endocentric as well exocentric phrasal organization, there are several parameters across which languages would be expected to vary and change and they indeed do. Thus, the common trend for languages to shift over time from a freer word order to a more fixed word order can be captured in terms of the development of an increasingly endocentric c-structure, as we discuss in Section 4.3. In such a scenario, the mappings between c-structure and f-structure will necessarily change, fed by the changing positions licensed at c-structure, as typically manifested in the changing realization of grammatical relations, as we discuss in Section 4.5.

Of course, most instances of language change do not involve just one change within one module of grammar (i.e. c-structure or f-structure), but are more complex. Given the inherently interactional nature of language change, certain changes which initially occur at c-structure may in turn feed changes at f-structure, and vice versa. In this sense, keeping surface form, syntactic categorization and functional information apart as in the LFG architecture allows one to neatly model the step-wise nature of such developments. Vincent (2001) notes that one of the most complex series of changes he has seen analyzed is that presented by Simpson (2001) on the grammaticalization of associated path in Warlpiri (see Section 3). Indeed, as Vincent (2001) also points out, another consequence of the complex interactional architecture of LFG is that an LFG perspective on language change does not expect abrupt, cataclysmic shifts in grammar as proposed in the influential work by Lightfoot (1979, 1991, 1997), for example. Rather, it is expected that a series of small changes, many of them at the lexical level, will combine together and gradually, over time and with attendant variation in usage, will result in a major structural change. This is what is argued for with respect to the introduction of ergativity in Indo-Aryan by Butt & Ahmed Khan (2011), for example (cf. also Traugott & Trousdale (2010) for an overview discussion).

Indeed, variation as an inherent property of language has been closely linked to language change in a strong tradition of work (e.g., Kroch 1989, 2001, Labov 1994, Pintzuk 2003). However, this empirical fact generally presents a challenge for generative frameworks, which did not originally feature gradience or stochastic variation as part of their basic design principles. One proposed architectural solution here has been in terms of Optimality Theory (Kager 1999), in particular stochastic Optimality Theory (Boersma & Hayes 2001). As we discuss in Section 5, this avenue has also been explored within LFG as a way to model gradual syntactic change via competing variants (Clark 2004), using OT-LFG (see Kuhn 2023 [this volume]).

Having briefly surveyed the explanatory potential of LFG with respect to diachronic change via a set of examples in this section, we delve into the issues and phenomena more deeply in the next sections, also involving other parts of LFG's projection architecture, most prominently a(rgument)-structure.

3 Lexical and functional change

We begin by discussing examples of lexical and functional change in Section 3.1, many of which have been analyzed as instances of grammaticalization. We then move on to more complex series of changes which involve a restructuring of the mapping relationship between semantic arguments (a-structure) and grammatical relations (f-structure) in Section 3.2.

3.1 Grammaticalization

The original characterization of the idea behind grammaticalization goes back to Meillet (1912: 131), who defines it as: "l'attribution du caractère grammatical à un mot jadis autonome [the attribution of a grammatical value to a formerly autonomous word]" (Vincent & Börjars 2020: 134). Essentially, this is a process by which an item with lexical content becomes reanalyzed as a functional element (Bybee et al. 1994). Recent decades have seen a substantial body of work on grammaticalization phenomena, where grammaticalization has been treated both as a grammatical framework (e.g., Lehmann 1985, Hopper & Traugott 2003) and as a pre-theoretical notion which is to be formalized via the tools and concepts available within a particular framework (e.g., Campbell 2000, Newmeyer 2000, Roberts & Roussou 2003, van Gelderen 2011). LFG belongs in the latter class: it sees grammaticalization as a pre-theoretical concept which describes certain observed historical changes that are to be modelled via the formal tool-kit and assumptions available as part of the projection architecture.

The progression from lexical to functional is typically not accomplished in one fell swoop, but consists of the combined effects of a number of individual changes (see, e.g., the various papers in Traugott & Trousdale 2010). The grammaticalization literature proposes that change progresses along a cline, for example as shown in (1) for a crosslinguistically well-established change in which auxiliaries, clitics and finally affixes develop from an originally contentful lexical verb. This change is also generally associated with the concept of "semantic bleaching", by which the item undergoes the gradual loss of semantic content until the formerly lexical content word is reanalyzed as a functional element.

(1) full verb > (vector verb) > auxiliary > clitic > affix
Typical Grammaticalization Cline (Hopper & Traugott 2003: 108)

Note that the cline represents a mixture of surface and functional changes (form and function): the change from a main (full) verb to auxiliary mainly revolves around a change in function, while the change from auxiliary to clitic/affix is very prominently a change in surface form. Given that LFG very clearly differentiates between form (c-structure) and function (f-structure), it seems particularly perspicuous to address issues of grammaticalization from the perspective of LFG, as we aim to illustrate in this section.

The category *vector verb* in the cline in (1) was introduced specifically for instances of light verb formation in Indo-Aryan (Hook 1991) and this has been taken up in discussions within LFG by Butt & Lahiri (2013), who argue that light verbs should not be placed on a grammaticalization cline, but are diachronically stable. Butt and Lahiri contrast the diachronic evidence available for Indo-Aryan light verbs with that of auxiliary formation and show that these two categories exhibit very different diachronic behaviour. Light verbs show no signs of morphophonological surface changes or further functional changes which often follow a categorial reanalysis in instances of grammaticalization. However, auxiliaries do. This is illustrated in (2) for the Bengali verb 'be' and in (3) for the Urdu verb 'go'.

In Bengali the verb ɑʧʰ 'be' can function as a full verb (2a), but also as a light verb (2b), in which case it is always form-identical to the main verb. On the other hand, the same verb 'be' has given rise to new verbal paradigms whereby the perfect is realized via a cliticized version of a former auxiliary version of ɑʧʰ 'be' (2c) and the progressive shows a fully affixal version (2d).[3] The cliticized and affixal versions of a former auxiliary are as expected/predicted by the grammaticalization cline in (1).

(2) Bengali

a. ɑmi bʰɑlo ɑʧʰi
I.NOM well be.PRES.1
'I am well.' Main Verb

b. amar mone ɑʧʰe
I.GEN mind.LOC be.PRES.3
'I remember.' Light Verb

c. rɑm ʧitʰi pe-(y)e=ʧʰ-ilo
Ram.NOM letter.NOM receive-PERF=be-PAST.3
'Ram had received letters.' Clitic

d. rɑm ʧitʰi pɑ-ʧʧʰ-ilo
Ram.NOM letter.NOM receive-be-PAST.3
'Ram was receiving letters.' Affix

Similarly, the verb ʤa 'go' in Urdu/Hindi has a light verb use (3b) that is always form-identical to its main verb use (3a). When the surface form of the main verb changes due to language change, the light verb version mirrors this change. On the other hand, the auxiliary version of 'go' that furnished the basis for the innovated future morpheme in Urdu/Hindi went through a clitic phase (3c) and is now an affix whose surface form is *-g-*, as in (3d).

(3) Urdu/Hindi

a. mɛ̃ gɑ-ya
I.NOM go-PERF.M.SG
'I went.' Main Verb

b. bɑʧʧa gɪr gɑ-ya
child.M.NOM fall go-PERF.M.SG
'The child fell (down).' Light Verb

c. kɑh-ũ=hi=ga
say-1.SG-EMPH-FUT.M.SG
'I will say (it), of course.' Clitic
(Kellogg 1893: s399)

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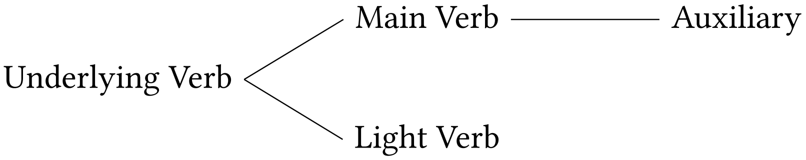
[3] For a full analysis of the morphophonological changes that led to the formation of new verbal paradigms in Bengali, see Lahiri (2000b).

d.	pʊlɪs	ʧor=ko	pɑkṛ-e-g-i
	police.F.SG.NOM	thief.M.SG=ACC	catch-3.SG-FUT-F.SG

‘The police will catch the thief.’ Affix

Butt and Lahiri focus on developing a theory as to why light verbs should be diachronically stable, proposing an underspecified approach to the deployment of lexical semantic information by which light verbs are inextricably linked to their full verb versions via a single underlying entry, see (4). When deployed as a light verb, they require combination with another predicational element, with which they form a complex predicate.

(4)



The diachronic path of change from verb to auxiliary to clitic and potentially an affix is assumed to be based on the main verb version. Along with other work on grammaticalization in LFG, Butt and Lahiri assume that grammaticalization primarily involves a loss or difference in functional information at f-structure, while the surface form is initially held constant. That is, the difference between a main verb use of ‘go’ and an auxiliary use of ‘go’ would be expressed in terms of a difference in functional information associated with the respective lexical entries. In the illustrative main verb entry (V) in (5a) vs. the auxiliary version (I) in (5b) one major difference in functional information involves the loss of the predicational power of the verb in terms of its PRED function. This then also instantiates the “semantic bleaching” generally observed in the grammaticalization process.

(5) a. *go* V (↑ PRED) = ‘GO⟨(↑ SUBJ)(↑ XCOMP)⟩’

b. *goes* I (↑ TENSE) = FUT

Thus, in the main verb use, the verb ‘go’ subcategorizes for a SUBJ and an XCOMP. In the auxiliary use that develops over time, this information is absent and is instead replaced by a futurate use of the verb. As such, the auxiliary version then merely provides tense information to an overall predication. That is, grammaticalization primarily involves a change in the functional information associated with an item. This functional change then engenders further changes, such as the reanalysis of the syntactic category of the item (from V to I) and possible ensuing changes in the morphophonological realization of the item due to its new functional status, so that the item eventually develops into an affix (typically via a clitic stage), as illustrated for Bengali and Urdu/Hindi in (2) and (3) above.

Grammaticalization does not tend to occur in one sudden step, but happens gradually over time and tends to involve several intermediate steps. It also does not take place randomly, but is generally motivated by a semantic reinterpretation of a given configuration (e.g., ‘goes to go’ ⟶ ‘go.FUT’). This type of semantically motivated change is also discussed in a recent paper by Börjars & Vincent (2019) with respect to Germanic *will* verbs. Börjars & Vincent (2019) propose an LFG analysis of how an original verb of desire (‘want’) undergoes change to a verb of intention and further to prediction, giving rise to a new modal in some languages and a futurate auxiliary in others. This semantic change goes hand in hand with a change in functional information (e.g., from a control to a raising verb) and a concomitant reanalysis at c-structure.

Similarly, Camilleri & Sadler (2018, 2020) postulate a total of four separate steps in the formation of a progressive auxiliary from a main verb meaning ‘sit’ in Arabic. Unlike Butt and Lahiri and Börjars and Vincent, who work with diachronic data, but in keeping with many studies on grammaticalization, the evidence Camillieri and Sadler adduce is mainly from synchronic variation found in dialects of Arabic, which are taken to be indicative of stages of diachronic development.

Camillieri and Sadler associate the origin of the progressive auxiliary in Arabic with constructions in which the posture verb ‘sit’ is used together with an adjunct clause, as in (6). The verb ‘sit’ is considered to be a V that projects a VP and this is modified by a VP adjunct. The corresponding (simplified) f-structure analysis is given in (7).[4]

(6) Wādi Ramm Jordanian Arabic

(Almashaqba 2015, cited by Camilleri & Sadler 2020: 24)

lagē-ta-h	gāʕid	ya-smaʕ	al-giṣidah
find.PFV-1SG-3.SG.M.ACC	sit.ACT.PTCP.SG.M	3M-hear.1PFV.SG	DEF-poem

‘I found him sitting down listening to the poem.’

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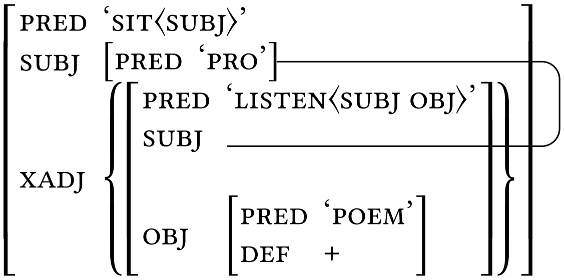
[4] Note that the f-structure in (7) differs from the original one in Camilleri & Sadler (2020: 26) in that we have rendered the XADJ as a set containing one element, which is what is described in Camilleri & Sadler (2020: 26), but not represented in their f-structure.

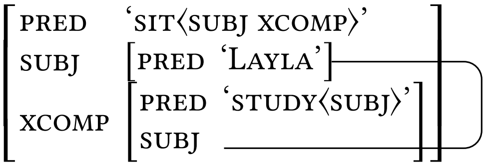
(7)



In a second stage this optional modifying XADJ is reanalyzed as an obligatory clausal complement of the posture verb ‘sit’, as shown in the f-structure in (9) for the attendant example in (8).

(8) Kuwaiti Arabic (Camilleri & Sadler 2020: 28)
layla gāʕd-a ta-dris
Layla sit.ACT.PTCP-SG.F 3F-study.IPFV.SG
‘Layla is (sitting) studying.’

(9)

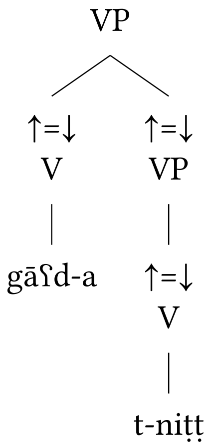


This use of ‘sit’ in combination with a clausal argument is in turn reanalyzed as signaling durational, stative semantics, abstracting away from the original postural, locational meaning. Once the step from a concrete postural meaning to an aspectual meaning dimension is made, the verb is assumed to lose its predicational power in terms of the PRED feature and to only contribute the durational aspectual information to the clause, resulting finally in an innovated progressive marker (cf. Deo (2015) for more discussion and evidence of this type of crosslinguistically attested language change). An example is shown in (10) with a corresponding f-structure analysis in (11). Under Camillieri and Sadler’s analysis the syntactic category of ‘sit’ itself is not reanalyzed; it merely no longer projects a VP of its own, but functions as a co-head with the formerly embedded verb, as shown in (12).

(10) Kuwaiti Arabic (Camilleri & Sadler 2020: 30)
gāʕd-a t-niṭṭ
PROG-SG.F 3F-jump.IMPFV.SG
‘She is jumping.’

(11)
$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{jump}\langle\textsc{subj}\rangle\text{’} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{pro}\text{’}\end{bmatrix} \\ \textsc{tense} & \textsc{pres} \\ \textsc{asp} & \textsc{prog} \end{bmatrix}$$

(12)



The change by which an adjunct is reanalyzed over time as a core argument of a verb has also been argued to play a role in Latin in the innovation of raising predicates such as ‘seem’ from verbs of perception such as ‘see’ (Barron 2001) and the grammaticalization of associated path in the Australian languages Warlpiri and Warumungu (Simpson 2001). It also plays a role in the spread of dative subjects in Icelandic, as argued for by Schätzle (2018) and discussed in Butt 2023 [this volume], as well as in Section 3.2 below.

Barron (2001) provides a theoretically sophisticated account for the development of Latin *videri* ‘seem’ from the perception verb *videre* ‘see’. The general idea is that the epistemic raising verb develops from a passivized version of *videre* in situations where there is a small clause (secondary predication), such as ‘Laelius was seen as an ideal person.’ This was reinterpreted as ‘Laelius seemed an ideal person’ and over time was generally concomitantly structurally reanalyzed as a raising predicate. The analysis is complex and involves changes at the semantic level which translate into functional changes at f-structure.

Another level of complexity is added by Simpson’s (2001) account of associated path in Warlpiri and Warumungu. The puzzle she addresses is how the path expressions (‘thither’ vs. ‘hither’) in (13) came to be grammaticalized as morphemes on a verb, given that the languages generally allow for free word order. She assumes that at some point there must have been a stage in which the path expressions were preferentially placed just after the verbs and that this preferential word order then paved the way for grammaticalization along the cline in (1).

(13) Warumungu (Simpson 2001: 174)

a. **Juku-nturrarni**=angi angkinyi kina ngurraji kina?
carry-THITHER.PAST=2S your to camp to
'Did you take it to your home?'

b. **Juku-ntukarni**=ajjul ngurraji kina.
carry-HITHER.PAST=3S camp to
'They (more than two) brought it here to camp.'

Again, the change is conceived of as a complex chain of reanalyses. The original construction is taken to be one in which a clause like 'I went to camp' is modified by a clausal adjunct, for example: 'after yam digging'. This adjunct was then preferentially realized clause-initially: 'after yam digging, (I) went to camp', thus placing the verbs next to one another in certain situations. This adjacent placement of the verbs is thought to have triggered clause unification, yielding a monoclausal structure in which the former verb of motion is eventually reanalyzed as a morpheme expressing the associated path of the event. We thus have a preferential word order opening the way for a semantic, then syntactic and concomitant functional reanalysis of an original verb into a bound morpheme.

For further discussions and examples of grammaticalization approaches within LFG, also contextualized in terms of comparison of approaches across theories, see Vincent & Börjars (2020). We discuss some aspects of their paper in more detail in Section 4.1, since some of the case studies involve a reanalysis of syntactic categories with attendant "mixed" effects. We return to grammaticalization in Section 4.3 in the context of c-structural change. Before turning to these topics, we discuss instances of language change which primarily involve a change in the linking configuration between semantic arguments and grammatical relations in Section 3.2.

3.2 Arguments and linking

In the previous section on grammaticalization we discussed phenomena of language change that involved a number of different dimensions. In this section, we focus on changes that are primarily concerned with reconfigurations in the linking between semantic arguments and grammatical relations. Work that addresses these kinds of specific changes within LFG is: Allen (1986, 1995), Kibort & Maling (2015), Schätzle (2018) and Beck & Butt (2024).

3.2.1 Experiencer verbs

As mentioned above, a very early application of LFG to diachronic change is Allen (1986), who considers the verb *like* in the history of English. This verb can be analyzed as having an Experiencer (the liker) and a Cause (the cause of liking).[5] Such verbs are interesting diachronically because they show a change in the correspondence between semantic arguments (experiencer, cause) and grammatical relations. In Old English the experiencer argument has the positional and morphological properties of an object, e.g., (14a), but is uncontroversially a subject in Present-day English, e.g., (14b).[6]

(14) a. Old English (Jespersen 1927, as cited in Allen 1986: 376)
Ðam cynge licodon peran
the.DAT king.DAT liked.PL pears
'Pears were pleasing to the king'
b. 'He liked pears.'

Based on detailed investigations of the historical data, Allen (1986) challenges the traditional account for this change (e.g., Jespersen 1927, Lightfoot 1979, 1981), which casts it in terms of a reanalysis of preverbal object experiencers as subjects, as a direct consequence of the loss of case-marking and the fixing of SVO word order. As Allen (1986) points out, there are various problems for this account, including the fact that the OVS order required as a source for the reanalysis is relatively rare with the verb *like*, and because of chronological issues concerning the link with the loss of case-marking. Moreover, the data indicates that the change proceeded gradually, with subject and object experiencers coexisting alongside one another for several centuries over the course of Middle English and Early Modern English, which is not compatible with a "catastrophic" reanalysis account as proposed by Lightfoot, for example.

In light of these observations, Allen (1986) puts forward an alternative account, which involves a gradual change in the mapping correspondences between semantic arguments and grammatical functions, modelled in terms of the introduction and gradual favouring of a new lexical subcategorization frame, employing an early LFG approach to this type of mapping. The new subcategorization frame with a dative-marked subject experiencer, shown here in (15b), is already available in Old English for the verb *lician* 'like', but sits alongside and is less common

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[5] Alternatively, this semantic role has been referred to as stimulus or theme, as in, e.g., later work by Allen (1995).

[6] As has been pointed out (Denison 1993: 81), the original example from Jespersen in (14a) is invented and represents a pattern which is in fact rather rare.

than the older frame in (15a) where the dative-marked experiencer maps to object.

(15) a. Older frame (adapted from Allen 1986: 388):

EXP CAUSE
lician V PRED ‘LICIAN < (OBJ) (SBJ) >’
(↑ OBJ CASE) = DAT
(↑ SBJ CASE) = NOM

b. Newer frame (adapted from Allen 1986: 394):

EXP CAUSE
lician V PRED ‘LICIAN < (OBJ) (SBJ) >’
(↑SBJ CASE) = DAT
(↑OBJ CASE) = NOM

According to Allen (1986), the gradual favouring of the correspondences in (15b) coincides with changes concerning the assignment of case-marking, specifically a shift from a system where case is lexically assigned to one in which it is structurally assigned on the basis of grammatical relations. Structural case-marking for objects is introduced in the early thirteenth century according to Allen and specification of case-marking for the experiencer subject is optional as of the mid-fourteenth century. Under pressure towards consistent structural case assignment, all lexically determined case-marking is finally lost, subjects are consistently nominative-marked and the frame for allowing object experiencers in (15a) is no longer available.

Allen (1995) develops this account of experiencer verbs in the history of English further in terms of Lexical Mapping Theory (e.g., Bresnan & Kanerva 1989, cf. Butt 2023 [this volume] and Findlay et al. 2023 [this volume]), discussing a wider range of data and additional changes including the rise of the recipient passive, which we discuss in Section 4.5. In particular, she demonstrates that lexical semantic factors, rather than loss of case-marking drives the change with respect to experiencer verbs, and that this can be elegantly modelled with LFG’s richly articulated lexicon and Lexical Mapping Theory.

3.2.2 Passives and impersonals

Kibort & Maling (2015) address the innovation of a new impersonal construction in Icelandic which they argue has emerged as a syntactically active construction via reanalysis of an impersonal passive with passive morphology. The new construction is thought to have been emerging approximately over the last fifty years (Thráinsson 2007) and has prompted a good deal of debate concerning what the precise analysis should be (Maling & Sigurjónsdóttir 2002, Eythórsson 2008, Jónsson 2009). Maling & Sigurjónsdóttir (2002) show that this is currently a change in progress and that speakers of Icelandic show variation in the interpretation of examples such as (16): some interpret it as an impersonal passive (Reading A), others as an active transitive with a [+human] agentive pro subject (Reading B). Such variation is expected when there is a change in progress, as we discuss further in Section 5.

(16) Icelandic

Loks	var	fundið	stelpuna	eftir	mikla	leit.
finally	was	found.n.sg	girl.the.f.acc	after	great	search

Reading A: 'The girl was finally found after a long search.'
Reading B: 'They finally found the girl after a long search.'

Kibort & Maling (2015) argue that this variation and change arises when a former impersonal passive with passive morphology is reanalyzed as an active form. They argue for a series of step-wise changes, beginning with the potential for the linking configurations of an impersonal passive and a regular passive being confused with one another when the obl$_\theta$ agent argument of the passive is left unexpressed, as is often the case in Icelandic language use. This means that a regular passive on the surface often looks very much like an impersonal passive, where there is a covert pro subj, as illustrated in (17) for transitive verbs (adapted from Kibort & Maling 2015).[7]

(17) a.

$$\begin{array}{llll} \textit{verb}_{\textit{passive}} & < & \text{arg}_1 & \text{arg}_2 & > \\ & & [-o] & [-r] & \\ & & [+r] & & \\ & & (\textsc{obl}_\theta) & \textsc{subj} & \end{array}$$

b.

$$\begin{array}{lllll} \textit{verb}_{\textit{impers\_passive}} & < & \text{arg}_1 & \text{arg}_2 & > \\ & & [-o] & [-r] & \\ & & [+r] & & \\ & & \textsc{pro}_{\textit{impers}} & \textsc{subj} & \end{array}$$

---

[7] In the version of Mapping Theory which Kibort & Maling (2015) employ, argument positions (arg$_1$, arg$_2$ etc.) are separated out from semantic participants and the thematic roles they instantiate. Here, for ease of exposition, and because this separation is not relevant for the changes discussed, we just represent the argument positions.

Kibort & Maling (2015) assume Kibort's version of Mapping Theory (Kibort 2013, 2014) by which argument slots and types are defined via an overall template allowing for specific types or argument slots, shown above as 'arg_1', 'arg_2' in the case of transitives. The linking between arguments and grammatical relations is accomplished via the $[\pm r, o]$ features of LFG's standard Mapping Theory. See Findlay et al. 2023 [this volume] for a detailed exposition on Kibort's Mapping Theory, also cf. Butt 2023 [this volume]. Maling and Kibort discuss several different paths of change that are predicted as possible within their assumptions as to Mapping Theory and draw on additional examples from Slavic as well as Mayan to illustrate the possible changes.

With respect to Icelandic, they propose that "non-promotional" versions of the passive opened the way for a reanalysis of the impersonal passive as an impersonal active. In these non-promotional passives, the patient/theme argument of transitives is not "promoted" and realized as a subj, as is usually the case under passivization. Instead, it is realized as an obj in examples such as (16) (as indicated by the accusative marking on 'girl' in (16)). The configuration for the non-promotional passive is shown in (18a). This configuration is in turn very close to that of an active impersonal in which there is a pro subj and so that is what it is reanalyzed as, see (18b).

(18) a. $$\mathit{verb}_{\mathit{passive\_obj}} \quad < \quad \begin{array}{cc} \text{arg}_1 & \text{arg}_2 \\ {[-o]} & {[-r]} \\ {[+r]} & \\ & \\ (\textsc{obl}_{\theta}) & \textsc{obj} \end{array} \quad >$$

b. $$\mathit{verb}_{\mathit{impers\_active}} \quad < \quad \begin{array}{cc} \text{arg}_1 & \text{arg}_2 \\ {[-o][-r]} & {[-r]} \\ & \\ \textsc{pro}_{\mathit{impers}} & \textsc{obj} \end{array} \quad >$$

Thus, a series of reanalyses that initially arose out of ambiguous surface structures are seen to lead to an overall diachronic reanalysis in which an originally passive construction is reinterpreted as a transitive, syntactically active impersonal with a pro subj and an obj, as illustrated in (18). This reanalysis was enabled by the variation in interpretation that arose from the ambiguous surface structures. Note that under this scenario, the verb does not change, nor does the passive morphology. The surface realization remains the same. What changes is the mapping or linking between arguments of the verb and the grammatical relations.

3.2.3 Dative subjects

Another example of a change involving only the linking configuration between semantic arguments and grammatical relations is the rise and spread of dative subjects in Icelandic and Indo-Aryan. Dative subjects were innovated as part of diachronic developments in New Indo-Aryan (NIA) from about 1100 CE onwards. Icelandic dative subjects can be traced back to the earliest documented stages of the language, but these only go back to 1150 CE, about the same time as the new case marking systems of the NIA cousins were developing.

Schätzle (2018) analyzes diachronic data from Icelandic and finds that dative subjects in Icelandic have increased over time. Besides the well-documented process of "dative sickness" or "dative substitution" (Smith 1996, Jónsson 2003, Barðdal 2011), by which accusative experiencer subjects are systematically replaced by datives, Schätzle finds that dative subjects arise via originally middle forms of verbs of searching or perception to give rise to lexicalizations of experiencer predicates which take a dative subject. As in the example of Latin raising verbs (Barron 2001) and the Arabic progressive (Camilleri & Sadler 2020), Schätzle identifies an intermediate stage involving secondary predication as an important step in the series of reanalyses that take place. We do not provide Icelandic examples and details of Schätzle's analysis here; the interested reader is referred to Butt 2023 [this volume] for a summary and examples.

Schätzle works out a theory of Linking or Mapping that is based on Kibort (2013, 2014), but that crucially integrates an event-based approach. She includes a notion of subevental participants that draws on Ramchand's (2008) tripartite view of events. She further introduces a way of determining relative argument prominence by including a notion of Figure vs. Ground (Talmy 1978), as well as information on Proto-Role properties (Dowty 1991) as suggested by Zaenen (1993) for LFG. The resulting linking system is complex, but it does justice to the complex interface between morphosyntax and lexical and clausal semantics that is involved in the relationship between semantic roles, event semantics and the realization of grammatical relations.

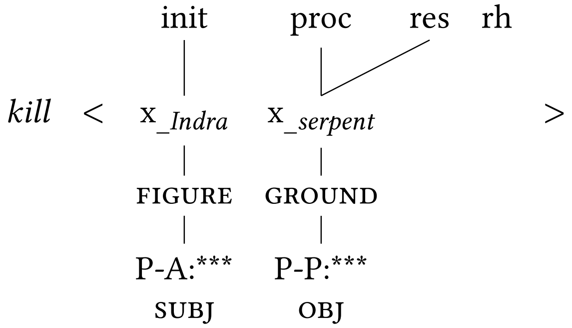
Beck & Butt (2024) refine Schätzle's framework and address dative subjects in both Icelandic and Indo-Aryan. The general linking schema they assume is shown in (19). As can be seen, a maximum of four argument slots are assumed. This number derives from the maximum of four subevental parts identified by Ramchand: 1) the init(iation) subevent, which requires an initiator (or agent) of the event; 2) the proc(ess) or progress of the event, which requires an undergoer or patient of the process; 3) the res(ult) of the event, which requires a resultee argument (often but not necessarily identical to the undergoer of the process). Finally there is (4) the rheme, which is not strictly speaking a subevent, but which can serve to modify the overall event in some way, i.e. by providing information on where the event took place or the manner in which it took place.

(19) General Linking Schema

		init	proc	res	rh	
Predicate	<	x	x	x	x	>
		FIGURE	GROUND			
		SUBJ	OBJ	OBJ_{theta}	OBL	

The linking in (20) provides an example of a typical agentive transitive verb. The verb 'kill' has two arguments. One of these ('Indra') is associated with the initiation subevent and thus serves as the initiator/agent participant of the event. The other argument ('serpent') is the undergoer of the event and thus affected as part of the on-going proc(ess) of the event, with a clear res(ult), namely that it is dead. This argument is thus associated with two subevents.

(20) Indra killed the serpent.

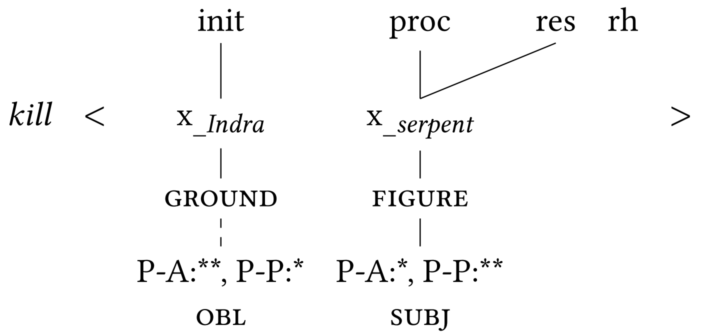


The initiator is naturally also the Figure of the event, and the undergoer serves as the Ground. This basic linking constellation is interpreted with respect to Proto-Role properties in the following way: a) one Proto-Agent (P-A) property each is adduced for: initiation and Figure; b) one Proto-Patient (P-P) property each is adduced for: proc, res, and Ground. In addition, sentient arguments accumulate an additional P-A property. The Proto-Role properties are registered via an ‘*’ in the linking schemas.

Overall, the linking of arguments works as follows. If an argument has more P-A than P-P properties, it is linked to subj. An argument with more P-P than P-A properties is linked to obj. When an argument has equally many P-A and P-P properties or no P-A and P-P properties, then other information must be taken into account. In this case the type of subevent the participant is associated with is taken to play a crucial role. That is, if the argument associated with init vs. res have equal amounts of P-A and P-P properties, the init argument will be associated with subj. This is also true for third and potentially fourth arguments of an event – once the subj and obj linking has been determined, the subevental semantics play a role in determining the linking to a secondary object (obj$_{\theta}$) or an oblique (obl). Obliques are likely to correspond to spatial terms and paths (rhemes) or an init-ground combination. Secondary objects are likely to be related to undergoer semantics. An init argument that serves as the ground rather than the figure is prohibited from being linked to the subj — this is the well-known effect of passivization that has often been described as “demotion” or “inversion” in the literature (e.g., Perlmutter & Postal 1977).

This constellation is illustrated in (21). The association of arguments with subevents remains the same, but the Figure-Ground relationship is flipped. This affects the number and type of Proto-Role properties associated with each argument.

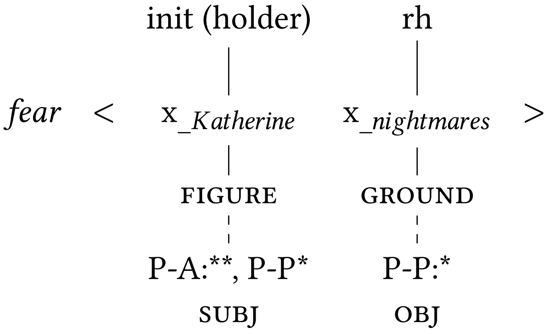
(21) The serpent was killed by Indra.



Since ‘Indra’ is no longer available to be linked to subj, the ‘serpent’ is the subj. Because ‘Indra’ still has more P-A (one for init, one for sentience) than P-P (one for ground) properties, it is not associable with an obj or obj$_{\theta}$, but is linked to obl.

An example of a linking configuration for an experiencer predicate is provided in (22). As per Ramchand’s analysis, the holder of the state of experiencing something is associated with the init subevent, and the stimulus is analyzed as a rheme (since it is neither part of the process or the result of the overall event). The experiencer 'Katherine' in (22) is also the FIGURE; the stimulus 'nightmares' is the GROUND. As a sentient argument who is also a FIGURE, 'Katherine' receives two P-A properties. As the holder of a state, this argument receives one P-P property. The 'nightmares' accumulate one P-P property from being associated with GROUND. Because rhemes are not properly event participants, they contribute neither P-A nor P-P properties for the calculation. Since 'Katherine' has the most P-A properties, it is linked to SUBJ. The 'nightmares' argument has only P-P properties and is thus linked to OBJ.

(22) Katherine fears nightmares.

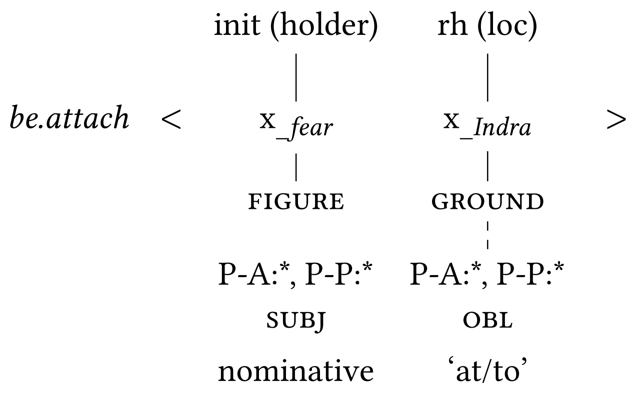


With this basic event-based linking schema in place, Beck & Butt (2024) chart a path of development for dative subjects in New Indo-Aryan. A crucial component is the innovation of ergative transitive active clauses from originally adjectival participles which featured a nominative and an instrumental adjunct (e.g., 'The by Indra killed serpent.'). Beck and Butt posit that the original instrument adjunct was a GROUND which was reinterpreted as a FIGURE in situations where the instrument could be seen as a sentient agent. This then opened the door to further Figure-Ground flips, such as with originally locative structures as in (23) (cf. also Bresnan & Kanerva 1989, Landau 2010 on locative inversion).

(23) Urdu/Hindi
ındra=ko dɑr lɑg-a
Indra.M=DAT fear.M.NOM be.attach-PRF.M.SG
'Indra was afraid.'

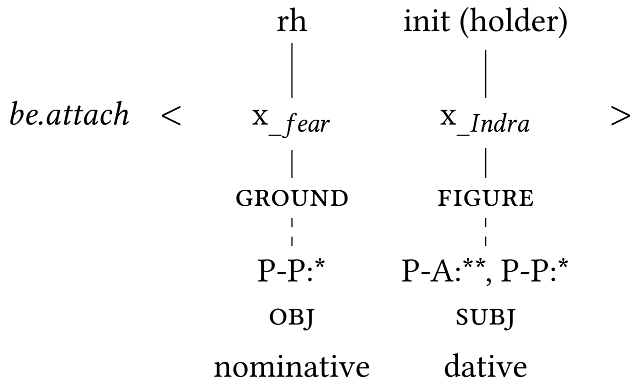
Their proposal is that the original locative predication involved a linking configuration as in (24). The overall predication is stative, so the two arguments involved are a holder of a state and a rheme. The 'Indra' argument is the location of the 'fear', so Indra is associated with a rheme and the GROUND. The 'fear' argument is then interpreted as the holder of a state: as a FIGURE it is located somewhere and receives one P-A property for being a Figure, and one P-A property for being the holder of a state. 'Indra' receives one P-P property for being the GROUND and one P-A property because it is a sentient argument. Both arguments thus have an equal number of P-A and P-P properties, but 'fear' is linked to SUBJ because it is associated with the init subevent.

(24) Fear was attached to Indra.



It is not difficult to see that the linking configuration in (24) is unstable. The two arguments have equal numbers of P-A and P-P properties and the sentient argument is associated with GROUND, which is non-canonical (Talmy 1978). Beck and Butt propose that as a consequence, in a series of steps, both the Figure-Ground relation and the association with init and rheme are flipped and the resulting linking configuration is as shown in (25), corresponding to (23). This configuration is clearly more stable as the sentient argument is more prominent and accumulates more P-A properties.

(25) Indra was afraid.



The original spatial adpositions (‘at, to’) in fact gave rise to the current dative/accusative case markers in Urdu/Hindi (and across New Indo-Aryan), resulting in the innovation of dative subjects from originally spatial terms (cf. Montaut 2003, Butt & Ahmed Khan 2011).

To summarize, the innovation of dative subjects is seen primarily as the reanalysis of an originally stative locative predication as an experiencer verb. The main change involves a reanalysis of various parts of the overall linking configuration. Beck and Butt see this as being common to both Icelandic and Indo-Aryan. In Indo-Aryan, however, there is an additional concomitant but independent change in syntactic category, from a spatial adposition to a case marker. Changes involving reanalysis of an item’s syntactic category are taken up in Section 4.1, with Section 4 focusing overall on change with respect to c-structure.

4 Syntactic change

4.1 Recategorization

Studies of language change abound with instances of syntactic recategorization, that is, instances in which an item belonging to one syntactic category is reanalyzed as belonging to a different one. We have already caught a glimpse of such a reanalysis with respect to the grammaticalization cline in (1), whereby a main verb is gradually reanalyzed as an auxiliary, which in turn often becomes a verbal affix. Within LFG, such c-structural recategorization is seen as being preceded by a change in an item’s functional import. That is, with respect to the well-studied changes such as the development of new futurate markers (e.g., Fleischman 1982), as we saw in Section 3.1 an originally fully predicating verb such as ‘want’ or ‘go’ can be used in situations describing the future attainment of a state or event (Börjars & Vincent 2019). Over time, this usage becomes conventionalized and the verb is seen as routinely fulfilling an additional function, namely the temporal placement of an event in the future. This meaning of the verb ceases to predicate fully and it develops into a functional item. Often the original lexical/content verb continues to exist side-by-side with the new auxiliary; in other cases it ceases to be used as a main verb. In English, for example, the item *will* is now only rarely used as a modal meaning ‘want’, but only as a futurate marker. On the other hand, as we saw for the examples taken from Urdu and Bengali in Section 3.1, the verbs ‘be’ and ‘go’ continue to exist as main verbs while also serving as auxiliaries and giving rise to new verbal affixes.

Within this same verbal domain, Börjars & Vincent (2017) argue for the historical development of a causative light verb in Romance from the Latin verb *facere* 'make, do', which in turn results in the reanalysis of a formerly biclausal construction as a monoclausal predication. This reanalysis of biclausal predications, where one verb embeds another into monoclausal structures, also generally results from the reanalysis of main verbs as auxiliaries (Butt et al. 2004, Butt 2010).

Vincent & Börjars (2020) go through a number of further examples of syntactic recategorization from an LFG perspective, including the development of adpositions from nouns, infinitival markers from prepositions, complementizers from prepositions (P to C; Vincent 1999) and case-marking functions from prepositions. They also engage in a comparison of analyses across frameworks (Minimalism (Chomsky 1995) and HPSG (Pollard & Sag 1994)) and ask the question of whether anything in LFG's architecture predicts the mainly *unidirectional* change in categorial reanalysis (meaning that a verb will change into an affix, but an affix does not change into a fully predicating main verb). The answer to this question is "no", unlike the clear predictions made by Roberts & Roussou (2003) within Minimalism, for example, where such reanalysis is seen as an instance of a lexical category raising upwards into the functional domain of a syntactic tree and eventually being reanalyzed as simply originating in that functional position. Upward "mobility" is expected in this framework, while downward movement is prohibited. However, Vincent & Börjars (2020) point out that while this type of grammaticalization along a cline from more lexical to more functional can be accounted for well within Minimalism, instances of "lateral" change whereby the recategorization involves adjacent categories like deictic markers into copular verbs (Börjars & Vincent 2017) are more challenging. In this case, an originally nominal category is reanalyzed as belonging to the verbal domain.

Another example of a recategorization that does not necessarily involve directionality can be observed in Chinese, where Börjars & Payne (2021) argue that nouns which originally denoted a container or a measure and which had the syntactic distribution and modificational properties of standard nouns in the language were reanalyzed over time as measure words and classifiers. They argue that the reanalysis as measure words involves only a syntactic recategorization by which these nouns have a more restricted syntactic distribution and modificational properties in comparison to standard nouns. This syntactic change is not accompanied by a systematic semantic or functional change: the words still measure out units, as in the original usage and appear to retain their full lexical semantics.

Van Gelderen (2011) seeks to address issues of recategorization by thinking of language change in terms of cycles (though there seems to be no discussion of actual full cycles of language change) and working heavily with features that are associated with syntactic categories. Changes in the features associated with an item eventually lead to reanalysis at the level of syntactic categories. Interestingly, this take on language change seems to move towards the separation out of functional vs. categorial characteristics of an item that is already in-built into LFG, but with a comparatively impoverished understanding of feature theory.

The difference in how many and what kinds of features and functionality are associated with an item can also lead to debates as to whether syntactic recategorization has taken place at all. Vincent & Börjars (2020: 144) discuss this with respect to prepositions being used to mark the subcategorized for arguments of a predicate, thus acquiring the properties of case markers and note: "Within Minimalism such shifts can be seen as involving a change from P to K, whereas once again, in HPSG and LFG, the change is in the information associated with the argument of P rather than in the category itself." This view of the relationship between adpositions and case clashes with the lexical semantic approach to case taken by Butt & King (1991, 2003, 2004), who use the category K to model the status of case markers in New Indo-Aryan as independent clitics that have a range of functional and lexical information associated with them. Ahmed Khan (2009) shows how spatial adpositions may be associated with feature structures specifying EX:HISTORICAL:PATH and PLACE and how changes in the specification of these features can result in case markers. Butt & Ahmed Khan (2011) further chart the development of originally spatial adpositions into case markers, analyzed as K, in modern Urdu.

4.2 Mixed categories

Recategorization as described in Section 4.1 also generally does not happen in one fell swoop, but via a number of intermediate stages. One side-effect of these intermediate stages is the emergence of *mixed categories*. Verbal nouns or gerundives, which have the external distribution of nouns, but the internal properties of verbs, are one well-known example. A recent survey and analysis of mixed categories by Nikolaeva & Spencer (2020) shows that there are several different types of mixed categories (see also the discussion in Lowe 2016b).

In her diachronic take on mixed categories, Nikitina (2008) argues for a clear disassociation of the lexical and syntactic components of category mixing, precisely because of the range of mixed properties displayed by syntactic categories. She investigates and analyzes phenomena from Romance and Wan (Mande) and proposes that a clear distinction be made between instances of *function retaining* derivational changes in syntactic category and *structural reanalysis*, including rebracketing. An example of the former function retaining change is the English *-ing* nominalization, whereby the head distributes as a noun, but retains the functional predication of a verb. Over time, this retention of function may be lost, resulting in a straightforward nominal, rather than a syntactic category with mixed properties. Examples of the latter (structural reanalysis) include types of instances discussed in the previous section, i.e. the development of adpositions and case markers from nouns and the development of complementizers from verbs (Lord 1993) or adpositions.

The work by Vincent & Börjars (2010) on the slippery slope between adpositions and adjectives serves as another example. Vincent & Börjars (2010) look at Germanic and Romance languages which are losing their overall case system and investigate paths of change that serve to compensate for this loss. One path of change involves the use of adpositions like Latin *prope* 'near' and English 'near'. These subcategorize for an OBJ and have the spatial meaning of adpositions, but can be used as adjectives and take comparative and superlative morphology. See also Vincent & Börjars (2020) for some further discussion on this issue.

Formal analyses of mixed categories in LFG have often invoked *lexical sharing* of one type or another (Bresnan & Mugane (2006), Lowe (2015, 2016a); see discussion in Section 4.4). Butt et al. (2020) propose an alternative to this approach in their analysis of complement clauses in Tamil. The complement clauses show a mixed set of nominal and verbal properties, which is due to a historical development by which an originally relative clause type structure incorporated a pronoun and thus acquired the external properties of a noun while retaining the internal verbal predication of a finite clause. Butt et al. (2020) propose an analysis of mixed categories in terms of the formal tool of *complex categories* first introduced in the context of the ParGram computational grammar development effort (Butt et al. 1999, Crouch et al. 2011). This approach essentially allows for the parameterization of syntactic categories, avoiding the monolithic assignment of one syntactic category to a given lexical item or phrase.

4.3 The growth of structure

The diachronic phenomena discussed under the term "grammaticalization" in Section 3.1 involved a change whereby an individual lexical item comes to be reanalyzed as a functional element. This could be considered grammaticalization in the narrow sense, in which the focus is on the changing status of a particular item, as in much of the classic work on grammaticalization where changes occurring above the level of individual lexemes (e.g., changes in word order) are typically secondary concerns. For example, in their seminal textbook, Hopper & Traugott (2003: 24, 59) suggest that word order changes, though "deeply interconnected" with grammaticalization, are not to be considered under the term on the basis that they do not exhibit the unidirectionality typical of grammaticalization (see also Sun & Traugott 2011 for a similar view). At the same time, some authors have called for a broader take on grammaticalization, encompassing also cases where a particular fixed word order comes to encode certain functional information. This type of change is argued for by Börjars et al. (2016) as grammaticalization involving a "template" made up of slots and categories, one example being V1 clauses which have grammaticalized to varying degrees so as to encode conditionality across the Germanic languages (see also Hilpert 2010). Börjars et al. (2016) extend the remit of grammaticalization further still, proposing a specific type of grammaticalization, couched within LFG, which involves two concomitant developments: (i) the development of a grammaticalized meaning in a particular item and (ii) the increasing association of that grammaticalized meaning with a particular structural position.

Börjars et al. (2016) propose this special type of grammaticalization on the basis of diachronic data concerning the development of definite markers and noun phrase syntax in North Germanic, specifically from Old Norse to modern Faroese. They provide empirical evidence which shows that Old Norse lacks an obligatory dedicated (in)definiteness marker via paired examples such as (26), where the bold element in (26a) receives a definite interpretation and that in (26b) an indefinite interpretation, despite the fact that neither is overtly marked for (in)definiteness.

(26) Old Norse (Börjars et al. 2016: e10)

a. **Austmaðr** kvezk …
east.man said
'The Norwegian said …'

b. Ok gekk **kona** fyrir útibúrsdyrrin
and went woman in.front.of outhouse.door.DEF
'A woman went in front of the door of the outbuilding'

Moreover the relative order of elements within the noun phrase is relatively free, although the initial position is associated with prominent and contrastive elements, as in the two instances of prenominal possessive pronouns with contrastive emphasis in (27).

(27) Old Norse (Börjars et al. 2016: e14)
at **minn** **faðir** væri eptirbát **þins** **fǫður**
COMP 1.SG.POSS father was after.boat 2.SG.POSS.GEN father.GEN
'that my father trailed in the wake of yours'

In the next diachronic stage which Börjars et al. consider – early Faroese (ca. 1298 CE) – they provide evidence which indicates that overt marking of definiteness is now obligatory, since unmodified nouns must occur with a definiteness marker in order to receive a definite interpretation, e.g., (28a). Indefinite markers are not yet obligatory, however, as evidenced by examples like (28b), which is interpreted as indefinite without any overt indefinite marker.

(28) Early Faroese (Börjars et al. 2016: e18)

a. Bardr Peterson war ritade **brefet**
B.P. was written letter.DEF
'Barður Peterson had written the letter.'

b. Ef **sauþr** gengi j annars haga …
if sheep goes in other's field
'If a sheep goes into another man's field …'

Moreover, unlike in Old Norse, where different definiteness markers can cooccur, by this stage of Faroese they are in complementary distribution. Only later in the history of Faroese — the representatives which Börjars et al. examine are a newspaper from the 1890s and data from Present-day Faroese — does overt marking for indefiniteness become obligatory via *ein*, e.g., (29a), and a prenominal syntactic definiteness marker (*tann* or *hinn*) is generally required when there is premodification, leading to "double definiteness", e.g., (29b)–(29c).

(29) Present-day Faroese (Börjars et al. 2016: e22–e23)

a. ein ungur maður
INDEF young.STR man
'a young man'

b. tann stóra gatan
DEF big.WK mystery.DEF
'the/that big mystery'

c. hin største vindmylluparkin í Europa
DEF biggest windmill.park.DEF in Europe
'the biggest wind farm in Europe'

In sum, the history of Faroese exhibits the grammaticalization of dedicated (in)definiteness markers which only later come to be associated with a particular structural position (the left edge of the noun phrase), in line with an overall increasingly fixed word order within the noun phrase.[8] Börjars et al. (2016) take advantage of the flexible nature of LFG's c-structure to model the observed gradual changes, building on a diachronic account of word order change in the context of grammaticalization concerning Romance prepositions by Vincent (1999). Central to both Vincent's (1999) and Börjars et al.'s (2016) accounts is the assumption that a new category can emerge diachronically without it necessarily needing to project a full endocentric phrase straightaway. Indeed, in the two accounts the full endocentric phrase projected by the new category is "grown" gradually at c-structure over time. This view is in line with the c-structure principle of Economy of Expression (Bresnan et al. 2016), which privileges lexical over phrasal expression and is radically different to the more standard universal application of X-bar theory in certain other generative approaches whereby, as soon as one posits a category, one also needs to posit a full endocentric phrasal projection complete with a specifier and complement position (cf. also Toivonen 2001, 2007 on non-projecting categories within LFG).

Applied to the Faroese story, Börjars et al. (2016) propose three c-structures to capture the structure of nominal phrases in the three periods: Old Norse (30a), early Faroese (ca. 1298) (30b) and Present-day Faroese (30c). In the earliest structure in (30a), word order is largely free (captured in the flat structure under NOM(inal)) but there is an initial position associated with information-structurally privileged elements. Crucially, in (30a) there is no category D; this only develops in early Faroese, cf. (30b), but at this point it is not yet associated with a particular structural position. Once definite markers are structurally associated with the left edge of the noun phrase, one can assume a projectional functional category, as captured in the endocentric DP structure for Present-day Faroese in (30c). The proposed growth of c-structure thus captures the grammaticalization of (in)definiteness in the context of a gradual shift from relatively free word order driven by information structure to a much more rigid, syntactically constrained word order as exhibited in modern Faroese.

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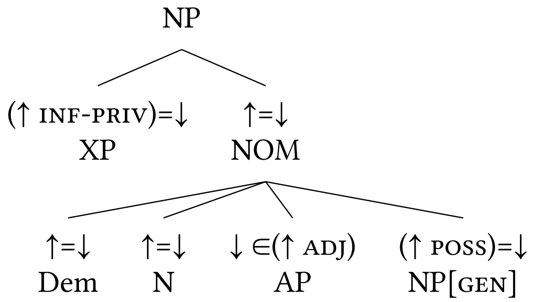
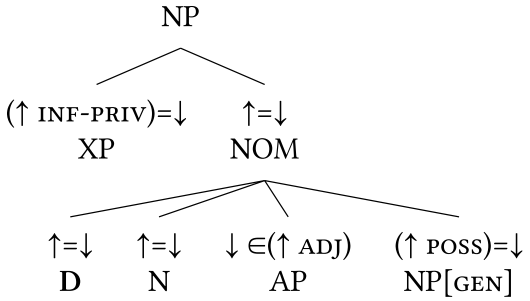
[8] Specifically, the definiteness marker was originally associated with the adjective in Old Norse, and frequently occurred postnominally, to the left of the adjective. The proposal by Börjars et al. is that, as adjectives became increasingly prenominal, the definiteness marker became associated with the left edge of the noun phrase overall.

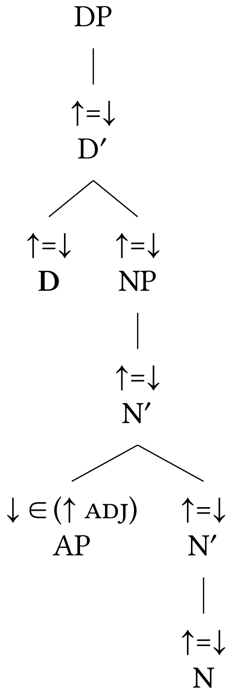
(30) a. Old Norse



b. Early Faroese



c. Present-day Faroese

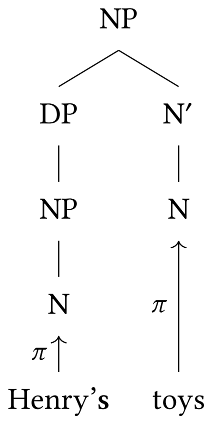


4.4 Degrammaticalization and lexical sharing

Another way in which gradual degrees of syntactic change have been captured at c-structure is via “Lexical Sharing”, as originally proposed within LFG by Wescoat (2002, 2005, 2007, 2009) and further developed by Lowe (2015, 2016a) as “Constrained Lexical Sharing”. Lexical Sharing is essentially a mechanism which allows two or more constituents at c-structure to map to a single lexical element. As we discuss in this section, Lowe (2015) employs this in the context of diachrony as a way to model degrees of “*de*grammaticalization” (see e.g., Norde 2009, Willis 2017) with respect to the English possessive marker *’s*, building on a synchronic analysis of Present-day English in Lowe (2016a).

The starting point for Lowe’s account is Present-day English, which indicates a mixed picture with respect to whether the possessive marker *’s* has clitic or affixal status. This is reflected in the literature, where some argue for it to be a clitic (e.g. Quirk et al. 1985, Anderson 2008) and others for it to be an affix (e.g., Zwicky 1987, Payne 2009). In this context, Lowe (2016a) claims that synchronically *’s* has dual status, i.e. that Present-day English exhibits both clitic forms and affixal forms and shows how this complex status can be modelled via Constrained Lexical Sharing. As Lowe points out, the lexicalism underpinning LFG leads to a discrete distinction between clitic and affix. An affix is assumed to attach to its host in the lexicon and will thus map to the same c-structure node as its host, e.g., (31a), while a clitic is a distinct lexical element which occupies its own c-structure node, e.g., (31b). The example c-structures here are as in Lowe (2015: 213).[9]

(31) a. Affix:



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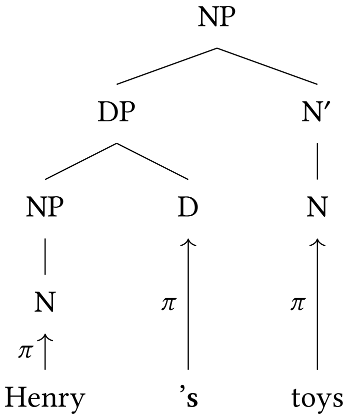
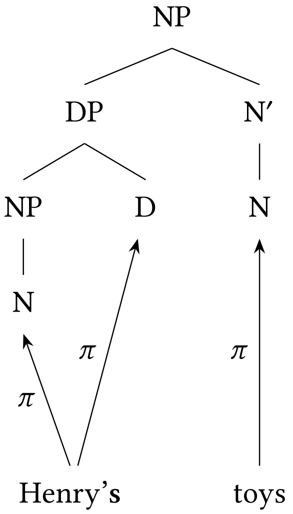
[9] In both Lowe (2015: 213) and Lowe (2016a: 174), different structures are provided for the possessum *toys* depending on whether one assumes the affix analysis or the clitic/lexically shared affix analysis; for the affix analysis, the immediate daughter of N’ is N, but for the clitic and lexically shared analysis the immediate daughter of N’ is given as an NP. Although Lowe does not provide any explanation for this difference, for the sake of consistency we simply repeat the structures here.

b. Clitic:



Rather than assume the straightforward affixal analysis in (31a) for affix-like instances of *’s*, however, Lowe (2016a) proposes an account involving (Constrained) Lexical Sharing. This allows one to capture the affixal status of *’s* whilst being able to maintain a consistent syntactic structure for possessive phrases, irrespective of the affixal/clitic status of *’s*. Wescoat’s original formulation of Lexical Sharing (Wescoat 2002, 2005, 2007, 2009) assumes an additional dimension, l(exical)-structure, which consists of a linearly ordered set of words. The idea behind Lexical Sharing is that it is possible for two adjacent c-structure elements to map to a single element at l-structure, i.e. “sharing” the same lexical exponent. Within the Constrained Lexical Sharing of Lowe (2015, 2016a), Wescoat’s l(exical)-structure is identified with the syntactic string (s-string) of Kaplan (1989), and thus Lexical Sharing refers to instances where a single element at the s-string is associated via the relation π with two adjacent c-structure nodes. In Lowe’s account, the affix-like *’s* is a lexically shared affix, e.g., (32), i.e. constitutes a single lexical element with its host but maps to a separate node from the host at c-structure, resulting in an overall structural configuration parallel to that for the clitic analysis in (31b).

(32) Lexically shared affix:



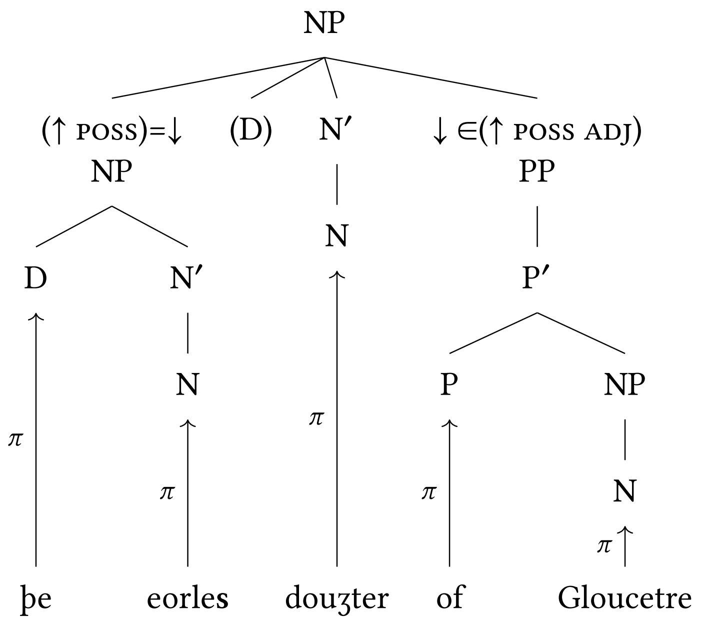
Applied specifically to diachrony, Lowe (2015) shows how this approach can be used to represent degrees of "*de*grammaticalization" of the English possessive marker, which "*de*grammaticalizes" over time from an unambiguous affix to a clitic (cf. the typical grammaticalization cline in (1) above). At the earliest attested stage, the Old English ancestor of Present-day English *'s*, *-es*, is one of a number of genitive case allomorphs and is uncontroversially an affix which is fully integrated with its stem in the s-string and maps to the same c-structure node as its host, cf. (31a). Crucially, as Lowe (2015) points out, drawing on data discussed by Allen (1997, 2003, 2008), the emergence of the clitic over the subsequent centuries is gradual and involves degrees of degrammaticalization and small-step changes from affix to clitic.

Specifically, in the period ca. 1100–1400 CE several changes are underway which affect the affixal status of the possessive marker: the various genitive case forms are largely lost and *-(e)s* becomes the possessive marker for most nouns, while possession is increasingly marked on just the head of the possessor, rather than on every element of the possessor. Lowe (2015) cites two construction types in particular which are attested during this period and indicate the beginning of a change in the morphosyntactic status of the possessive marker: (i) possessors which involve coordination where possession is marked only on the rightmost head, e.g., (33a) and (ii) possessor phrases with split postmodification flanking the possessum, where possession is marked on the head of the possessor, e.g., (33b).

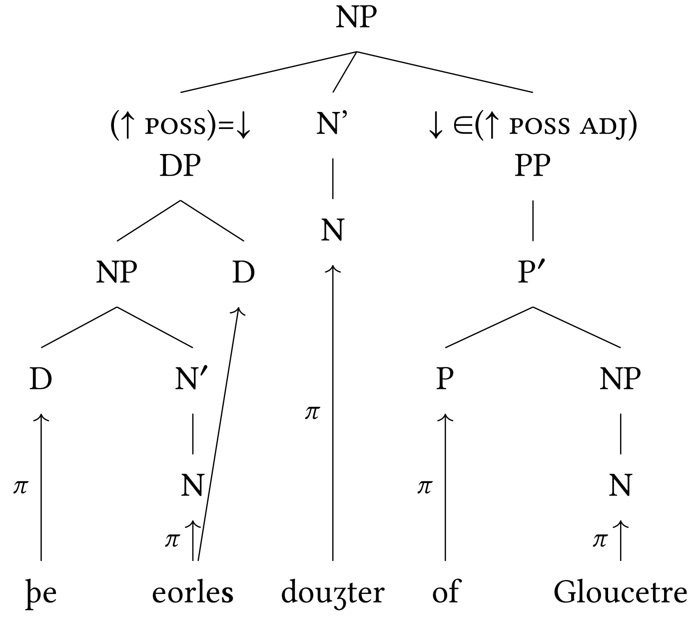
(33) Middle English
a. wif & were**s** gederunge
wife and man.GEN union
'The union of man and wife.'
(*Hali Meidenhad*, c. 1225 CE)
b. þe eorle**s** douʒter of Gloucetre
the earl.GEN daughter of Gloucester
'The Earl of Gloucester's daughter'
(*Polychronicon* VIII, ca. 1380)
(Lowe 2015: 217–218)

The two constructions in (33) show a strong positional constraint, whereby the possessive marker on the head of the possessor phrase must immediately precede the possessum. Lowe interprets this as evidence that the possessive marker is no longer fully affixal, since it is now constrained by the syntactic context in which it appears, rather than just being dependent on the position of the word to which it attaches. In the Lexical Sharing approach, this change can be captured by assuming that the original affix (modelled in (34a)) is reanalyzed as a lexically shared affix as shown in (34b) (structures from Lowe 2015: 222). In (34a), an optional D node is assumed, which is later incorporated into the head of the possessor phrase (see (34b)), once possessor phrases come to supply the definiteness of the possessum, in line with the broader grammaticalization of the definite article which is underway in the period.

(34) a.



b.



However, the Middle English lexically shared affix in (34b) is not yet equivalent to the status of the possessive marker in Present-day English but rather has a subtle difference. As Lowe (2015) points out, in the former, the noun component must supply the head of the possessor phrase. This is captured in the lexical entry in (35a), where the N component is associated with an f-description which requires that the f-structure of the noun serve as the value (or a member of a set of values) of the feature POSS in a wider f-structure; the D does not need to have any f-descriptions associated with it. By contrast, for Present-day English – where the possessive marker is closer to a clitic – Lowe assumes the lexical entry in (35b), "Partitioned Lexical Sharing", which involves two c-structure nodes each with their own set of f-descriptions (structures from Lowe 2015: 215, 223).

(35) a. Unified Lexical Sharing:

eorles:	N	D
	(↑ PRED) = 'earl'	
	(POSS (ϵ) ↑)	
	((POSS ↑) DEF) = +	

b. Partitioned Lexical Sharing:

species':	N	D
	(↑ PRED) = 'species'	(POSS ↑)

According to Lowe, only from the end of the 14th century are "phrasal possessives proper" attested, i.e. phrasal possessives with postmodified possessors with possessive marking on the right edge of the postmodifier, rather than on the head of the possessor as in early examples, cf. (33b). The example Lowe provides is from Chaucer (ca. 1400 CE), shown here in (36). These more clitic-like examples coexist alongside the more affix-like split examples as in (33b) throughout the Middle English and Early Modern English periods, with an increasing preference for the more clitic-like type in (36). This is modelled in terms of gradually shifting preferences in favour of the Partitioned Lexical Sharing analysis, cf. (35b) over the Unified Lexical Sharing analysis, cf. (35a).

(36) Middle English (Lowe 2015: 219)
The grete god of Loves name

'The great God of Love's name.'

Taking advantage of Lexical Sharing thus allows Lowe (2015) to model the nuanced steps involved in syntactic change via degrammaticalization and, applied to Present-day English, also to capture the coexistence of older and newer variants at a synchronic level (Lowe 2016a).

A very different approach to the mix of clitic and affixal properties is exemplified by Bögel & Butt (2012), who work out an analysis of various different Urdu possessive constructions, including case clitics and the originally Persian *ezafe* construction. Their analysis factors in prosodic features typical of clitics (rather than leaving them out) and avoids the introduction of lexical sharing or other complex formal machinery.

4.5 Grammatical relations and licensing

As Vincent (2001) points out, the fundamental design of the LFG architecture, in which position and function are captured separately, means that it is well suited to modelling changes concerning grammatical relations. A consequence of assuming f-structure as an independent level of representation for abstract functional information is that grammatical functions such as SUBJ and OBJ are viewed as basic building blocks of the theory. As such, unlike in some other generative approaches, SUBJ and OBJ need not be defined in terms of structural position. This allows one to neatly capture the full cross-linguistic spectrum with respect to how languages encode grammatical relations, from those where structural position plays a strong role, e.g., modern English, to those where morphological marking is the dominant encoding means, e.g., Latin, but also languages which use a mixture of means, e.g., Chicheŵa (Bresnan & Mchombo 1987) and Icelandic (Zaenen et al. 1985). Previous work in this area has tended to focus on the cross-linguistic possibilities from a synchronic perspective; see Nordlinger (1998) and Snijders (2015) for relevant typologies. But this approach to grammatical relations also has much to offer for diachronic studies, since change concerning how languages encode grammatical relations is well-attested across languages (e.g., Kiparsky 1997, Hewson & Bubenik 2006, Ponti & Luraghi 2018) and individual historical stages will naturally exhibit intermediate stages along a change trajectory, with a particular balance between structural and morphological encoding strategies.

4.5.1 Word order and recipient passives

A complex change in this area which has been investigated in detail by Allen (1995, 2001) is the rise of the recipient passive in English, i.e. constructions like (37), where the recipient rather than the theme is treated as the subject.

(37) He was given a book.

According to Allen (2001), recipient passives are unattested in Old English; the earliest known example of a recipient passive is from 1375 CE, alongside other scarce examples from the late fourteenth and early fifteenth centuries. The earliest example according to Allen, from 1375, is shown here in (38).

(38) Middle English (Award Blount, p. 207, Allen 2001: 51)
Item as for the Parke, she is alowyd Every yere a dere and xx Coupull of Conyes and all fewell Wode to her necessarye…
'Item: as for the park, she is allowed a deer every year and 20 pairs of rabbits and all firewood necessary to her…'

As with the change concerning experiencer verbs discussed in Section 3.2, Allen again challenges classic accounts of this development (e.g., Jespersen 1927, van der Gaaf 1929, Campbell 1998), which assume that recipient passives emerged via reanalysis of an ambiguously case-marked fronted indirect object as the subject, as in (39).

(39) Middle English (Ric.Couer de L. 1307, Auchinleck MS, Allen 2001: 49)
The Duke Mylon was geven hys liff, and fleygh out of land with his wife.
'Duke Mylon was given his life, and fled out of the country with his wife.'

Allen (2001) points out that the chronology does not stack up to support the classic account, for a variety of reasons. This includes the observation that the loss of the morphological distinction between nominative and dative which results in the prerequisite ambiguity for the classic reanalysis account occurred long before the first recipient passive examples are attested, with a gap of 175 years.

Allen (2001) argues instead for a change involving reanalysis of the indirect object (theme) of active sentences as the direct object, which in turn has consequences for the status of the recipient argument and ultimately facilitates its promotion to subject under passivization. Rather than being driven by ambiguous case-marking, as assumed in the classic accounts, Allen argues that her reanalysis story was triggered by the fixing of the relative word order of two objects. This is based on the observation that the first attestation of recipient passives coincides with the disappearance of examples like (40), in which a (non-pronominal) NP which is the Theme precedes a (non-pronominal) NP which is the Recipient. According to Allen, such orderings with two NPs are unattested as of the last quarter of the fourteenth century.

(40) I gave [a gift]$_{\text{theme}}$ [the king]$_{\text{recipient}}$

Allen suggests that once nominal recipients became fixed in the immediately postverbal position, the simplest analysis from the perspective of the language learner was to analyze the recipient as an OBJ, due to the fact that the learner could now calculate grammatical relations directly on the basis of position, and in turn the semantic relations too. Specifically, a new processing strategy arose which stated that the first non-pronominal NP after the verb would be the OBJ, provided no pronoun preceded it — the strategy for pronouns would be rather different according to Allen, presumably owing to the special positional distribution of pronouns in Early English. As a result, the semantic role could now be determined on the basis of position: if the OBJ was followed by another NP, the OBJ could only be the Recipient and the second NP could only be OBJ_θ, with the only possibility in terms of semantic role as the Theme. In this way, the fixing of the order eases the hearer's processing concerning the assignment of grammatical relations and thematic roles. Moreover, since the Recipient as an OBJ is now $[-r]$, it can map to SUBJ under passivization in accordance with the natural classes which fall out from the features $[\pm r, o]$. Thus recipient passives are now possible.

Allen's account thus investigates the connection between word order and the assignment of grammatical relations and in particular a change whereby grammatical relations become increasingly encoded via position. Next, we discuss other work which has considered this type of change within LFG.

4.5.2 Positional licensing and information structure

Change whereby structural position becomes an increasingly dominant licensing strategy for grammatical relations over time is well attested cross-linguistically; cf. the rise of (argument) configurationality (e.g., Hewson & Bubenik 2006, Luraghi 2010). In the linking theory developed by Kiparsky (1987, 1988, 1997, 2001), where case, agreement and position are viewed as interacting licensing strategies for grammatical relations, this type of change has been formalized as the rise of "positional licensing" (Kiparsky 1997). Focusing on the history of English, Kiparsky (1997) argues that as English lost its morphological case system, position became the dominant licensing strategy for grammatical relations. Beyond Allen's analysis of the recipient passive, this idea has been explored more recently within LFG by Booth et al. (2017), who present a positional licensing account in LFG terms for the diachrony of subjects in Icelandic. As both Kiparsky (1997) and Booth et al. (2017) point out, Icelandic offers an interesting point of comparison with Kiparsky's original account since, unlike English, Icelandic has maintained rich morphological case up to the present day.

Booth et al. (2017) observe that Icelandic subjects are increasingly realized in the clause-initial prefinite position and capture this change in terms of the rise of positional licensing, also bringing information structure into the account. Two other concomitant changes are observed and feed into their analysis: (i) a decrease in V1 declaratives as in (41) and (ii) the emergence of the expletive *það* which is positionally restricted to the clause-initial prefinite position; cf. the contrast in (42), when the expletive is ruled out in contexts where this position is otherwise occupied.

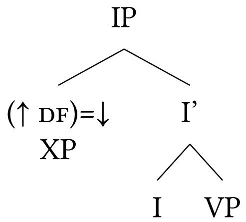
(41) Middle Icelandic (Georgius, 1525, Booth et al. 2017: 111)
Sýndi drottinn mikla miskunn vin sínum
show.pst.3sg lord.nom.def great.acc mercy.acc friend.dat his-own.dat
sankti Georgíum
saint.dat George.dat
'The Lord showed great mercy to his friend St. George.'

(42) Modern Icelandic (Booth et al. 2017: 111–112)
a. **Það** var ekki minnst á önnur dýr.
expl be.pst.3sg neg mention.ptcp on other.acc animals.acc
b. Ekki var minnst á önnur dýr.
neg be.pst.3sg mention.ptcp on other.acc animals.acc
'There was no mention of other animals.'

Following a proposal by Hinterhölzl & Petrova (2010) for the history of West Germanic, Booth et al. (2017) put forward an information-structural account for the rise of the expletive *það* and in turn the decrease in V1 declaratives, assuming that the finite verb serves as an information-structural boundary separating topic and comment. The change is captured in terms of the growth of structure, whereby a flat structure lacking functional categories yields to a more articulated structure making use of functional categories and projections, similar to the account of North Germanic noun phrases by Börjars et al. (2016) (see Section 4.3). In Booth et al.'s account at the clausal level, the relevant functional projection which emerges from an earlier flat structure is IP, headed by the finite verb in I; cf. the LFG accounts of modern Scandinavian clause structure by Sells (2001, 2005) and Börjars et al. (2003).

Once the IP structure is established, various changes occur concerning the nature of the clause-initial prefinite position, i.e. SpecIP. The information-structural role of the finite verb as a boundary between topic and comment leads to SpecIP becoming increasingly associated with a discourse function (df) capturing given or topical information, cf. (43).

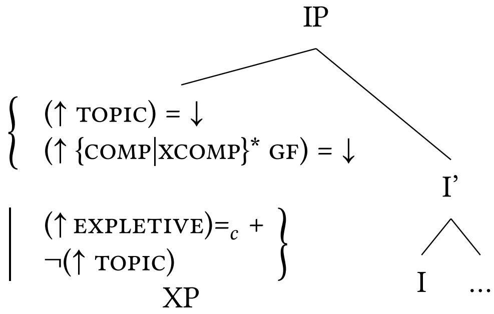
(43)



In their account, this increasing association of SpecIP with topicality can in turn explain the observed increasing realization of subjects in this position. Agentive and sentient entities tend to make for better topics than non-sentient entities, and, since subjects typically represent the more agentive, sentient semantic participants, subjects will accordingly often occur in this new topic position (see also Givón (1990), who discusses subjects as “grammaticalized topics”).

However, as Booth et al. show, SpecIP does not straightforwardly develop into a designated subject position, since subjects can still occur postfinitely in modern Icelandic. In particular, in clauses which lack a topic altogether, i.e. impersonal and presentational constructions, the expletive occurs in the SpecIP topic position as a signaller that the clause lacks a topic. As such, they propose the functional annotations in (44) for SpecIP in the modern stage: it can be occupied by any topical GF, or alternatively the expletive, provided the clause lacks a topic.

(44)



Thus the reorganization of information structure and word order in Icelandic, and in particular the changing status of SpecIP, is seen as the underlying shift which results in a decrease in V1 in favour of V2 sentences with a clause-initial topic or an expletive in topicless contexts. Booth et al.’s study shows that information-structural properties are an important consideration in the context of change with respect to word order and the licensing of grammatical relations. For a similar account which presents this change in terms of shifting correspondences between c-structure, f-structure and LFG’s i(nformation)-structure (Butt & King 1996, King 1997), see Booth & Schätzle (2019) and Booth & Beck (2021). In a similar vein, Booth (2021) shows how assuming that languages can gradually change their status with respect to argument configurationality and discourse configurationality can account for subtle changes in word order between Old and Modern Icelandic, which have otherwise prompted heated debate within approaches which assume configurationality to be a binary parameter (e.g. Faarlund 1990, Rögnvaldsson 1995).

5 Variation and change

In this last section, we turn to the question of the role of variation. It is well-known that language change is gradual and goes hand-in-hand with variation (e.g., Weinreich et al. 1968, Kroch 1989, Labov 1994, 2001, Pintzuk 2003, Chambers & Schilling 2013). However, formal grammars are discrete in nature, so a natural question which arises is how to combine the inherent variability and gradualness associated with language change into formal models of grammar.

One very popular way forward has been the combination of *Optimality Theory* (Boersma et al. 2000, Kager 1999) with stochastic methods (Boersma 2000, Boersma & Hayes 2001), which has been argued to account for patterns of variation and language acquisition. Optimality Theory (OT) was adapted into LFG very early on to yield a version of LFG dubbed "OT-LFG" (Kuhn 2023 [this volume], Bresnan 1996, 1998) and combined with stochastic methods to yield explanations for gradience in judgements (Bresnan et al. 2007, Bresnan & Nikitina 2010) and variation across dialects (Bresnan 2007, Bresnan & Hay 2008, Sharma et al. 2008, Bresnan et al. 2001).

In terms of historical linguistics, Clark (2004) is the first to lay out a formal model of diachronic variation that has led to gradual change.[10] He works with two case studies from the history of English: 1) word order change from primarily OV to VO; 2) the preferred association of subjects with the clause-initial position. Clark models the observed changes within stochastic OT-LFG and shows how the model parallels the observed stages in the historical development and variation in the corpora. Change is essentially effected via competing variants, as in much influential work on syntactic change in recent decades (e.g., Kroch 1989, Pintzuk 2003). In Clark's OT-LFG account, these competing variants are taken to be the result of constraints that are liable to be re-ranked with respect

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[10] Note that 'gradual' in this context refers not to incremental steps along, e.g., a grammaticalization cline as in (1) but rather the gradual diffusion of a particular change through a population of speakers, or even possibly the gradual establishment of an innovation in the grammar of an individual.

to one another due to inherent "noise" in the communication process between humans and the asymmetry of goals between perception (more information is generally useful for decoding) vs. production (producing less information is generally less burdensome). The stochastic OT-LFG approach is able to capture the steady quantitative rise in the use of an innovated structure by associating it with gradual changes in the relative strength of the relevant constraints. A constraint re-ranking that may be due to "noise" variation may become statistically preferred and from there finally lead to a categorical change.

In a comprehensive look at auxiliary contraction in English, Bresnan (2021) proposes a new hybrid model of LFG and a usage-based mental lexicon to explain the synchronic distribution and diachronic development of auxiliary contractions/clitics. The usage-based mental lexicon is conceived of as a combination of ideas coming from Pierrehumbert's examplar-based model of the mental lexicon (Pierrehumbert 2001, 2002) and Bybee's usage-based approach (Bybee 2006). The frequent co-occurrence of certain combinations of words, e.g., *you+are* or *we+will*, are predicted to undergo contraction. Frequencies are calculated using a measure termed *Informativeness*, which is the logarithm of the inverse of the conditional probability of one word following the other. In Bresnan (2021), the corpus study, the frequency calculations and the development of the hybrid LFG plus usage-based mental lexicon make for a rich and complex paper which combines the strengths of formal grammar modelling with by now well-established effects of frequency and variation in usage.

The auxiliary contractions themselves are modelled via the formal concept of lexical sharing within LFG (cf. Section 4.4) and this is where Bresnan (2021) draws a concrete connection to diachrony: "lexical sharing as a formal construct can be viewed as a grammaticalization of high-probability syntactic distributions in usage…". However, as argued for by Bögel (2015), clitics do not necessarily need to be modelled via lexical sharing. She instead proposes a more articulated architecture of the prosody-syntax interface for an analysis of clitics and provides a means for integrating effects of frequency and variation (Bögel & Turk 2019). Frequency effects can also be modelled via preferences applied directly to rules or lexical items, as practiced with respect to computational grammar development in LFG (Frank et al. 2001, Dost & King 2009).

Overall, the area of variation and change provides an interesting area of research for LFG, with initial architecturally complex and sophisticated proposals having recently been formulated, pointing the path towards innovative and exciting research in this area.

6 Summary

This chapter has endeavored to provide an overview of the types of work done within LFG on language change. Like most formal theories of grammar, LFG did not address language change from the outset and the first serious work on language change only began appearing in the 1990s. However, as LFG is fundamentally designed to separate form from function, the complex interaction between the function of an item and its overt realization can be modelled very well. Indeed, given LFG's complex formal design, in which the different components of grammar are represented with component-appropriate rules and representations, and interface with one another via the projection architecture, one might argue that there are too many moving parts to permit a clearly delineated theory of language change.

In one sense this is correct, but in another sense, one could argue that, as with synchronic description, what LFG provides is a broad formal framework, which must be specified by linguistic theorizing. By its very nature LFG pursues an *inductive* approach — the framework provides a broad perspective on the data (e.g., form and function are assumed to be separate, c-structure is assumed to model linear order, constituency and hierarchical relations, grammatical relations and argument structure are core objects over which generalizations can be stated, etc.) but the linguistic explanations and generalizations themselves emerge from the data and can be stated independently of the theory, thus allowing for potential cross-theoretic validity. Another aspect of the inductive approach is that the overall framework can be adjusted in the face of strong empirical evidence. For instance, when there is strong empirical evidence that information about frequency of items plays a role, the theory is adjusted and opens up interesting new ways of modelling language change, as we saw in Section 5.

Furthermore, the fact that LFG is very functionally oriented allows for an open channel of communication with the functional-descriptive and grammaticalization literature, leading to natural and insightful accounts of lexical and functional change, as we discussed in Section 3. Change in terms of syntactic categories and clausal organization is seen as being motivated by changes in function in the first place, with syntactic recategorization and reorganization following to reflect the change in underlying function (Section 4).

In this chapter, we have followed the very broad notion of reanalysis adopted by Harris & Campbell (1995) and hope to have shown how LFG can naturally account for reanalysis at various different levels: lexical, functional, categorical. In fact, one could see LFG as providing a firm formal basis for understanding the possible moving parts involved in reanalysis as part of language change, while also providing a basis for understanding how the well-attested gradualness, variation and frequency-based effects of language change can be modelled formally. That said, and despite the length of the chapter, it should be obvious to the reader that the existing body of historical linguistic work within LFG is so far not large and there is thus much room for investigation into language change. There is also room for experimentation and innovation with respect to how to represent and understand language change. This might include a new model of the lexicon, a new version of LFG or the introduction of new methods of probabilistic modelling, as we have seen above, or working with new ways of accessing the diachronic data, for example by means of a platform developed together with experts from visual analytics (e.g., Schätzle et al. 2019, Beck & Butt 2020, Beck et al. 2020).

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Chapter 21

LFG, Optimality Theory and learnability of languages

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Optimality-Theoretic accounts of grammar specification do not rely (exclusively) on rules and descriptions that every expression in the implied formal language has to satisfy strictly. Instead, a universal set of violable constraints is posited, and most grammatical expressions are not perfectly harmonic in all respects, but violate some of the constraints. A particular language is characterized by a certain priority ranking over the universal constraint set. This conceptualization of grammatical knowledge gives rise to the prediction of cross-linguistic variation: across languages, the same underlying meaning is realized by different expressions since different rankings of the constraints make different candidates optimal. The framework comes with a straightforward algorithmic formulation of the language learning problem – as error-driven constraint reranking.

Optimality Theory (OT) was combined with many linguistic description frameworks in the 1990s. LFG turned out to be a very appropriate base formalism for specifying the candidate representations in OT's competition-based definition of grammaticality. The novel way of characterizing formal languages prompted a range of debates regarding central assumptions in linguistic theorizing; various extensions of the competition-based setup were proposed; and the concept of violable constraints was taken over as an effective modeling device for managing ambiguities in broad-coverage computational grammar development. This chapter provides an introduction of the core concepts of OT as fleshed out on the basis of LFG, it illustrates the most influential extensions, and it reviews important conceptual debates triggered by the approach.

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1 Introduction

The term Optimality Theory (OT) refers to a family of grammatical frameworks developed in various subfields of linguistics following the original proposal for phonology by Prince & Smolensky (1993). Bresnan (1996), in her keynote address at the first LFG conference,[1] showed that LFG constitutes a natural base formalism for an OT account of syntax, laying the foundation for substantial research activities in the late 1990s and early 2000s.

The key idea behind OT is that grammatical knowledge is not captured in distinct rule systems for each language, but theorists assume a universal set of constraints responsible for determining the harmony or markedness of potential realizations of some underlying input representation. For example, both the clause structure *you see who?* and *who do you see?* are candidate realizations for expressing a *wh*-question that asks for the object of a transitive verb. In some languages, the equivalent of the former is grammatical, whereas in English, the latter is. Neither of the two variants is perfectly unmarked; each violates certain constraints (in essence: an interrogative phrase is best realized at the beginning of the clause vs. the object of a verb is best realized in the canonical VP-internal complement position). What differs across languages is the relative prominence among the universal constraints, such that there are different winners in the competition for the most harmonic/least marked candidate, which is defined to be the language-particular output. Learning a language thus amounts to determining the correct prominence ranking over a known set of constraints to replicate the behavior observed in adult speakers. A more technical illustration of an OT system building on the LFG formalism will follow in Section 1.1.

The notion of violable grammar constraints inspired linguists to explore the explanatory potential of a competition-based definition of grammaticality for a whole range of linguistic subfields. Moreover as Section 1.2 will discuss, the notion turned out fruitful for computational work aiming at linguistically grounded broad-coverage grammars: expanding "classical" constraint-based grammar formalisms with a novel type of violable constraints enables a competition-based filtering of ambiguity sources and thus greatly facilitates the treatment of relatively rare lexical variants and grammatical constructions (Frank et al. 2001). An outline of the remaining sections of this chapter will be provided in Section 1.3.

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[1] Details of the analysis presented in the keynote address are discussed in Bresnan (2001a) and Bresnan (2002).

1.1 Example of an OT-LFG analysis

The tableau in Figure 1 demonstrates more technically how an OT-LFG account predicts *who will she see?* to be the grammatical structure for realizing this type of question in English. It is adapted from Bresnan (2001a), a contribution that recasts Grimshaw's (1997) OT analysis of English verb inversion in an LFG framework assuming Extended Head Theory (as detailed in Bresnan 2001b: ch. 7 and Bresnan et al. 2016: ch. 7).

Input: $\left[\begin{array}{ll}\text{PRED} & \text{`see(x, y)'}\\ \text{GF}_1 & [\text{"you"}]\\ \text{GF}_2 & [\text{"who"}]\\ \text{Q-FOC} & \text{———}\\ \text{TNS} & \text{FUT}\end{array}\right]$	Op-Spec	Ob-Hd	Stay
a. ⟨ $[_{\text{IP}}$ you will $[_{\text{VP}}$ see who]], ...⟩	*!		
b. ⟨ $[_{\text{CP}}$ who *e* $[_{\text{IP}}$ you will $[_{\text{VP}}$ see *e*]]], ...⟩		*!	*
☞ c. ⟨ $[_{\text{CP}}$ who will $[_{\text{IP}}$ you *e* $[_{\text{VP}}$ see *e*]]], ...⟩			**

Figure 1: Tableau for the competition that leads to *who will you see?* being the most harmonic candidate under the constraint ranking for English. The candidates' c-structure trees are shown as bracketing expressions; their full f-structures is not shown here. Only a small subset of the candidate set is listed, omitting other realization variants. These are excluded for English by additional constraints, but could be grammatical in other languages and are thus included in the candidate set.

The tableau shows the comparison of three candidate realizations for the underlying content, the input – here the proposition *see*(x, y), where x is a pronominal for the second person singular, y is the focus of a question, and the clausal realization expresses future tense. Particular syntactic choices, for instance the realization of the semantic arguments by grammatical relations such as SUBJECT and OBJECT are underspecified in the input. In the OT-LFG framework, the range of realization options across languages can be captured very well by assuming that the input is a partially specified f-structure, and the candidate set consists of all fully specified LFG analyses whose f-structure is subsumed by the input.

The excerpt from the full candidate set shown in Figure 1 focuses on c-structural realization alternatives for clause structure. In Extended Head Theory, functional categories (such as I and C) and their c-structure projections are mapped to the same f-structure as their corresponding lexical categories (V). The functional projections occur optionally, but they offer the possibility to realize additional head elements such as tense auxiliaries and they come with one c-structural specifier position each, which can for instance be used for *wh* operators. Also, it is a possibility across languages for verbal head elements to be realized in a higher, c-commanding, position (e.g., V in I or I in C, as in candidate c.). By definition, elements in such a functional position are still *extended heads* of the lower projections. This nonderivational account of head mobility, which Bresnan (2001b: ch. 7) also formalizes in a non-OT setting of LFG, thus opens up a considerable spectrum of alternative candidate realizations for the basic clause structure.

Let us now consider what effect the three violable constraints have that Figure 1 shows in the order of the ranking for English (the constraint formalization will be discussed in more detail in Section 2.2). The harmony/markedness of a candidate is determined by its constraint violation profile. In the tableau notation, a violation is signalled by a star in the row for the corresponding constraint. Since OT assumes a *ranking* of the constraints (and not a more general weighing as for instance in Harmonic Grammar, Legendre et al. 1990), one can simply proceed from left to right through the constraints to determine the winning candidate(s): at each constraint, only the candidates that have the fewest violations for this constraint are kept. The other candidates have no more chance of winning the competition, even when they do not violate any of the lower-ranking constraints. It is common to mark the decisive constraint violations with an exclamation mark following the star; the cells for the lower-ranking constraints are often grayed out in tableaux. In our example competition, the Op-Spec constraint demands that syntactic operators such as *wh* phrases be realized in c-structural specifier positions (highlighting the operator's prominence). Candidate a. violates this constraint, since the *who* is realized inside the VP. Op-Spec is the highest-ranking constraint and the other candidates satisfy this constraint, hence candidate a. is excluded from further comparison. The Ob-Hd constraint (for obligatory head) says that every projected category (X′, X″) should have a lexically filled extended head. Candidate b., which includes a CP projection without a lexically filled head, incurs a violation of this constraint.[2] The third constraint, Stay,[3] states that categories should *dominate* their extended heads, thus punishing c-structural realizations in higher, c-commanding positions: In candidate c., the *wh* phrase in the CP-Spec position incurs one Stay violation (due to a lexically empty DP inside the VP), the *will* that is not realized within IP another one. Since Stay is low in the constraint ranking for English, candi-

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[2] The notion of *extended* heads leads to the situation that the empty I head in candidate c. does not incur an Ob-Hd violation: The C head, which contains *will*, is in a c-commanding position and thus acts as an extended head for the I′ and IP.

[3] The name Stay is carried over from Grimshaw's (1997) account, which assumed a derivational base formalism with upward movement in trees. The reconstruction is entirely nonderivational.

date c. is optimal despite the two violations: there are no surviving competitors with fewer violations.

Under different rankings of the same three constraints, different clause structures come out as optimal. When Stay outranks Op-Spec, for instance, candidate a. is the most harmonic. This predicts non-echo matrix questions like in (1) to be grammatical, as is the case in a *wh*-in-situ language like Chinese.

(1) Mandarin Chinese (Huang 1982: 253)
ni kanjian-le shei?
you see-ASP who
'Who did you see?'

According to OT assumptions, a language learner starts out with an uninformed initial constraint ranking. Whenever they hear an utterance by an adult speaker of the language, they check whether the observed output (for a contextually inferred input) is the same that their current ranking would have predicted. If not, the constraints responsible for the error are demoted in the ranking (Tesar & Smolensky 1998). Details of the OT approach to characterizing grammaticality and the OT-LFG formalization will be discussed Section 2.

1.2 Ranked soft constraints in computational grammar development

As mentioned, Joan Bresnan gave a keynote at the first LFG conference in 1996, presenting her proposal for integrating the competition-based grammatical framework of Optimality Theory with LFG's declarative specification of parallel representations that are in imperfect correspondence (Bresnan 1996). The concept of violable constraints immediately prompted interest in the computational LFG community, which was working towards implementations of LFG grammars that robustly cover real-life text data, most notable in the Parallel Grammar Development project ParGram (see also Forst & King 2023 [this volume]).

As Frank et al. (2001) discuss, violable constraints can alleviate a considerable practical problem with broad-coverage grammars that aim for linguistic precision: the *ambiguity management* problem. To reach an acceptable coverage of real corpus data with a linguistically precise grammar, the rules have to cater for essentially all conceivable realizations of variable phenomena – even for those that are infrequent and tend to underlie special contextual restrictions. In a grammar with such a comprehensive rule set however interactions among multiple variable phenomena can lead to an enormous degree of ambiguity in parsing. Although ambiguity packing techniques keep the computational parsing task itself tractable (Maxwell & Kaplan 1989) (see also Cahill & Way 2023 [this volume]), it can become hard for the grammar writers to keep track of whether the contextually justified readings are among the readings predicted by the grammar (King et al. 2004). The notion of violable constraints puts grammar writers in a position to overcome the ambiguity management problem via perspicuous filters.

The following examples may illustrate the proliferation of sources of ambiguity in a comprehensive grammar. In English, temporal adverbials can have the shape of a plain NP headed by a time expression such as *year, day, moment*, etc., as for instance in (2a,b). A carefully constrained grammar will rely on a lexical marking of the relevant nouns to avoid overgeneration. Without such a lexical restriction, any intransitive verb used with an NP in object position, such as (2c), would be incorrectly predicted to form a grammatical sentence.

(2) a. The car had problems all weekend.[4]
b. What are your future plans the next half year?[5]
c. * Lou yawned two big bones.

The rule in (3) uses a constraining equation to ensure that the adverbial NP comes with the marking [NTYPE TIME +].

(3)
$$\begin{array}{lllllllll} \text{VP} & \rightarrow & \text{V} & \text{(NP)} & \{ & \text{PP} & | & \text{NP} & \}^{*} \\ & & \uparrow=\downarrow & (\uparrow\textsc{obj})=\downarrow & & \downarrow\in(\uparrow\textsc{adj}) & & \downarrow\in(\uparrow\textsc{adj}) & \\ & & & & & & & (\downarrow\textsc{ntype time}) =_{c} + & \end{array}$$

Examples (4a,b) show however that adverbial uses of plain NPs can also occur with nouns that do not refer to time expressions.

(4) a. Being prepared will save your soles from aching the entire trip.[6]
b. And WoW had problems every expansion for years […][7]

By a semantic process of type coercion (see, e.g., Pustejovsky 1995), NPs referring to segments of a process (e.g., during spatial movement, as in (4a), or in repetitive processes, as in (4b)) can receive a temporal reading. A grammar that strictly ties adverbial NPs to a lexical marking of time expressions will fail on these examples. And since such coercion processes are relatively productive, grammar writers

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[4] https://www.flickr.com/photos/speedcenter/19225841474

[5] https://www.reddit.com/r/UnderCards/comments/kdjbb1/ama_is_the_way_to_get_a_free_vieeeews/

[6] https://vivaglammagazine.com/how-to-effortlessly-look-good-when-traveling/

[7] https://forums.newworld.com/t/fix-your-product-this-isnt-an-indie-company/247609/59

face a difficult tradeoff between maximizing coverage and risking a proliferation of ambiguity.

The issue is amplified when several variation phenomena interact, as the following considerations demonstrate. Completely independent of the type coercion process we just saw, many transitive verbs in English can occur with an understood object in appropriate contexts – i.e., without a syntactically realized direct object: *enjoy* and *announce* are both strictly transitive, but (5a,b) show that occasionally, an understood object can be filled in contextually.

(5) a. [Text message with a video posting:]
Here it is. Lean back and enjoy for the next 7 minutes.[8]

b. [News headline:]
Troy Williams will announce tomorrow[9]

To capture such uses, one could have transitive verbs optionally fill in a pronominal PRED value for their object (this can for instance be done by putting an optional equation in the lexical template for transitive verbs: { (↑ OBJ PRED) = 'pro' }). The pronominal PRED value indicates that its referent can be contextually inferred.

Both the temporal type coercion discussed previously and understood objects occur rather infrequently overall; yet, a broad-coverage grammar should cater for these constructions. Unfortunately, it is impossible to fully capture the contextual constraints on the use of such constructions within a knowledge engineering approach – individual uses may depend on inferences involving situational knowledge and general world knowledge.

By employing violable "soft" constraints inspired by Optimality Theory in a broad-coverage LFG grammar, the infrequent constructions can be captured in the grammar without causing a proliferation of ambiguity for the core constructions. Sentence (6a) is an example of a plain transitive use of the verb *announce*. A conspiracy of the two infrequent constructions we just discussed would however also lead to an understood object reading of *announced* (corresponding to the only reading available for (5b)) when *every expansion* would be analyzed as a coerced temporal adjunct (like in (2e)). With a comprehensive grammar allowing for these rare options, every single transitive VP (as in (6b)) would receive duplicate readings – although a temporal reading of the NP is extremely implausible in most cases. As (6c) shows, even an NP including a time expression will

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[8] https://mobile.twitter.com/automobilirimac/status/765505874425180160

[9] https://www.on3.com/teams/kentucky-wildcats/news/troy-williams-will-announce-tomorrow/amp/

rather fill the position of the direct object than acting as an adverbial NP alongside an understood object (although in this particular case, the two readings are semantically hard to distinguish).

(6) a. The company announced every expansion.
    b. The dog chases every bird.
    c. [From a comment page for a music band:]
       Super talented, professional. We enjoyed every minute.[10]

The mechanism of ranked violable constraints discussed by Frank et al. (2001), which is implemented in the XLE system (Crouch et al. 2011), provides a highly convenient way of dealing with this situation. In (7), template definitions are seen that optionally[11] introduce the infrequent construction of a type-coerced common noun (such as *expansion*, *trip* and even *bird*) and an understood object with a transitive verb.

(7) a. common-noun(_p) ≡ (↑ pred) = '_p'
       { (↑ ntype time) = +
       TypeCoercionToTimeNoun ∈ *o*(*) }
    b. transitive(_p) ≡ (↑ pred) = '_p ⟨ (↑ subj) (↑ obj)⟩'
       { (↑ obj pred) = 'pro'
       UnderstoodObj ∈ *o*(*) }

Note that the optional functional descriptions go along with statements of the form 'xyz ∈ *o*(*)'. These have the effect of introducing so-called optimality marks (xyz etc.) to a data structure projected from c-structure to a novel *o*-projection (for Optimality projection).[12] Mathematically, the data structure is a multiset (i.e., a generalization of sets that can include two or more identical 'copies' as distinct elements). The purpose of this multiset is simply to implement a counting mechanism that keeps track of how many times a certain functional description was used in the construction of a particular LFG analysis. In c-structure rules $A \rightarrow B_1 \dots B_n$, the union of the multisets from all daughter categories $B_1 \dots B_n$ forms the multiset projected from the mother category A. So the root node of

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[10] https://www.esteemlivemusic.com/we-enjoyed-every-moment/

[11] Enclosing functional descriptions in curly brackets has the effect of creating one option with the descriptions and one without.

[12] Like the ϕ-projection, the *o*-projection starts out from c-structural entities (i.e., lexical or phrasal c-structure nodes, denoted by '*'). This makes it possible to introduce distinct marks from several c-structure nodes that map to the same f-structure. This can for instance be relevant for economy constraints that favor structures with fewer nodes.

a c-structure tree will always provide access to the aggregate counts of marks from the full tree.

The multiset of optimality marks provides the basis for filtering a set of candidate analyses, very much like in the OT tableaux illustrated in Section 1.1. The grammar writer can define the relative ranking of the violable constraints (the OPTIMALITYORDER) that guides the filtering:

(8) OPTIMALITYORDER UnderstoodObj TypeCoercionToTimeNoun.

Starting with the highest-ranking type of optimality mark, the set of readings is successively reduced; for each type of OT mark only the candidates that have the fewest marks are kept. The effect of this is that the structures for infrequent constructions as illustrated in (4) and (5) will only be seen in the final output of the grammar when there is no alternative, more canonical way of analyzing the same string. In our example scenario, plain transitive sentences like (as (6b)) will hence receive only the canonical subject-object reading. At the same time however, the OT-style ranking system *does* cover uses of type coercion or understood objects. For instance when analyzing sentences that contain type-coerced adverbial NPs like (4a,b), *all* candidate analyses include at least one mark TypeCoercionToTimeNoun, hence they will survive this step of the filtering.

With such a filtering mechanism, the grammar writers can transparently control many of the interaction effects of the linguistic phenomena they are dealing with – without having to come up with explicit descriptions of contextual conditions for the rare special uses. The approach has hence been widely applied in the broad-coverage grammars of the ParGram project. As we will see in Section 2.6, some modifications of the plain ranking mechanism open up further functionality for grammar development.

To conclude this section we note however that there is a clear difference in the conceptual role played by the competition among candidate analyses (i) in OT-LFG, as discussed in Section 1.1) vs. (ii) in the "OT-style" filtering approach in grammar development, as discussed in this section: in the former case, the competition serves to define grammaticality in a given language, whereas in the latter case, all candidates are assumed to be grammatical in principle, and the competition serves to filter out implausible readings.

1.3 Chapter outline

The remainder of the chapter is organized into four sections and a conclusion: Section 2 discusses the OT framework and its combination with the LFG formalism in more detail. Section 3 provides a number of demonstrations of how the competition-based notion of grammaticality can systematically derive variation patterns within a language and predict typological patterns across languages. Section 4 goes into important extensions of the standard OT framework and reviews discussions of the status of key components of an OT system such as the violable constraints. It also provides a discussion of linguistic formalisms and learnability of languages. Section 5 reviews the developments after the mid-2000s, with an emphasis on a comparison of OT and other competition-based architectures. It also includes a discussion of the relationship between OT and the recent so-called neural modeling paradigm in Machine Learning and Natural Language Processing research. Section 6 concludes with a summary of important epistemological considerations regarding the OT approach.

2 OT: Formalism and computational considerations

Section 2.1 discusses the key components of an OT system in general and their motivation for the Theory of Grammar. On this basis, Section 2.2 addresses the application of OT systems in syntax and expands on the OT-LFG approach outlined in the introduction. Section 2.3 contrasts the OT-LFG approach with OT syntax approaches using a derivational base formalism.

Section 2.4 discusses the most important computational considerations regarding OT-LFG. An excursion in Section 2.5 addresses potential concerns regarding plausibility of OT-LFG that might arise if one assumes that the declarative specification of the candidate set has any direct psychological reality during human sentence processing. Section 2.6 provides some more details on the use of soft constraints in broad-coverage grammar development illustrated in Section 1.2.

2.1 Key components and assumptions of OT

The initial example shown in Figure 1 already provided an illustration of the key components of Optimality Theory in general and OT-LFG in particular. Within an OT system, the set of grammatical expressions for a particular natural language L is defined using (i) a language-independent function *Gen*, which maps a given input representation to a set of candidates, (ii) a universal set of violable constraints *Con*, and (iii) a harmony evaluation function *Eval*, applying a language-specific prominence ranking $\gg_L$ that is defined over the constraint set. We define an expression to be grammatical in L if it is (one of) the most harmonic candidate(s) in the set of competing realizations for some input according to $\gg_L$. A candidate C_1 is more harmonic than a candidate C_2 iff it contains fewer violations for the highest-ranked constraint in which the marking for C_1 and C_2 differs.

With the variable ranking relation over a universal set of constraints, an OT system does not just predict an individual language, but essentially an entire constellation of possible languages, the so-called factorial typology. The task for a theorist working on some family of phenomena is to find a set of constraints that plausibly predicts the spectrum of cross-linguistic variation as it is empirically attested in the languages of the world.

A key methodological assumption of linguistic work employing OT systems is that the input includes no language-specific information or restrictions. This is called the "richness of the base" (Smolensky 1996). A construction that is only available in some languages should not be explained by differences in the input, but must be derived as an effect of constraint ranking. In other words, the role of candidate generation, *Gen*, is limited to providing the space of possibilities; the substantive linguistic regularities should by assumption all be dealt with in the constraint set.

In phonology, the input can be thought of as the target sound sequence a speaker intends to realize. In the case of loan words, this target sequence may include sound clusters that cannot be expressed in the language. For instance, the Dutch loan word *plan* is realized as *päläna* in Sinhalese:

(9) Sinhalese (Indo-Aryan; Boersma et al. 2000: 5, citing Sannasgala 1976)
päläna
'plan'

The OT explanation is that there is a constraint against complex syllable onsets and that in the constraint ranking for Sinhalese, this constraint is ranked higher than a constraint against the addition of epenthetical vowels. As a consequence, a surface realization that deviates from the target sound sequence arises as optimal. To capture the full spectrum of phonological systems, *Gen* must make far-reaching deviations from the input available.

Constraints that evaluate whether a property from the input is preserved in the output are called *faithfulness constraints*; there are three types, punishing (a) the insertion and (b) the deletion of a segment and (c) the alteration of some feature value (e.g., devoicing of a voiced consonant) (Prince & Smolensky 1993, McCarthy & Prince 1995). Which part of the space of more or less faithful candidates a language uses for a certain phenomenon is determined by the relative ranking of faithfulness constraints and a second class of constraints, the so-called *markedness constraints*. These constraints assess the output shape of a candidate, irrespective of the input it is supposed to convey. By and large, OT predicts typological differences to arise from different strategies of reconciling conflicts among faithfulness and markedness constraints.

2.2 Optimality-Theoretic Syntax and its formalization

The predictive potential of OT systems regarding language typology as demonstrated in phonology soon attracted researchers working on different subfields of grammar, including syntax (Grimshaw 1997, Samek-Lodovici 1996, Pesetsky 1998, Legendre et al. 1998).[13] Technically, it is relatively straightforward to assume that some modular part of a conventional theory of grammar is replaced by an OT system: instead of the conventional output representation, a set of alternative candidates is assumed whose harmony is then assessed based on ranked violable constraints.[14] (It should be noted however that depending on which part of a conventional approach is being replaced by the output of an OT competition, there can be great differences in the predictive potential of the model component; we come back to this in Section 2.3.)

The fact that the explanatory power of an OT system comes largely from constraint interaction had an interesting effect in terms of sociology of science: Optimality-theoretic extensions of base formalisms from different schools of thought could be subjected to a meaningful comparison, even where diverging assumptions in the conception of the base formalisms themselves had before made comparisons very difficult. This led to an opening up of channels for exchange among theoretical frameworks (see for instance the collection of contributions in Legendre et al. 2000).[15]

Early work on OT syntax sometimes relied on an intuitive and informal conception of the syntactic structures that should compete with each other in the same candidate set. To preserve the idea from OT phonology that all conceivable alternatives for saying the same thing are included in the candidate set, the natural assumption for the input in OT syntax is an abstract representation of the syntactically relevant *semantic content* of an utterance. As Bresnan (1996) points out, this intuition can be cashed out straightforwardly if candidate generation

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[13] The account of unaccusativity in French by Legendre et al. (1990) in the framework of Harmonic Grammar predates much of the work in OT phonology. Nevertheless, many syntacticians presumably only took notice of competition-based approaches in the aftermath of the success of OT phonology and reacting to Grimshaw's (1997) paper.

[14] The approach of "Harmonic Serialism" assumes an architecture that is broken down into a sequence of steps with local optimization. Müller (2020) for instance explores an extension to morphology.

[15] This unifying potential is discussed for instance by Newmeyer (2002: 44).

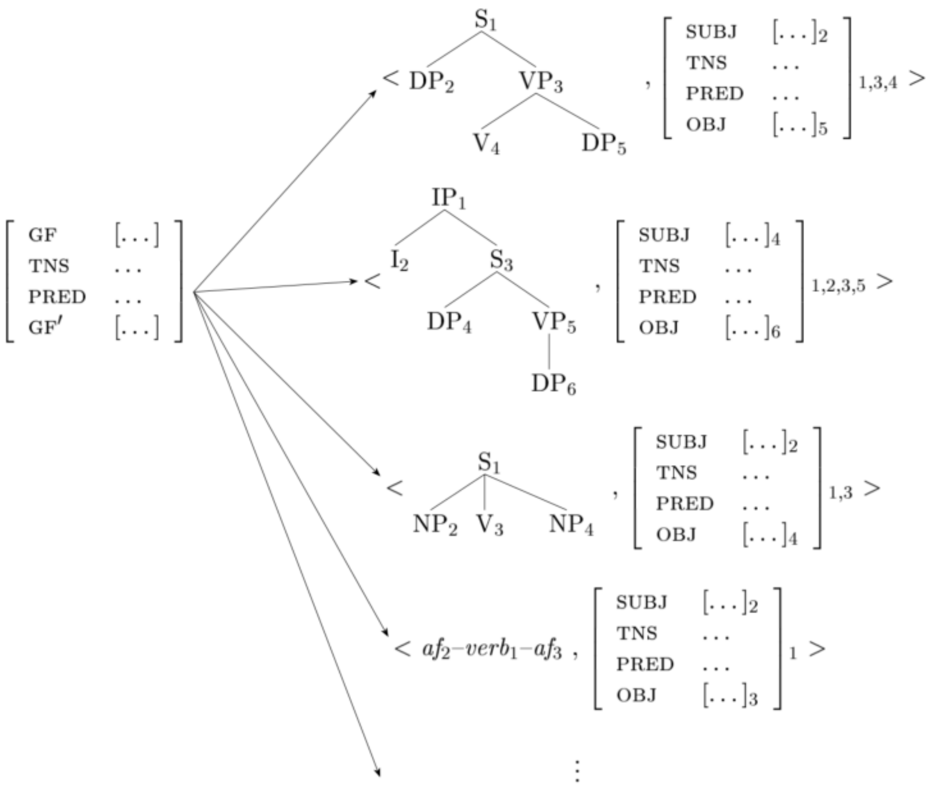

Figure 2: Illustration of candidate generation in OT-LFG (Bresnan 2001a): an underspecified functional structure (on the left) is the basis for generating full LFG analyses (c-structure/f-structure pairs) whose f-structure is subsumed by the input.

is based on a monotonic unification formalism like LFG: the input can be operationalized as a partial representation including the relevant semantic information, and the set of candidates as all the complete representations expanding this input representation – in the case of LFG pairs of c-structures and corresponding f-structures that are subsumed by the input presentation, as is illustrated in Figure 2 from Bresnan (2001a). Cross-linguistic variation at the level of constituent structure is captured by including all typologically different options for expressing some core semantic information in the candidate set.

A formal definition for the candidate generation function *Gen* in OT-LFG is shown in (10) (Kuhn 2003: 74).[16] *Gen* depends on an LFG-type base grammar G_{inviol}, which specifies the space of structurally valid candidate tuples from the full typological spectrum by means of the 'inviolable principles', and is applied to a partially specified f-structure Φ_{in}.

(10) Restricted definition of *Gen*

$$\begin{aligned} Gen_{G_{inviol}}(\Phi_{in}) \;=\; \{\; & \langle T, \Phi' \rangle \in L(G_{inviol}) \,|\, \Phi_{in} \sqsubseteq \Phi', \text{ where } \Phi' \text{ contains} \\ & \text{no more semantic information than } \Phi_{in} \qquad \} \end{aligned}$$

The candidate set generated by *Gen* includes all c-structure/f-structure pairs from the base grammar whose f-structure Φ' (i) is subsumed by the input f-structure Φ_{in} and (ii) does not add any semantic information.[17]

The violable constraints in OT-LFG operate on the candidate representations. It is in principle conceivable to include the detection of constraint violations already in the specification of the base grammar G_{inviol}, using disjunctive f-annotations of the kind shown in Section 1.2 on soft constraints in computational grammar development and introducing marks to a special *o*-projection for counting. However, the specification would presumably become unmanageable fast, since the representational patterns addressed in the various constraints are interdependent; moreover, many constraints address not only patterns in f-structures, but make reference to portions of c-structure. The formalization of OT constraints in Kuhn (2003: ch. 4) therefore proposes to leave constraint marking out of G_{inviol} and assume a conceptually separate step for detecting the constraint violations for each c-structure/f-structure pair in the candidate set. This step can employ straightforward descriptive constraint *schemata* which use a special metavariable $\star$ that is successively being instantiated to every structural element in a candidate analysis, i.e., to each c-structure node, and to each (sub) f-structure.

In (11), the schema-based formal capturing of Bresnan's (2000) constraints Op-Spec and Ob-Hd, which were discussed in Section 1.1, is seen (for details, see Kuhn 2003: 90ff):[18]

(11) a. Op-Spec ('An operator must be the value of a DF in the f-structure.')

$$(\textit{f-str}(\star) \land \exists v.[(\star\ \textsc{op}) = v])$$
$$\rightarrow \exists f.[(f\ \textsc{df}) = \star]$$

---

[16] The language $L(G)$ generated by an LFG grammar G is here defined as the set of tuples $\langle T, \Phi \rangle$ such that T is a c-structure generated by the context-free skeleton in G and Φ is a valid f-structure for T according to the functional descriptions in G.

[17] The restriction excluding surplus semantic information will be addressed in Section 2.4.

[18] The schemata assume appropriately defined auxiliary predicates *cat* (for category) etc.

"If $\star$ is an f-structure bearing a feature OP (with some value v), then there is some f-structure f such that $\star$ is embedded in f under a DF function."

b. Ob-Hd ('Every projected category has a lexically filled extended head.')

$(\mathit{cat}(\star) \wedge (\mathit{bar\text{-}level}(\star, 1) \vee \mathit{bar\text{-}level}(\star, 2))$
$\rightarrow \exists n.[\mathit{ext\text{-}hd}(n, \star)]$

"If $\star$ is an X-bar or X-max category, then there is some node n which is the extended head of $\star$."

The evaluation function *Eval* is operationalized as a trial of all schemata in the constraint set C on every structural element of a candidate analysis (c-structure node or partial f-structure). For the trial, the metavariable $\star$ is instantiated to the element under consideration; the count for the relevant constraint is increased in case the proposition is satisfied. The language-specific ranking $\gg_L$ over the constraints then controls the filtering of the most harmonic candidate(s), in the same way as illustrated in Figure 1 in Section 1.1.

All candidates that are optimal (under the constraint ranking for a given language L) for some underlying partial f-structure Φ_{in} then form the language (= set of c-structure/f-structure pairs) generated by an OT-LFG system for language L (Kuhn 2003: 117):

(12) Definition of the language generated by an OT-LFG system $O = \langle G_{inviol}, \langle C, \gg_L \rangle \rangle$ for language L:

$$L(O) = \{ \langle T_j, \Phi_j \rangle \in L(G_{inviol}) \mid \exists \Phi_{in} : \langle T_j, \Phi_j \rangle \in \mathit{Eval}_{\langle C, \gg_L \rangle}(\mathit{Gen}_{G_{inviol}}(\Phi_{in})) \}$$

The OT-LFG formalization thus provides a declarative, fully operationalized framework for specifying a theory of the typological space of options for a range of grammatical phenomena, predicting specific realization patterns for languages associated with certain constraint rankings. Computational considerations, in particular regarding the complexity of *Gen*, will be addressed in Section 2.4.

Combining the OT concept of competition-based specification of grammatical knowledge with the LFG formalism for operationalizing the components of such an account was beneficial for both sides: For OT theorists interested in exploring the expressiveness of the Optimality-Theoretic approach when applied to phenomena from the broad field of morphology/syntax/semantics, the OT-LFG framework provided a basis whose formal and computational properties were well understood. Consequently, (i) concrete accounts for phenomena of interest could be worked out and tested against attested linguistic data, and (ii) formal and computational implications of the novel conceptualization of modeling grammatical knowledge could be pinpointed. In the reverse direction, the LFG community benefited from the extension of the classical formalism, since OT-LFG provided a formalized framework for predicting patterns in the variation observed across languages (and within a language). By couching an LFG account for a phenomenon in the OT-LFG framework, its generality thus becomes testable against empirical data from language typology. And even when trying to capture variation patterns within a single language, an OT-LFG approach readily supports a reasoning that reduces the range of available realization options to a small set of independently justifiable directives.

2.3 OT-LFG's conceptual advantages over a derivational base formalism

A large proportion of work in OT syntax is not couched in the OT-LFG framework, but assumes a derivational base formalism such as Principle-and-Parameter Theory (Chomsky 1981) or Minimalism (see Grimshaw's 1997 original account and much subsequent work, e.g., Pesetsky 1998). With candidate analyses that are inherently derivational, an implementation of the original OT idea – that the input corresponds to the semantic content of the expressions under consideration – inevitably leads to a more complicated architecture. In the study of syntax, the expressions under consideration are full sentences; so, to implement the original OT idea, all alternative surface sentences expressing the same semantic content should be included in a candidate set. The complication for an OT architecture now arises from the fact that in a Chomskyan derivational approach, semantic interpretation is located at the level of logical form (LF), which is by definition one of the end points of a derivational process that starts out from a D-structure (as in the T-model underlying Principle-and-Parameter Theory, shown in Figure 3) or a set of lexical items, the "numeration".

In a non-OT framework, the derivational processes that lead to a phonological form and a logical form are controlled by language-particular factors. When the derivational processes are taken to be the candidates of an OT system that adheres to the richness of the base, the derivational mechanisms have to be opened up in such a way that all language-particular restrictions on the derivations are lifted – generating all conceivable variants as alternative candidate derivations and leaving the calculation of language-particular effects to *Eval*, which selects the optimal derivation based on the constraint ranking. The input (for the definition of the OT candidate set) has to be (some relevant part of) an LF representation, and the set of candidates that *Gen* assigns to such an "input" LF must

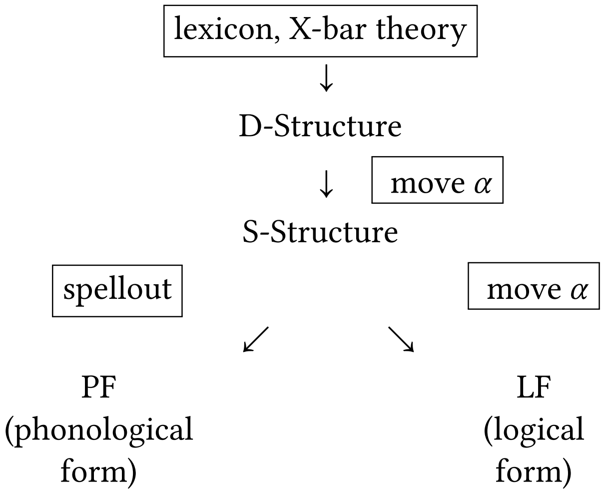

Figure 3: The T-model (or Y-model) of the derivation processes underlying a single analysis couched in Principle-and-Parameter Theory (Chomsky 1981)

be all derivations that *end in* this LF via unconstrained derivation – from any possible starting point (i.e., any numeration of lexical items that could arrive at this LF through unconstrained transformational derivations). Leaving aside concerns regarding the computational tractability of such a system, it is challenging to conceptualize the workings of the OT constraints if the candidate-internal derivation is taken literally as a (potentially destructive) structure-transforming process: if the evaluation of candidate derivations does not take place until a particular LF has been reached, how can the constraints be used to control the language-specific choices in the derivation steps happening early on in the process?

The constraint evaluation challenge can be resolved by viewing the derivational process inherent to the candidates as some abstract process that produces a *representation* including a record of all relevant steps (such as traces of a movement). With this representational strategy, a definition of the candidate set via a shared LF becomes possible. Let us call this an LF-as-input OT system, which preserves the original, meaning-related concept of the OT input (but enforces an abstract view of the derivations, with a representational record).

For a research approach starting out with a derivational framework, it may seem more natural however to resolve the constraint evaluation challenge in a different way: giving up the fully meaning-related notion of the OT input, one can turn to a different way of characterizing the set of competing candidates: since the derivations have their own technical starting point – D-structure or a numeration of lexical items – why not adopt a conceptualization in which this part of the candidate derivations constitutes the input for the OT system and have *Eval* compare the various possible derivations with identical D-structures/numerations? Important typological considerations regarding syntax and morphology *can* be addressed under this view. In fact, when a study focuses on a small set of specific phenomena – as is common practice both for typological and for language-particular studies in linguistics – the two approaches are often indistinguishable, since the (supposedly) *relevant* variation across candidates on which the study is centered originates from the same derivational subprocess across all candidates. This is presumably the explanation for the fact that the simpler system is often tacitly assumed. However, in situations where attention is not focused on a narrowly delineated range of phenomena, the two ways of conceptualizing the input *do* make an enormous difference. Only a semantically based input will leave the choice among realizations that differ in the lexical material in non-trivial ways to *Con* and *Eval*.[19]

A numeration-as-input approach generally imposes restrictions on the candidate space that are tied to particular languages (since semantically equivalent paraphrases of the same content which use different lexical material do not compete in the same candidate set). It is actually a consequence of the predominance of the numeration-as-input approach (and similar input conceptualizations) that *language-particular ineffability* was considered a central issue for OT accounts of syntax. The issue can be characterized as follows: since by definition there is always a most harmonic candidate in any given candidate set, the OT approach appears to systematically exclude the possibility that in some languages there is no grammatical realization at all for a conceivable linguistic construction. Fanselow & Féry (2019) provide the example in (13). While (13a) is grammatical in English, there is no grammatical way of saying (the equivalent of) (13b). They argue that a standard system of OT syntax as Grimshaw's (1997) will include a candidate set of alternative clause realizations for (13b), and one of them will inevitably be the most harmonic, incorrectly predicting that there is some grammatical realization used this set of lexical items.

(13) a. Who did the president think that the foreign minister met in Afghanistan?

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[19] Of course, not all accounts incorporating a competition-based subprocess are necessarily following the idea that all cross-lingual variation should be reduced to a global, fully meaning-based optimization. It is also conceivable to construe distinct derivational steps as separate, self-contained optimizations (compare e.g., Heck & Müller 2000, Müller 2003). Many approaches explicitly couched in a derivational setting indeed assume fairly restricted structural or derivational *domains* of local optimization (Müller 2012: sec. 4).

b. * Who did the president resign although the foreign minister met in Afghanistan?

Note however that with a sufficiently abstract semantic input, an LF-as-input OT system *could* be devised that makes reasonable predictions for all languages: Where there is no compact realization of a thought in a single clause, a more verbose, multi-clause paraphrase can be used (for (13b) maybe *Who was it that the foreign minister met in Afghanistan when the president resigned nevertheless?*). This appears like a plausible analogy to examples from phonology, where some languages enforce a very unfaithful realization of loan words or foreign names that fall outside the phonological patterns of a language (as exemplified by (9) above). Thus, the language-particular ineffability problem arising in numeration-as-input approaches is not a problem under a global meaning-based conceptualization of the input.

The considerations in this subsection have shown that while a competition-based construal of dedicated derivational subprocesses may be fruitful in order to systematically derive typological patters for a certain submodule of a broader derivational theory of grammar, the original OT idea of deriving all cross-lingual differences – and thus learnability – as an effect of constraint reranking presupposes a comprehensive global competition among all alternative candidate expressions for a given underlying meaning. For capturing constraint evaluation in global competition with a derivational base formalism, there does not seem to be a good alternative to using representational traces of the (abstract) derivational process inherent to each candidate representation.

Bresnan's (1996) recasting of Grimshaw's (1997) account of extended projections – employing Extended Head Theory as sketched in Section 1 – can be viewed as a blueprint of a strategy that translates some relevant key aspects of a derivational approach into a representational approach. So, one can effectively view OT-LFG not only as an OT extension of the LFG framework; it also provides a feasible implementation for LF-as-input approaches, in particular a whole range of work that follows the general spirit of Grimshaw's (1997) proposal.

To sum up the previous and this section, OT-LFG as proposed by Bresnan (1996, 2000, 2001a, 2002) spells out a conceptualization of OT syntax that allows for a clean and comprehensive separation of language-independent candidate generation and violable constraints capturing the spectrum of typological variation. LFG's representational framework makes this separation conceptually simple. Global competition, for instance between morphological vs. syntactic means of expressing for realizing an underlying feature is naturally accounted for since LFG assumes parallel correspondence among all representational structures.

2.4 OT-LFG: Computational considerations

Conceptually straightforward as it is, the idea of relying on feature structure subsumption to define the set of candidate analyses (i.e., tuples of c-structure, fully specified f-structure and potentially more LFG projections) in *Gen* as specified in Section 2.2 raised computational concerns. Johnson (1998) points to the issue that the parsing problem for an OT-LFG grammar is undecidable in the general case. To solve the parsing problem given a string *s*, all optimal analyses have to be found that have *s* as the yield of their c-structure tree.[20]

Figure 4 from Kuhn (2003: 173) illustrates the procedure with a semi-abstract example. In a first step (i) all potentially underlying input representations have to be found. This can be achieved by standard LFG parsing (which is decidable), using the base grammar that defines the set of all universally available candidate structures. The input information is by definition part of the f-structure in each candidate. This predicate-argument structure representation has to be filtered out (step (ii)). In a next step (iii), for each potential underlying input representation, the set of all candidates has to be generated (including the original as well as all alternative full c-structure/f-structure tuples); the constraints are applied to each candidate (iv) and the most harmonic candidate can be determined, given the relevant constraint ranking. This candidate is only included in the set of valid analyses for the original string *s* if *s* is indeed the yield of the optimal candidate (v).

We note that step (iii) involves generation with an LFG-type grammar from a partially specified f-structure. Wedekind (1999) shows that the general problem of generation from partial f-structures, given some LFG grammar, is undecidable. This implies that there could be cases in which the candidate set for a given input f-structure cannot be computed, so it would also be impossible to determine the effect of an OT system. However, Wedekind also points out that the decidability problem for generation with plain LFGs occurs only with certain technical feature representations that are not used to represent the semantics of natural-language sentences. How does this translate to the application of an

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[20] Johnson (1998) assumes stronger conditions for the optimal candidate: the input representation determined in the first step needs to be included in the optimal analysis of the string. This corresponds to (strong) bidirectional optimality, as discussed in Section 4.4. For standard OT, only the production-based competition is relevant, as assumed in the remainder of this section.

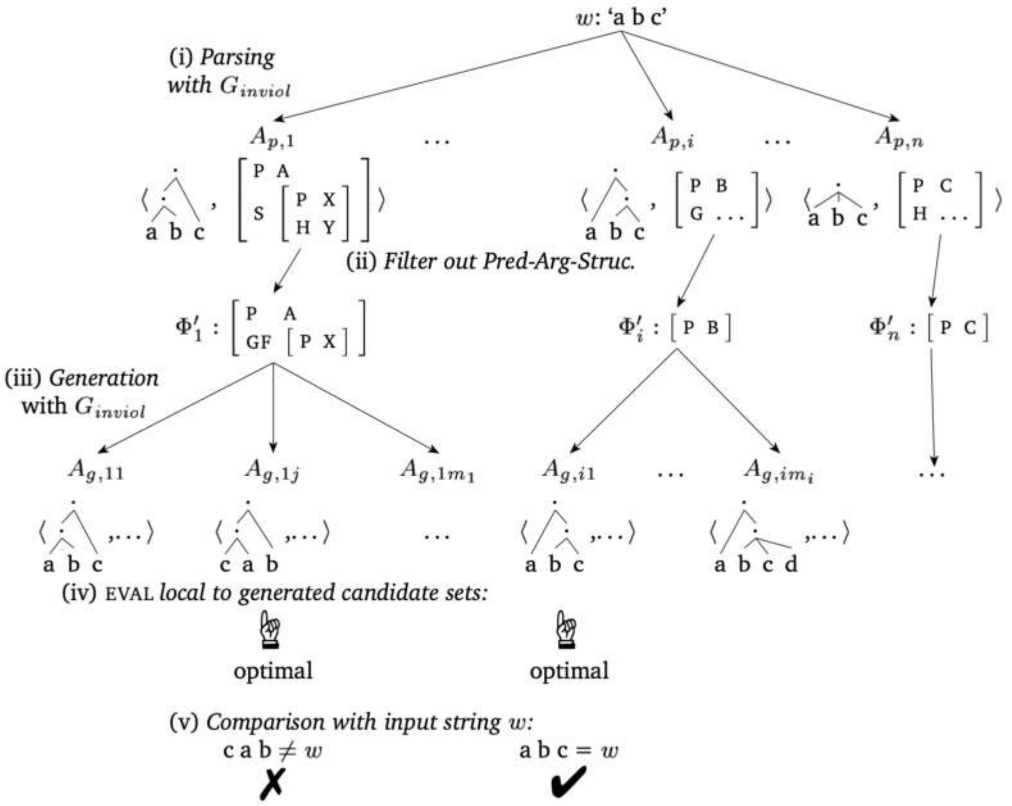

Figure 4: Illustration from Kuhn (2003: 173) for the parsing procedure for a standard OT system, with grammaticality based on production-based optimality.

LFG-style grammar in OT candidate generation? Is it possible to formulate restrictions on admissible partial f-structures and thus guarantee decidability of the parsing problem?

Potentially problematic cases are candidates that include violations of faithfulness constraints, as they are for instance assumed to derive *do*-insertion in English questions (Bresnan 2000: ex. 44). As we will see in the following, restrictions on the formalism can be devised that guarantee decidability but nevertheless permit the use of faithfulness constraints to derive syntactic variation of this kind. Taking advantage of the explanatory potential of OT, Bresnan's (2000) analysis does not stipulate a special, PRED-less lexicon entry in *do* insertion (like in standard LFG), but derives insertion of an additional verb as a consequence of the ranking of violable constraints. To achieve this effect, the *Gen* function underlying in this system has to be able to add "unfaithful material" quite freely. Does this mean that we are confronted with the decidability problem?

As Kuhn (2003: ch. 4) discusses, the option of adding unlimited amounts of material in a candidate is not only undesirable from a computational point of view. It also goes against the key idea of treating all candidates as potential verbalizations of some identifiable semantic content. The definition of *Gen* should therefore be restricted in such a way that the candidates' f-structures (i.e., the interpretable part of the representation) are not only subsumed by the input f-structure, they also may not contain any additional semantic information.[21] With this restriction, it can be guaranteed that the set of candidates stays computationally tractable (Kuhn 2002, Kuhn 2003: 199ff). The definition (10) above already incorporated the necessary restriction.

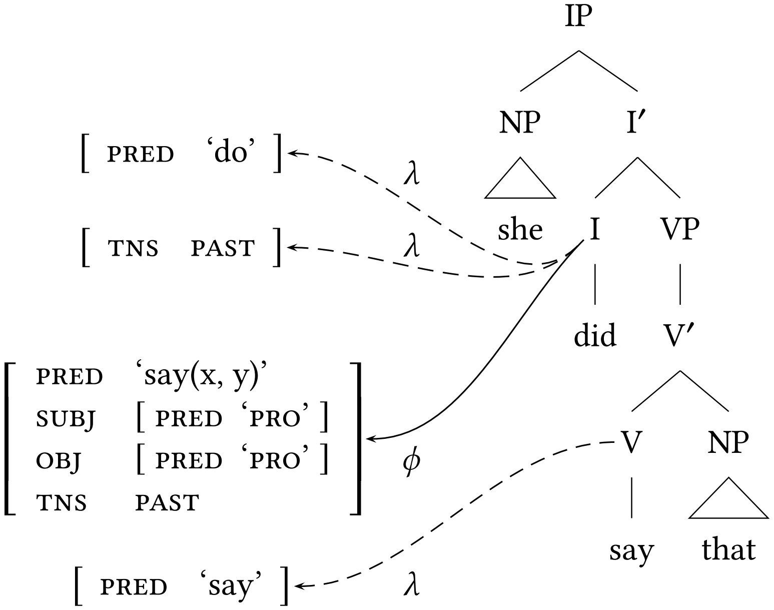

Figure 5: Illustration of a candidate incurring a faithfulness violation, following the technical formalization of Kuhn (2003: 112); c-structure nodes project not only to f-structure (via function ϕ), but also to a (very local) lexical structure (via function λ).

Figure 5 illustrates a formalization of faithfulness violations that is compatible with this restriction and can be used to derive *do* insertion in English. The key idea from Bresnan (2000: ex. 44) is that the lexical contribution of elements that are inserted "unfaithfully" (as a way of satisfying some other constraint

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[21] It is allowed for candidates to contain additional non-semantic f-structure information and material at the level of c-structure and other projections; this is unproblematic for decidability, since the amount of information that can be added is bounded by the size of the grammar.

that is higher-ranking than faithfulness) does not make it into the candidate's f-structure. The technical operationalization from Kuhn (2003: 112) uses a special λ-projection to keep track of all lexical contributions from the words, which may or may not re-appear in f-structure. In case they do *not* re-appear, a violation of a faithfulness constraint (Dep-IO) will be recorded by *Eval.*

The lexical entries underlying the analysis in Figure 5 are specified as shown in (14) (adapted from Kuhn 2003: ex. 140):

(14)	*did*	I	$g_1 = \lambda(\mathcal{M}*)$ $(g_1\ \textsc{pred}) = \text{‘}\textsc{do}\text{’}$ $\{\, g_1 = \uparrow \}$ $g_2 = \lambda(\mathcal{M}*)$ $(g_2\ \textsc{tns}) = \textsc{past}$ $\{\, g_2 = \uparrow \}$
	say	V	$g_1 = \lambda(\mathcal{M}*)$ $(g_1\ \textsc{pred}) = \text{‘}\textsc{say}\text{’}$ $\{\, g_1 = \uparrow \}$

In these entries, the functional annotations make use of local metavariables (such as g_1 and g_2) in the following way: The equation $g_1 = \lambda(\mathcal{M}*)$ defines g_1 as the variable name for an attribute-value structure that is λ-projected from the current element's c-structural mother (= the node I for *did*). The equation $(g_1\ \textsc{pred}) = \text{‘do’}$ introduces a PRED feature and value into the attribute-value structure. The third equation $\{\, g_1 = \uparrow \}$ identifies the local l-structure with the c-structural elements normal f-structure (i.e., its ϕ-projection; recall that $\uparrow$ is defined as $\mathcal{M}*$). What is crucial is that the third equation is enclosed in curly brackets, which means that it is applied optionally. Hence, the lexical specification will either be included in the f-structure or not. (Since the rest of the LFG structure leads to an identification of the f-structure projected from *did* and from *say*, maximally one of the two entries can introduce their PRED value to f-structure.)

The enormous variation opened up by this optionality is controlled by the faithfulness constraint Dep-IO, which in this setup can be formalized as in (15):

(15) Dep-IO (referred to as Fill in early OT work)
General OT formulation (Kager 1999: 68): ‘Output segments must have input correspondents.’

$$(\mathit{atomic\text{-}f\text{-}str}(\star) \rightarrow$$
$$\forall n, P.[(\mathit{cat}(n) \wedge \mathit{feature\text{-}path}(P) \wedge (\lambda(n)P) = \star) \rightarrow (\phi(n)P) = \star])$$

> "For all categories *n* and feature paths *P*, if ⋆ is an atomic value under *P* in the *λ*-projection from *n*, then ⋆ is also the value under *P* in the *ϕ*-projection from *n*."

Recall that in the application of the *Eval* function, every structural element in a candidate representation – i.e., every c-structure node, every local f-structure, and also every local l-structure – will be tested for all constraints. For the topmost l-structure seen in Figure 5, ⋆ will be instantiated to the PRED-value 'do', which *is* an atomic f-structure and which is also in the *λ*-projection of a node *n* (namely I) under a path *p* (namely PRED). So to satisfy the DEP-IO faithfulness constraint, PRED 'do' should also be in the f-structure for I, which it is not. This leads to the desired effect of capturing an insertion in c-structure which has no correspondence in f-structure as a DEP-IO violation.

To sum up, the insertions that are required to implement a generalized OT account are compatible with the restricted definition of *Gen*. By definition, the semantic information in a candidate's f-structure is always the same as the semantic information in the underspecified input f-structure Φ_{in}. Additional material can only occur in locally projected l-structures. While it is not forbidden to have infinitely many distinct candidate structures for an input f-structure, the restriction keeps the candidate set computationally tractable (Kuhn 2003: ch. 6).[22]

2.5 Excursion: The cognitive status of "directional" candidate set specification

As established in the previous subsection, it is possible to provide a declarative formal characterization of the language generated by an OT system. Thanks to the non-derivational character of (tuples of) LFG structures, it is possible to use the sharing of the semantic part of the structures as the defining element for candidate sets (independent of the question of how a computational system might be implemented that takes a string of words as an input and produces all fully specified LFG structure tuples with that surface string that are optimal for some input according to the OT system for a given language). Moreover, it can be shown that the task of determining whether a string of words is in the language generated by an OT system is not computationally undecidable. This subsection is an excursion that discusses a reaction that LFG practitioners might have when confronted with the multi-step breakdown of the abstract parsing task for an (LFG-based) OT system sketched in Figure 4: the assumption of a back and forth

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[22] Exploiting results from Kaplan & Wedekind (2000), recursive loops that lead to infinite candidate sets can be captured in a tractable way.

of generation and parsing processes seems to go against the goal of developing a cognitively plausible model architecture to capture grammatical knowledge.

The intuitive algorithmic breakdown of parsing with plain LFG does not carry over to parsing in the OT-LFG framework, which necessarily has to incorporate a production-based directionality, while parsing models comprehension. Parsing with a plain LFG grammar follows the logic of the structure specification step by step: given a string, matching lexicon entries and c-structure rewrite rules are used to construct a set of c-structure trees spanning the string. To narrow the set down to the trees which correspond to a valid f-structure, functional descriptions from the lexical annotations and the rule annotations are then taken into account in a process of model construction (in a feature logic), and wherever we find a valid f-structure, we have one possible analysis for the input string. The intuitive simplicity of the algorithmic breakdown has presumably played a role in the attraction of the LFG formalism as a psychologically realistic framework – in particular as it contrasted with the model of Chomskyan derivational approaches, which work with a notion of an underlying deep structure (D-structure or numeration). The theoretically motivated transformation of an underlying deep structure into a surface structure does capture intuitions regarding the highly systematic relationship between expressions like *the cat drinks milk* and *what does the cat drink?* or between *she saw the cat* and *the cat was seen*. But in comprehension, a listener is confronted with the linear string from a surface structure (say, *the cat was seen*), and there is no cognitively intuitive algorithmic process that leads back to conceivable underlying deep structures. When spelling out a parsing procedure with OT-LFG, we now find ourselves in a similar situation: if we translate the bidirectional characterization of the set of valid structures for a given string into an algorithmic procedure, we do not arrive at a plausible rendition of what could be going on in comprehension.

One might suspect that these considerations challenge the cognitive plausibility of Optimality Theory. It should be noted however that there is an oversimplification in the reasoning that assumes a direct conceptual mapping of a declarative specification of some function (such as the function from a string of words to a set of c-structures associated with valid f-structures) to the seemingly straightforward algorithmic breakdown of this function. It is misleading in the general case to assume that an intuitively appealing translation of a composite function into some procedure is the only option for realizing the theoretically motivated function in a cognitive system. As a matter of fact, there would be no computationally tractable parsers for standard LFG if one relied on the simplemost translation of the conceptual steps underlying grammatical specification in LFG into an algorithm. As the discussion in Maxwell & Kaplan (1996) illustrates, LFG parsing performs a highly sophisticated interleaving of the various sources of grammatical and lexical knowledge. Vice versa, Edward Stabler's work on the formalization of Chomskyan derivational grammar models (e.g., Stabler 2011, 2013) shows that algorithmic solutions do not have to stick to the seemingly counterintuitive procedures in the underlying theoretical characterization.

The complicated procedural breakdown of the parsing task for OT systems follows in fact from the decision to incorporate an important consideration into the conceptualization of grammatical knowledge that has nothing to do with the procedural knowledge needed for parsing a particular given input string, but rather reflects a language learner's and adult speaker's conscious or tacit knowledge of the expressive *potential* that lies in the language system: for a speaker of language X to know the grammatical way of expressing something in X amounts to knowing which other potential ways of expressing the same thing are not available in X.[23] During the acquisition of X, the speaker will have learned from exposure to adult speakers' language behavior which realizational variants can be completely excluded. So, the adult speaker's grammatical knowledge may well be thought of computationally as a "hard-wired" input-output mapping that freezes the patterns which have stabilized in the competition system (superseding a dynamic acquisition phase, during which the relevant constraint rerankings were triggered for language learner).

As a side note, the "pre-compilation" of a cascade of optimality constraints with their step-by-step filtering effect into a single input-output function was subject to research in the context of OT systems that can be fully formalized with finite-state systems. Karttunen (1998) proposed a special finite-state operator (so-called lenient composition) that has the effect of turning a sequence of individual constraints formulated as transducers into a single transducer with the same effect as an OT competition.[24] To achieve a similar computational effect for a syntactic OT-LFG system, the internal data structures built up during parsing (following a chart-based or dynamic programming approach) would have to be re-designed to simultaneously incorporate a production-based and a comprehension-based directionality – which could then be instantiated in a single bottom-up algorithmic pass, avoiding direct bidirectionality processing (compare the "interleaved" bidirectional processing approach proposed in Kuhn

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[23] When working with a classical grammar formalism, the formal model of a speaker's grammatical knowledge provides no way of making this differential knowledge explicit, yet to arrive at a particular formal grammar in language acquisition, the learner must have pruned away certain realization options that the language under consideration does not exploit.

[24] A similar approach is discussed by Frank & Satta (1998).

2000b). Since work in computational linguistics focusing on learning without any language-specific prior knowledge had already reached a relatively advanced state using different approaches, there was no substantial practical interest in putting the full OT-LFG account to use on a larger scale.

2.6 OT-style constraint ranking in broad-coverage grammars

Section 1.2 provided an illustration of the constraint ranking mechanism implemented in the XLE system, which is widely used in grammar development. The examples showed how violable constraints allow grammar writers to include rule variants for infrequently occurring constructions without causing a proliferation of implausible readings for canonical constructions.[25]

The XLE implementation of violable constraints via a special *o*-projection provides some further mechanisms that are of high practical value in broad-coverage grammar development. The specification of the ranking of the optimality marks in (16) illustrates some of these mechanisms. We will shortly go through a number of details, but first of all we note that the ranking is specified in the configuration section of the grammar code. This means that the relative ranking of the marks (and hence of the soft constraints) can be adjusted for different application scenarios of the grammar without changing the grammar code itself. Thus the ranking specification can be used to flexibly adjust the grammar to peculiarities of certain language registers or text domains.

(16) OPTIMALITYORDER +PPasOBL (UnderstoodObj TypeCoercionToTimeNoun) NOGOOD Missing3SgMarking STOPPOINT Fragment.

In (16), the highest-ranking mark PPasOBL is preceded by a plus sign. This indicates that in the filtering of analyses, the mark is not considered to be negative, but positive. When the available readings differ in the count of PPasOBL, the ones with the *maximal* number of marks survive. This provides grammar writers with a way of giving preference to a certain variant rather than having to "punish" a different variant, which, depending on the feature representation adopted, may be impractical. Rule (17) exemplifies the introduction of PPasOBL as a preference mark for the oblique object analysis of PPs (like in *wait for someone*). The oblique reading will be preferred over the alternative of analyzing the

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[25] Computationally, we can note in the light of Section 2.4 that XLE's OT-style constraint ranking is not normally used to modify the notion of grammaticality from the base grammar; hence, the additional complexity of a two-way application of the grammar in parsing and generation mode does not arise.

PP as an adjunct whenever both are available. This has the effect of reducing the number of parses for a considerable number of input sentences. In real-world uses of grammars, the available information makes it often hard to make an informed decision. So, in many application scenarios, it may be preferrable to make a (more or less arbitrary) decision in favor of one of the variants.[26]

(17)
$$\text{VP} \longrightarrow \begin{array}{c}\text{V}\\ \uparrow=\downarrow\end{array} \quad \left(\begin{array}{c}\text{NP}\\ (\uparrow \textsc{obj})=\downarrow\end{array}\right) \quad \begin{array}{ll} & \quad\text{PP}^*\\ \{ & \downarrow \in (\uparrow \textsc{adj})\\ | & (\uparrow \textsc{obl}_\theta)=\downarrow\\ & \text{PPasOBL} \in o(*) \quad \} \end{array}$$

The ranking in (16) also illustrates the workings of parentheses and of some specially defined keywords. The marks UnderstoodObj and TypeCoercionToTimeNoun, which were introduced in Section 1.2, are now jointly enclosed in parentheses to treat them as equally ranked. In grammar writing practice, such constraint ties are frequently used for phenomena that are independent from each other, since there is no grammar-internal justification for giving preference to one of them.

To the right of the two we see the mark NOGOOD. This is a predefined keyword that has the effect that all marks that follow receive a special interpretation that is best explained with a concrete example. Consider Missing3SgMarking: this mark is introduced in the definition of the template SubjNon3SgAgr in (18). This template is used in present tense verb forms of English like *I laugh* or *they laugh*. There is a similar template for third-person singular forms like *she laughs*. The third disjunct in (18) covers the use of the form *laugh* with a third-person singular NP like in **she laugh*, which is ungrammatical in standard English. By providing this option, the grammar will robustly cover agreement mistakes or it can be used for varieties of English that include this variant.

(18)
$$\textsc{SubjNon3SgAgr} \equiv \begin{array}{l} \{\ (\uparrow \textsc{subj num}) = \textsc{pl}\\ |\ (\uparrow \textsc{subj num}) = \textsc{sg} \quad (\uparrow \textsc{subj pers}) \sim= 3\\ |\ (\uparrow \textsc{subj num}) = \textsc{sg} \quad (\uparrow \textsc{subj pers}) = 3\\ \quad \textsc{Missing3SgMarking} \in o(*) \qquad\qquad \} \end{array}$$

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[26] Contrary to the situation with very infrequent constructions that were discussed in Section 1.2, the filtering may here have the effect that a contextually inappropriate analysis is chosen over the more appropriate analysis (for instance in *Sue was waiting for hours*). But in a range of applications this may not be too problematic, while a reduction of the sources of ambiguity can be extremely helpful during the process of extending the grammar or fixing a certain problem. When the grammar is used in application scenarios in which it can be harmful to occasionally choose the contextually inappropriate variant, the preference mark can simply be taken out of the ranking specification, so the parser outputs both variants.

With the ranking specified as in (16), *she laugh* will receive an analysis; however due to the use of the NOGOOD mark, it will be labeled as ungrammatical by the parsing system.

A last point illustrated by (16) is the predefined mark STOPPOINT. This mark offers a way for grammar writers to control the computational behavior of the parser. Putting an optimality mark to the right of STOPPOINT (like Fragment in the example) has the effect that the functional descriptions that it marks will not be used at all in the first pass of running the parser. However, if parsing leads to an empty set of valid analyses, the parser will be reset for a second pass, this time including marks like Fragment. This mechanism can be used to make the grammar more robust without compromising the runtimes of the parser for "well-behaved" input sentences. A typical example for using STOPPOINT in the ParGram grammars is as part of a fall-back option for covering strings that do not receive an analysis with the standard root symbol of the grammar. An artificial category like FRS (for fragments) is provided as an alternative root symbol. (19) is a schematic depiction of a recursive rule for such a category. Its purpose is to collect c-structure fragments such as NPs, PPs and certain incomplete verb projections. With such a rule, problematic input sentences (e.g., with misspellings or rare constructions) will still receive an analysis for the parts that are covered correctly. The partial f-structure contributions are collected in a first/rest data structure. Note that each fragment introduces one Fragment mark, so the filtering mechanism will output the option with the fewest (i.e., on average the largest) fragments. It is even possible to use several instances of STOPPOINT in a ranking to potentially trigger several resets.

(19)
$$\text{FRS} \longrightarrow \{ \begin{array}{c} \text{NP} \\ (\uparrow \textsc{first}){=}\downarrow \\ \textsc{Fragment} \\ \in o(*) \end{array} \mid \begin{array}{c} \text{PP} \\ (\uparrow \textsc{first}){=}\downarrow \\ \textsc{Fragment} \\ \in o(*) \end{array} \mid \begin{array}{c} \text{VP} \\ (\uparrow \textsc{first}){=}\downarrow \\ (\uparrow \textsc{subj pred}){=}\text{‘pro’} \\ \textsc{Fragment} \in o(*) \end{array} \} \begin{pmatrix} \text{FRS} \\ (\uparrow \textsc{rest}){=}\downarrow \end{pmatrix}$$

As the various mechanisms we briefly discussed show, a flexible ranking for specially marked parts of the grammar conveniently puts grammar writers in a position of exerting control over the set of valid structures that an LFG grammar will assign to a given input string in parsing (and similarly for a given input f-structure in generation).[27]

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[27] One way of looking at the addition of rankable constraints to an LFG grammar writer's means of expression is to include ideas from grammatical frameworks that never factorized the task of disambiguation out, most notably Constraint Grammar (Karlsson 1990).

An alternative approach to controlling the space of ambiguities is the use of probabilistic techniques, which have been widely applied in the context of structural analysis of realistically occurring language (Collins 1997, Riezler et al. 2000, 2002). Here, the approach to the ambiguity problem is to rely on supervised training of probabilistic models that predict the distribution of alternative linguistic representation structures, dependent on a variety of contextual factors. If a sufficiently large training corpus is available that was manually disambiguated by competent speakers of the language, a so-called treebank, the complex interaction of knowledge sources on the contextually appropriate choice of readings can be captured quite reliably. When the sentences parsed in the application scenario are similar enough to the training corpus, the disambiguation quality that can be reached is typically higher than in a knowledge engineering approach of classical grammar writing, since statistically relevant patterns of all kinds (e.g., word order preferences, lexical-semantic argument selection preferences, but even statistical effects unrelated to grammatical knowledge) are learned “in passing”.

The XLE system offers both the optimality ranking approach discussed in this section and a probabilistic filtering approach that relies on supervised treebank training. In the practice of broad-coverage grammar development with a highly expressive formalism such as LFG, both mechansisms have their place and a combination is arguably the most effective way to go: a probabilistic approach exploits the empirical distribution of interacting factors, such that a sufficiently expressive probabilistic formalism (or machine learning model) will induce implicit statistical knowledge even about patterns that could not (yet) be captured in symbolic terms (see, e.g., Cahill et al. 2007, Forst 2007). On the downside however, a plain probabilistic approach leaves little leeway for grammar writers to inject specific symbolic knowledge about certain constructions. By using symbolic optimality ranking as a pre-filter for the set of candidate analyses going into treebank training, the grammar writers can easily experiment with alternative strategies (King et al. 2000).[28]

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[28] It has to be noted that in the combined setup, the grammar writer is not in a very informed position to determine the relative ranking among the optimality constraints for multiple different linguistic constructions – for instance UNDERSTOODOBJ and TYPECOERCIONTOTIMENOUN from Section 1.2. This is something that an empirically informed training procedure can do better. The utility of symbolic soft constraints for linguistically informed ambiguity management lies more in the flexibility of experimenting with preference, dispreference and delayed execution (via one or more STOPPOINT marks) of constraints. By leaving the ranking of OT marks within a section (before NOGOOD, between NOGOOD and STOPPOINT, etc.) very flat through the use of parentheses, the ranking decision is postponed to the subsequent probabilistic filtering module.

There are a number of publications that report on the use of ranked constraints in various contexts of grammar specification, for instance Zaenen & Crouch (2009), Bögel et al. (2009), Dione (2014).

3 Linguistic applications of the competition-based concept of grammaticality

Section 2.6 provided details on the OT-style ranking mechanism that offers very effective functionality for ambiguity management in broad-coverage grammar development. We now go back to the original, theoretically motivated OT syntax model that employs competition among candidates to determine the grammatical way of expressing an underlying meaning. The model has been broadly employed to (a) systematically derive variation patterns within a language and (b) predict typological patterns across languages.

A broad range of syntactic phenomena have been addressed with OT syntax approaches. We will take a closer look at a few accounts in this and the subsequent sections – mostly to illustrate some specific properties of OT systems, in particular in the guise of OT-LFG and extensions that have been proposed. A full overview of all important phenomena addressed in the literature is beyond the scope of this chapter.[29] This section focuses on two important predictive schemes that the OT approach offers at the interface between syntax and morphology. Section 3.1 shows how morphological blocking phenomena can be derived in a very general way. Section 3.2 reviews the harmonic alignment account of the typological spectrum of differences in argument linking.

3.1 Generalizing blocking accounts to incorporate morphology-syntax competition

LFG's system of corresponding parallel representations can be straightforwardly integrated in the competition-based grammaticality account of OT. This opens up a path for formulating a generalized theory of morphological blocking that was described before a generic mechanism of comparison was included in the overall formal framework. Prominent examples are the accounts by Andrews (1982, 1990), building on top of the Elsewhere Principle from phonology (Anderson 1969). The idea of morphological blocking offers an explanation of how

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[29] Important areas excluded for space reasons are for instance positional alignment accounts of phrase structure such as Sells (1999, 2001). Sten Vikner and collaborators have worked out a detailed account of object shift in OT (Vikner 2001, Engels & Vikner 2014).

within a morphological paradigm such as the inflection of English verbs in present tense, an unmarked form (like *laugh*) can fill all cells in which no explicitly marked form (like the third person singular form *laughs*) is available. When alternative forms are available that express different degrees of specificity with respect to certain morphosyntactic features, the existence of a marked form for some specific feature combination (or position in a morphological paradigm) blocks the use of an unmarked form for this particular combination: *laughs*, which is marked for PERSON and NUMBER (to the values 3 and SINGULAR, respectively), blocks the unmarked *laugh*, which is underspecified for PERSON and NUMBER. Technically, Andrews (1982) proposes a blocking condition which states that a less specifically marked form A cannot be used in a position X if there is a form B that comes with a more specific marking, subsumed by A's specification.

With a competition-based definition of grammaticality, blocking effects can be construed as a consequence of general constraint interaction (Bresnan 2002, 2001a): the unmarked form is assumed to incur faithfulness violations, since it does not explicitly realize the underlying feature information in the input. For each inflectional category, a faithfulness constraint (e.g., $\text{FAITH}^{\text{NUM}}$ for number) checks whether a surface form accurately marks the underlying feature. On the other hand, a markedness constraint is assumed for each specific feature value, punishing the explicit marking of this value (e.g., *PL "avoid marking the plural explicitly", *SG "avoid marking the singular"). The markedness constraints implement the tendency in natural language to keep expressions as concise as possible. On the basis of these two antagonist constraints, learning their relative ranking for a given language[30] has the effect of learning in which paradigm cells to use a marked form vs. the unmarked form:[31] if *PL outranks $\text{FAITH}^{\text{NUM}}$ in a language, the plural (of the word class under consideration) is realized by an unmarked form in this language; under the reverse ranking, a marked form is used for plural. For fusional morphology, in which a single morpheme (like for instance the *-s* in English present tense verb forms) can realize person and number simultaneously, conjunctive faithfulness constraints to *sets* of inflectional categories have to be assumed besides faithfulness to an individual inflectional category, for instance $\text{FAITH}^{\text{PERS\&NUM}}$ (Bresnan 2001a: ex. 22). The verb inflection paradigm for present tense in modern English can be predicted by the following ranking: *PL, *1, *2 $\gg$ $\text{FAITH}^{\text{PERS\&NUM}}$ $\gg$ *SG, *3 $\gg$ $\text{FAITH}^{\text{PERS}}$, $\text{FAITH}^{\text{NUM}}$. Plural as well as first

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[30] The learner acquires the constraint ranking through exposure to output produced by adult speakers; the speakers' underlying input has to be inferred from the situational context.

[31] To capture the finegrained differentiations inherent to inflectional paradigms, the faithfulness constraints have to be parametrized, for instance to specific verbs/verb classes for which learners have to learn distinct patterns.

and second person is never marked, since the markedness constraints for these feature values outrank all faithfulness constraints. For the combination of PERSON SINGULAR and NUMBER 3, a fusional form is used, since faithfulness to the combination of PERSON and NUMBER outranks the markedness constraints *SG and *3. For the other PERSON/NUMBER combinations, the fully unmarked form (*laugh*) is used, since $\text{FAITH}^{\text{PERS}}$ and $\text{FAITH}^{\text{NUM}}$ rank lower than the markedness constraints *SG and *3.

Given this characterization of the task of learning inflectional paradigms, the following typological spectrum is opened up by the interaction of faithfulness and markedness constraints: (i) when the markedness constraints outrank all faithfulness constraints, a paradigm with no inflectional distinctions follows; (ii) when faithfulness outranks all markedness constraints, all paradigm cells go along with an explicit forms; (iii) blocking effects occur when faithfulness is ranked in between certain markedness constraints. The account then predicts features (or feature combinations) whose markedness constraints outrank faithfulness to be realized by an unmarked form.

The OT-LFG framework makes it even possible to generalize the OT account of blocking to situations where it is not just alternative synthetic word forms that could be used to express an underlying feature bundle, but syntactically complex expressions are an additional alternative. Speakers of English have learned for instance when to use the analytical realization of a comparative adjective or adverb (such as *more quickly*) instead of a synthetic realizations (such as **quicklier*). In LFG's system of imperfect correspondence among parallel representations (Bresnan 2001b), such alternatives are just different surface realizations of the same f-structure. Now, the set-up in OT-LFG is to have such alternatives compete for the status of the most harmonic candidate. It is clearly possible for a theorist to find constraint sets that will lead to analytical realization of a phenomenon in one language an synthetic realization in another. This alone may not be considered a strong argument in favor of a competition-based framework using parallel representation structure like LFG. However, when it can be shown that having analytical and synthetic alternatives side-by-side in the candidate set for realizing an input (i.e., expanding the same partial f-structure) leads to a systematic explanation of variability in inflection paradigms that mix analytical and synthetic realizations – via a generalization of the morphological blocking effect – this constitutes persuasive evidence that the architecture of the theoretical account does capture aspects of the human cognitive system quite well. This is exactly what Bresnan (2001a) achieves by the account of negation in varieties of English she proposes.

The tableaux in Figure 6 illustrate competitions among different analytic c-structural realizations of negation; in Bresnan (2001a: ex. 43), these tableaux serve to motivate the constraint set for an account in which an analytical form blocks a synthetic form. The analysis assumes two alternative realizations for the negation of verbs or auxiliaries in English: *not* can adjoin to the auxiliary itself, which is realized in I^0, or it can adjoin to the VP. (For the modal verb *can*, the orthographic rules of English happen to make the distinction visible in the written form.) By hypothesis, both alternatives can have the meaning of a wide-scope negation, but only the latter can mean negation of the VP. Bresnan assumes one markedness constraint for each of the two possible sites for adjoining negation, *neg-vp and *neg-i; in English *neg-vp is ranked higher than *neg-i. Faithfulness to the negation scope (i.e., the constraint faith$^{\text{NEG}}$) however is ranked higher than both markedness constraints. As an effect, the neg-i option (*cannot*) arises as the optimal realization for a wide-scope reading of negation, whereas the more marked analytic form (*can not*) is required to express the VP scope of negation.

¬(poss(work(he)))	faith$^{\text{NEG}}$	*neg-vp	*neg-i
☞ a. *he cannot have been working*			*
b. *he can not have been working*		*!	

poss(¬(work(he)))	faith$^{\text{NEG}}$	*neg-vp	*neg-i
a. *he cannot have been working*	*!		*
☞ b. *he can not have been working*		*	

Figure 6: Two tableaux from Bresnan (2001a: ex. 43)

For the realization of negated forms of the auxiliary *be* in various varieties of English, analytical forms compete with synthetic forms: the negated third person singular can be realized as *is not* or as *isn't*. Moreover, a synthetic form that is unmarked for person and number is available: *aren't*. Interestingly, although Standard English has a marked form for declarative first person singular (*am*), there is a lexical gap for the negated first person singular.[32] In negated interrogative clauses, this gap is – for many speakers – filled by the unmarked *aren't* (examples from Bresnan 2001a: ex. 14-15):

(20) a. * Am I not going?
b. I am not going.

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[32] For synchronic learnability of such an idiosyncratic gap, it is not relevant how the gap came about. Bresnan (2001a: fn. 26) mentions stigmatization of an older synthetic form *ain't* as a potential explanation.

(21) a. Aren't I going?
b. * I aren't going.

This effect can be derived in an OT-LFG analysis that assumes high-ranking markedness constraints punishing analytic negation adjoining either to C^0 (which would yield **Am not I going?*) or to VP (yielding (20a) (Bresnan 2001a: ex. 61-63). These markedness constraints outrank the constraint $\text{FAITH}_{be}^{\text{PERS\&NUM}}$, which regulates faithfulness to the person and number feature for the auxiliary *be*. A hypothetical synthetic form **amn't* marked for person and number is unavailable due to the idiosyncratic lexical gap in English that was just discussed.

How can the grammatical framework model that a person acquiring English learns about such an idiosyncratic gap? In the OT framework, it has been proposed to assume a constraint LEX parametrized for specific lexical material and incurring a violation whenever it is used. Learners of a language with an idiosyncratic gap will rank the respective LEX constraint above all other constraints (because adult speakers never use this material when one would expect them to, based on the context).[33] For the English speakers using (21a) rather than (20a) to fill the lexical gap in the interrogative case, the third analytical option, adjoining negation to I^0, is ranked lower than $\text{FAITH}_{be}^{\text{PERS\&NUM}}$. This has the effect that the pattern in (20)/(21) is predicted: when *be* can be realized in I^0 as is the case in a declarative clause, the fully marked analytic form is the most harmonic; in a question however, where *be* is in C^0, the unmarked form *aren't* wins out.

This analysis demonstrates the explanatory potential coming from a competition-based account of grammaticality that makes distinct grammatical means available in candidate sets based on an input corresponding to the underlying content.

3.2 Harmonic alignment

In many languages, certain properties that argument phrases like subjects and objects can bear (e.g., first person vs. third person, full NP vs. pronoun, overt case marking, but also the choice of grammatical relation itself) are correlated with the availability of grammatical syntactic realization options, for instance in

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[33] Note that assuming constraints sensitive to specific lexical material in a language does not go against the principle of richness of the base, which excludes language-particular restrictions on the candidate set. However, it is not fully compatible with the assumption of a (finite) universal set of constraints. From the point of view of learning algorithms, it seems quite plausible however that instances of some constraint schema can be parametrized by lexical items that the learner has added to their inventory. See also van der Beek & Bouma (2004) for a discussion of language-particular lexicon properties within OT-LFG.

a clause with a transitive verbs. In the Australian language Dyirbal for example, the case marking patterns for transitive verbs are sensitive to such properties: "1st/2nd person pronouns are marked when they are objects, but not when they are subjects" (Aissen 1999: 674). When looking at the distribution of the relevant properties across languages, typologists have made the following observation: it is possible to organize these properties along markedness scales in such a way that the different scales tend to align with each other (Silverstein 1976). In a relational scale, subjects are used for the most salient/central arguments, followed by objects for less salient arguments, followed by obliques. In terms of thematic roles, agents are more prominent than patients. Animacy hierarchies have first and second person pronominals at the top of the scale, followed by third person pronouns, common nouns referring to humans, to animate referents and finally inanimate referents. Aissen (1999, 2003) develops an influential OT syntax account[34] demonstrating that many fine-grained observations from typological studies can be explained when the following assumption is made: the OT constraints that make reference to the various markedness or prominence scales cannot be arbitrarily (re-)ranked, but there are universal subhierarchies that are imposed over families of related constraints. These subhierarchies, technically implemented by the mechanism of harmonic alignment, have the effect that the various different markedness or prominence scales are systematically aligned.[35] For certain pairs of constraints, the relative prominence is fixed *a priori*,[36] while their interaction with other factors can still be freely learned from the observations.

For instance, Aissen's (1999) account explains the split ergativity patterns in Dyirbal, where under specific conditions argument phrases are realized without case marking: the subject is generally unmarked when it is first or second person; the object is unmarked when it is third person. When the subject is third person, case has to be marked; likewise when the object is first or second person. (22) shows the OT subhierarchies that ensure the alignment of the relational scale and the person scale (combining first and second person as "local"). In essence, it is more marked to align a high element from one scale with a low element

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[34] Aissen does not explicitly couch her account in an OT-LFG setting, but it is fully compatible and has greatly influenced subsequent OT-LFG work.

[35] The technique of harmonic alignment across prominence scales was already introduced by Prince & Smolensky (1993) for phonological features (sonority and syllable structure).

[36] Zeevat & Jäger (2002) demonstrate that the effect of the subhierarchies may also follow empirically from a systematic skewedness in patterns of usage. To the extent that this skewedness follows from invariant aspects of human social interaction, etc., it is presumably hard to tell empirically whether *a priori* rankings should be assumed within in the language faculty.

from another scale than to align either two high elements (Su/local) or two low elements (Ob/3rd).

(22) a. *Su/3rd ≫ *Su/local
     b. *Ob/local ≫ *Ob/3rd

To capture the case marking patterns, each of the alignment constraints is locally conjoined with the constraint $^*\varnothing_{\text{CASE}}$, which punishes expressions that do not use overt marking for the respective combination – similar to faithfulness constraints. Local conjunction (C_1 & C_2) of two distinct OT constraints C_1 and C_2 within a given local domain *D* is a mechanism that captures the fact that in certain cases, it can be more marked when the two constraints are violated within the same local domain, for instance the same argument phrase, than when there are two independent violations of C_1 and C_2 (Smolensky 1995). Since the local conjunction C_1 & C_2 can be ranked independent of the individual constraints, special markedness patterns that are sensitive to the conjunction can be learned.

In Aissen's (1999) account, the universal subhierarchies assumed for alignment constraints like *Su/3rd carry over to the family of their local conjunctions:

(23) $^*\varnothing_{\text{CASE}}$ & *Su/3rd ≫ $^*\varnothing_{\text{CASE}}$ & *Su/local

Learning the case marking patterns for a particular language amounts to learning where within the universal subhierarchy a structural markedness constraint for the relevant grammatical feature is placed in that language – here the constraint $^*\text{STRUCT}_{\text{CASE}}$. In Dyirbal, $^*\text{STRUCT}_{\text{CASE}}$ splits up both of the two hierarchies from (22):

(24) a. $^*\varnothing_{\text{CASE}}$ & *Su/3rd ≫ $^*\text{STRUCT}_{\text{CASE}}$ ≫ $^*\varnothing_{\text{CASE}}$ & *Su/local
     b. $^*\varnothing_{\text{CASE}}$ & *Ob/local ≫ $^*\text{STRUCT}_{\text{CASE}}$ ≫ $^*\varnothing_{\text{CASE}}$ & *Ob/3rd

Hence, it is more harmonic to avoid using a structural case marking on an argument when this is the subject and first or second person, while for third person subjects the high ranking of the conjunction $^*\varnothing_{\text{CASE}}$ & *Su/3rd, excludes an unmarked subject in favor of a case-marked one.[37]

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[37] We will come back to Aissen's harmonic alignment account in Section 4.2, as it forms the central target of Newmeyer's (2002) critique of functionally motivated constraint sets.

4 Extensions and debates

The competition-based definition of grammaticality in OT with its typological predictions attracted considerable attention in linguistic research communities, at the same time triggering debates about consequences of the new formal framework. Extensions were proposed to capture aspects of language(s) that the standard OT setup does not bring out. One such phenomenon is free variation, which one would expect not to exist under a plain OT approach. Section 4.1 discusses stochastic OT, an extension of the OT approach that does capture free variation.

Section 4.2 addresses a debate regarding the motivation of OT constraints. A substantial part of the OT community has been following the practice of providing a motivation for each constraint they assume which is grounded in functional considerations (for instance physiological considerations in OT phonology). This led to controversies, which are illustrative for the conceptual status different researchers assign to the constraints formulated in a theory of grammar. Section 4.3 steps back and discusses some of the cognitive considerations that led to the proposal of a competition-based account of knowledge of grammar in the first place. The section links this specifically to the question of learnability.

A second important extension of the basic architecture, bidirectional OT, is discussed in Section 4.4. It is motivated, *inter alia*, by the so-called phenomenon of word order freezing in languages with a (relatively) free order. In word order freezing, a clausal pattern that one would actually expect to be ambiguous *de facto* receives only one interpretation.

4.1 Extension I: Stochastic OT

One counterintuitive prediction of the competition-based definition of grammaticality is that languages should display very little (if any) free variation among two equally grammatical ways of expressing the same thing – for example *we need a more catchy title* vs. *we need a catchier title.* Even when it is just some minor and low-ranking constraint in which the two realization options differ, the OT system will by definition predict one variant to be ungrammatical for the relevant input.[38] Most natural languages *do* however offer free variation for certain lexical or grammatical means – there is for instance a certain amount of free word order variation in many languages.

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[38] Of course, two equally harmonic candidates *can* arise when the relevant constraints are tied. In more comprehensive grammatical accounts however, this modeling option will only be available in exceptional circumstances, since most constraints play a role in multiple constraint interactions. So other phenomena will enforce a resolution of the ties.

The circumstance that a standard OT system covering a non-trivial range of phenomena is extremely unlikely to ever predict free variation is concealed by the fact that linguistic studies commonly focus their attention on a particular family of phenomena. When isolating a specific set of constraints that is relevant for deriving the observations regarding these phenomena, the possibility of ranking two or more constraints at the same level for a given language (= a constraint tie) *does* create a basis for explaining the systematic occurrence of free variation. For instance, Bresnan's (2001a) account of English auxiliaries discussed in Section 3.1 predicts variation among *cannot* and *can't*. However, for a more comprehensive account of grammatical knowledge, we have to assume that all the constraint sets posited for certain phenomena are combined in one larger constraint set. As a consequence, the effect of most constraint ties will go away – since the alternatives will differ in properties that are of relevance for some independent account (e.g., *cannot* has an extra syllable).

The problematic implications that standard OT has for free variation triggered several independent proposals for an extension of OT systems that will naturally predict free variation (see, e.g., Müller 2014, Asudeh 2001). One of the most influential proposals is known as stochastic OT (Boersma 1998, Boersma & Hayes 2001).[39] It preserves most of the original OT architecture; the key modification is that the ranking of the OT constraints is no longer viewed as fixed and discrete, but (1) the rank of a given constraint is a value on a continuous scale, and (2) the constraints are assumed to oscillate stochastically around their (mean) rank. Hence, at the time of harmony evaluation for a particular OT competition, it is possible with a certain probability for two constraints that are close in rank to effectively swap on the prominence scale. As an effect, a stochastic OT system (SOT) can predict variation patterns. The learning algorithm proposed for SOT operates with incremental error-driven adjustment of the constraints' mean rank, which even puts the learner in a position to replicate the quantitative distribution pattern in the observed variation data. Asudeh (2001) shows that in combination with a harmonic alignment analysis following Aissen (1999), SOT can derive optionality patterns in Marathi (Indo-Aryan, India): for non-volitional transitive verbs like *saapaḍṇe* ('to find'), either of the two arguments can be realized as the subject (while the other is realized as the object).

Bresnan et al. (2001) demonstrate with an analysis of the corpus distribution of passives that the SOT approach, again combined with Aissen's (1999) harmonic alignment analysis, can explain strong quantitative effects in a language like English (which does not categorically enforce passive for certain person constellations among the arguments of transitive verbs) in parallel to strictly categorical

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[39] A similar account was proposed by Anttila (1997).

patterns in Lummi (Straits Salish, British Columbia). In Lummi, the realization of a transitive verb with a third person agent and a first or second person patient in active voice is ungrammatical. The underlying input has to be realized in passive voice. Now, although in English a clause like *she invited me* is not ungrammatical, Bresnan et al.'s (2001) study showed that in corpora of spontaneous spoken English, there is a significant statistical effect of an elevated passive use in this constellation (i.e., *I was invited by her*) – a circumstance that is exactly what one would expect when the standard OT treatment of Lummi is extended to English in a stochastic OT framework.[40]

4.2 Functional motivation of the constraint set

In any linguistic account that makes use of abstract descriptive categories such as 'syllable', 'subject', 'passive', 'quantifier', etc., the symbolic expressions assumed to describe formal and content-related properties of linguistic utterances are theoretical constructs. They are not directly observable. However, most linguistic theories attempt to choose their central descriptive representations in a way that permits a mapping to empirically observable properties based on as few assumptions as possible: phoneme representations are chosen based on semantically distinguishable minimal pairs, for the definition of syntactic notions like subject, operationalized tests are advanced, etc. In the same vein, the candidate representations in most OT work (and definitely in OT-LFG) are chosen under an operationalized regime assuming that all candidate distinctions can be derived from the surface distribution and contextual clues reflecting semantic distinctions.

What about the choice of constraints used to drive the typological predictions? It is important to notice that even with perfectly uncontroversial, empir-

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[40] In their criticism of Boersma & Hayes (2001), Keller & Asudeh (2002) argue that viewing a stochastic OT system not just as a model of variation/optionality, but of some notion of graded grammaticality tied to corpus frequencies, is conceptually problematic since it blurs the standard distinction between competence and performance. It should be noted however that certain systematic observations regarding quantitative distributions in corpus data seem to make it inevitable to revise some standard assumptions. Compare Bresnan's (2011) autobiographical notes: "Strikingly, the rare, marginal, and 'incorrect' construction types in large collections of English language usage parallel the rare grammatical phenomena that can be found across languages of the world. Moreover, judgments of ungrammaticality are often unstable and can be manipulated simply by raising or lowering the probability of the context. Most remarkably, language users have powerful predictive capacities, which can be measured using statistical models of spontaneous language use. From all these discoveries I have come to believe that our implicit knowledge of language has been vastly underestimated by theoretical linguistics of the kind I had practiced." (Bresnan 2011)

ically grounded candidate representations, there are generally many extensionally equivalent choices of the constraint set for deriving the same distribution of optimal candidates (= the predicted language typology). For a given constraint set, an alternative set of *ad hoc* constraints with the same empirical prediction can be constructed. OT systems are empirically underdetermined in this respect (and this is no design fault; many formal systems employed as scientific models are underdetermined along certain dimensions). Therefore, to convince oneself that an OT analysis does indeed reflect a linguistically valid pattern, it is important to exclude that one or more of the constraints are ill-justified and merely play the role of getting the predictions right. Hence, starting out in phonological OT work, it has become good practice to provide a plausible motivation for each constraint, independent from this constraint's role *within* the constraint set – a "functional" motivation. In phonology, many constraints can be given a motivation based on considerations of articulation, aerodynamics or perception, for instance "a constraint against voiced obstruents, e.g., the Voiced Obstruent Prohibition (VOP, *[+voice], *Laryngeal) can be said to be functionally grounded, since vocal fold vibration is difficult to sustain if the outgoing airstream is blocked." (Krämer 2017: sec. 3.2.3). In syntax, the argumentation often needs to be more indirect, for instance by putting forward general considerations of economy to motivate a constraint against movement in a derivational framework, such as STAY in Grimshaw's (1997) and similar frameworks. But throughout the application fields of OT, a wide-spread argumentation practice sees the need for independent justification of constraints beyond the fact that it reaches a particular effect within the factorial typology. Many researchers welcomed that OT syntax triggered a confluence of the formalist and the functionalist perspective on language and grammars.[41] Still, Newmeyer (2002) presents a vigorous argument against the conception of "functionally-based optimality theory" (FOT) accounts, specifically targeting Aissen's (1999, 2003) harmonic alignment account. As the argumentation shows however, and as Bresnan & Aissen (2002) argue in detail in their rebuttal of Newmeyer (2002) in the same volume of *Natural Language & Linguistic Theory*, the notion of constraints that Newmeyer's argumentation is based on is not the one inherent to the standard OT conception (which completely shifts the definition of grammaticality away from a rule-based system to the interaction of violable constraints). Newmeyer criticizes that by requiring constraints to be paired with an external functional motivation, FOT "incorrectly locates the form-function interplay in the mental grammar itself, rather than see-

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[41] Haspelmath (1999) argues for the additional need to take diachronic evolutionary processes into account.

ing the response of form to function as emerging from language use and acquisition" (Newmeyer 2002: 43). Newmeyer draws into question whether "the claim that every constraint has a functional motivation" (Newmeyer 2002: 56) is empirically contentful for OT syntax. But if we take into account that constraints are abstract constructs which are not directly observable in any particular language, this formulation somehow reverses the need for justification that a theoretician should provide for their assumptions. Putting forward some plausible motivation for theoretical constructs, beyond the technically desired effect, responds to principles of scientific practice precluding arbitrariness in an underdetermined formal system. Providing a functional motivation for an OT constraints does not amount to an empirical *claim*, but it is part of the argumentation that the abstract choices made adhere to second-order principles of good scientific practice. It is only a full OT system that is empirically falsifiable; inadequacy may come to the surface when there is no way of extending a system which plausibly covers a core set of phenomena to clearly observable additional evidence.

4.3 Learnability in the context of the broader cognitive architecture

As has become clear from the discussions up to this point, a theorist's decision to move from a conventional generative grammar formalism to the competition-based formal model of grammaticality underlying OT does not merely mean that instead of working with hard constraints they now work with violable constraints. The status of familiar descriptive devices becomes fundamentally different with the different characterization of the set of well-formed analyses. Some of the debates that this development triggered have been already addressed in the previous sections – for instance the question how ineffability might be modeled and how optionality/free variation can be accounted for.[42]

But it is worthwhile to pause and consider the status of the components of an OT system as a model of the language faculty within our broader cognitive system. The competition-based frameworks of Harmonic Grammar (Legendre et al. 1990) and Optimality Theory (Prince & Smolensky 1993, 2004) were originally developed to reconcile (i) the potential of connectionist networks for learning complex input-output functions from exposure to data following up on work in the Parallel Distributed Processing framework (Rumelhart et al. 1986)[43] with (ii) the insights from linguistic theory in the generative tradition, which models

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[42] Wunderlich (2006), in his encyclopedia article on OT in morphology and syntax, provides a list of fundamental questions that arise when adopting an OT approach.

[43] The collection edited by Smolensky & Legendre (2006) is devoted to this perspective, but it does not seem to be very prominent in linguistic debates.

systematic generalizations in a formal system. Optimality Theory is an attempt to gain ground towards resolving some of the most central challenges for the cognitive sciences: understanding how abstract systematic knowledge (which is best described using recursive symbolic systems, relying on logical inference) is implemented in connectionist architectures and how it blends with associative knowledge (which is best captured in subsymbolic terms). We know that the neurophysiological basis for all our cognitive systems, the human brain, is a large and complex connectionist network. For artificial connectionist networks, the potential to pick up complex patterns from empirical learning data has been convincingly demonstrated for many scenarios. However, the abstract symbolic concepts that are at the core of many linguistic accounts of grammar – allowing for a very compact characterization of very far-reaching generalizations – turn out to be hard learning targets for a bottom-up empirical learning procedure with the comparatively simple artificial networks available (Marcus 2001).[44]

Given the complexity of the brain and our very preliminary understanding of the interaction of cognitive subsystems available to humans, it is no surprise at all that there is still a gap between our current understanding of systematic knowledge, captured via abstract concepts, and what we know about the level of neurophysiological implementation. Yet, when looking more specifically at knowledge about language, there seems to be a certain degree of impatience in the research communities taking a conncectionist vs. an abstract symbolic approach – possibly because on both sides of the gap, mature theories and modeling frameworks have evolved substantially over the past decades, yet the key question of how the views go together remains rather open.

From the point of view of linguistics, it may seem that the concerns about the missing path across scientific levels are just a problem for cognitive scientists who believe that a connectionist implementation of linguistic knowledge needs to be spelled out in concrete terms. Under the working assumptions of many linguistic frameworks, details of a technical implementation are of subordinate importance as long as one can convince oneself that a symbolic approach could be implemented in principle. This thinking ignores however that many of the established frameworks, including LFG, had (and have) a major weakness when it comes to capturing the learnability of languages. This weakness is no embarassment *per se*, since it was never in the focus of research interests; but it implies that it is not even clear in principle how an abstract description of grammatical knowledge could be implemented at the neurophysiological level – where it can-

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[44] Compare e.g., the systematicity debate started by Fodor & McLaughlin (1990) (Buckner & Garson 2019).

not be the case that the relevant language-specific knowledge is symbolically encoded, but some representation needs to be learned from observable indications. Formally, the Principles-and-Parameters Theory (Chomsky 1981) has an answer to the question of learnability: the framework assumes an articulate structural system to be innate, such that learning amounts to setting a small number of switches, the parameters. The Minimalist Program (Chomsky 1995) attempts to derive the complex structural displacement patterns (which are required to reduce the complex sound/meaning relationship available in natural languages to a uniform construction plan and which by assumption must be predetermined by universal grammar) as a consequence of a small set of assumptions that are justified on the grounds of simplicity of the theory. Through innate universal grammar, the learner of a language has access to the principles that govern the displacement patterns and thus the learner only needs to learn the language-particular choice of linearizing the displacement configurations (Chomsky et al. 2019). Language learning is here conceptualized as a process of setting a number of discrete parameters. What is not very clear however is how the language acquisition system interacts with other parts of the cognitive learning system, many of which are quite clearly responding to the statistical distribution of cues. But linguistic knowledge could not be acquired and put to use if it had no effective interfaces with the statistically sensitive parts of cognition. It is hard to imagine that a learner can find out about the space of possible constructions in a language when they cannot rely on expectations regarding *typical* (= highly frequent) ways of saying something; when the learner notices that certain expectations were incorrect, this will trigger a highly informative learning step regarding the relationship between the language system and contextual factors. For instance, a learner can only learn about a rare phenomenon like heavy NP shift as in (25) if they have a notion of a canonical order, so they can reconstruct the conditions for deviations.

(25) I gave [$_{\mathrm{PP}}$ to Sue] [$_{\mathrm{NP}}$ the books that I found on my aunt’s attic]

The aspect of statistical learning is where connectionist approaches turn out to capture the empirical behavior quite realistically – but a theory that construes language acquisition as an entirely different process provides no grounds for capturing such triggers and any frequency-related patterns.

The classical constraint-based theories of grammar, such as LFG and Head-driven Phrase Structure Grammar (see Przepiórkowski 2023 [this volume]), *do* emphasize the objective of finding psychologically realistic models of the cognitive processes of production and comprehension (i.e., parsing and generation algorithms that start from an information state that corresponds to what is available to a human listener or speaker). However, the goal of coming up with realistic algorithmic accounts capturing the information processing of real cognitive agents does not traditionally extend to the cognitive process of *learning* a language, i.e., acquiring the lexical and grammatical knowledge necessary to perform the tasks of production and comprehension. The grammar formalisms are not designed in such a way that there is a formal learning procedure that always starts from the same initial state, and then takes in observations from adult speakers of Bulgarian, English or Mandarin. But this would be required to have a falsifiable theory of the way grammatical knowledge is instantiated in cognitive agents. In the classical paradigm, the precise grammatical knowledge representation for a particular language is (still) specified by a scientific observer, the linguist, who is able to "look behind the scenes" and make far-reaching decisions about the use of certain descriptive means from a meta perspective – which is clearly not a realistic rendering of the information available to human learners (who however nevertheless reach the knowledge state robustly and fast). Of course, there are good research-strategic reasons why the classical paradigm stops short of also trying to model the cognitive process of acquisition: the grammatical knowledge that is available to adult speakers of the languages of the world is complex and the systematic workings of most language-particular systems are far from being understood. So one might say that the research community is still at the stage of clarifying what the exact targets for the acquisition process are, thereby avoiding a situation where it could not be truly judged whether a learning algorithm is on the right track from a theoretical point of view. An opponent could however argue that it is not clear whether the formalism that was designed so meta observers can specify a theory of adult linguistic knowledge provides the right concepts and interfaces to ever support a realistically learnable knowledge representation of grammar and the lexicon (for instance because it is unclear how associative knowledge merges in, as mentioned above). If there is any truth in this objection, the best strategy is probably to adopt a parallel strategy: advance systematic accounts of the adult linguistic knowledge and at the same time try to explore architectures that are better suited for modeling learning and for interfacing with knowledge that is more readily captured in a connectionist framework.

The design of Optimality Theory provides a link between the abstract symbolic level, tying in with established concepts from linguistic theory, and the level of connectionist implementation. From the point of view of LFG, the greatest conceptual gain from adopting an OT perspective might lie in the fact that this provides a fleshed-out learning algorithm (Tesar & Smolensky 1998), which is compatible with insights about the low-level generalizing behavior of connectionist approaches.

4.4 Extension II: Bidirectional optimization

The standard definition of grammaticality in an OT system is based on what is often called a speaker-oriented, or production-based competition. Here, the most harmonic candidate analysis realizing some underlying content representation is determined. The characterization of the competing candidates reflects the fundamental knowledge that a competent speaker of the language has: they know which is the grammatical way of expressing some thought in their language. When they learned their language, they had to exclude other ways that would be possible in principle. The candidate set and rerankable constraints are thus a straightforward rendering of the mathematical search space for learning an input-output function capturing the speaker's competence.

A competent language user however has an additional ability: the listener is (mostly) able to reconstruct what the speakers wanted to express in the given context. Formally, the disambiguation problem for a given surface form can be construed as the mirror image of the task of realizing some underlying representation with the grammatical means of some particular language. Hence, it is tempting to explore to what extent the same competition-based architecture can be applied to model our ability to disambiguate. The representational setup of OT-LFG makes it particularly easy to implement the reverse competition: for a listener-oriented, or comprehension-based optimization, all that needs to be altered from the standard scenario is the basis for defining the candidate set. Here, all candidate analyses sharing the same surface string are compared.

A realistic model of our cognitive ability to make disambiguation decisions of course has to incorporate a lot more than just grammatical and lexical knowledge. On reading an ambiguous request/instruction like (26) (compare (27a) vs. (27b)), a reader may exploit frequency knowledge about the phrasal verb *read in* vs. the simple verb *read*, which one might argue is part of their extended lexical knowledge. However the utterance context of the request will probably play a much more important role: Does the building have a physical library? Or is the reader receiving programming hints? Ultimately, reasoning about what the speaker/author meant will draw upon any available world knowledge.

(26) Read in the library.

(27) a. Read in the comma-separated data file.
  b. Read in the living room.

So, taking all relevant knowledge sources into account, there is an asymmetry between production-based and comprehension-based optimization. Nevertheless, it is a valid question what disambiguation decisions are made when there are no grammar-external clues. If we can isolate such cases, we might learn a lot about the way our grammatical knowledge is organized.[45]

A case in point are so-called word-order freezing phenomena, which have received considerable attention in OT frameworks. For languages with relatively free word order, the following type of effect is often reported: when there are no other disambiguating clues, listeners interpret examples as unambiguous that due to freedom of word order should actually have two possible interpretations. Bouma & Hendriks (2012), who provide a detailed discussion of OT treatments of word order freezing, give the Dutch example in (28):

(28) Dutch (West Germanic; Bouma & Hendriks 2012: ex. 4)
Fitz zag Ella.
Fitz saw Ella
Only 'Fitz saw Ella' (SVO), although structurally compatible with 'Ella saw Fitz' (OVS)

The interpretive preference for cases like (28) is directly predicted if one assumes that not only the determination of grammatical (surface) outputs follows a (production-based) optimization, but also the distinction among potential underlying interpretations in comprehension – assuming the very same constraint set.[46] Accounts that make use of this idea are called bidirectional optimization accounts. Early discussions of such an account in an OT-LFG setting are found in Lee (2001) and in Kuhn (2000a, 2003).

Assuming that comprehension-based competition plays a role in a model of grammatical knowledge immediately raises questions about the relationship between the two directions: in a standard OT setting, one would not want to assume in general that listeners *only* apply constraint evaluation on the possible analysis candidates of a surface string to retrieve the semantic interpretation; they should also double check that the surface string is also optimal in the reverse direction[47] – otherwise, a listener may end up with a candidate structure that is not

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[45] Recall from Sections 1.2 and 2.6 that comprehension-based optimization is also predominantly used with the OT-style constraint ranking scheme implemented in the XLE system (Frank et al. 2001).

[46] Zeevat (2006) argues that bidirectional optimization is not an adequate account for word order freezing; but see Bouma & Hendriks (2012).

[47] The simple comprehension-based optimization *does* play a role in work in OT phonology. The mechanism of lexicon optimization, assumed by Prince & Smolensky (1993), is such a competition. Also, Tesar & Smolensky (1998) propose a procedure of robust interpretive parsing during the learning process.

even grammatical in the language that the speaker used. For illustration, let us consider what optimizations listeners have to take into account when processing the English sentence (29a) and the German sentence (29b), which is superficially a close correspondence of the English sequence.

(29) a. Lou hopes not to arrive before Sunday.
b. German
Lou hofft nicht vor Sonntag anzukommen.
Lou hopes not before Sunday to-arrive
'Lou doesn't hope to arrive before Sunday.' or 'Lou hopes not to arrive before Sunday.'

If it was enough in comprehension to determine the optimal most harmonic structure for the observed surface string, we would expect that there is no great difference between the processing of the English and the German example. However, since in German simple negation of full verbs is grammatical, whereas in English it is not, there is a difference in the number of readings available. For (29a), a listener of English would never come up with the matrix negation reading – even in a context that would strongly favor it. This observation can be captured if we assume that a listener verifies that the most harmonic candidate in the comprehension-based optimization (with meaning $\hat{m}$) is also the most harmonic in a production-based optimization (taking $\hat{m}$ as the input). Demanding that a form-meaning pair has to be optimal both among all production-based and among all comprehension-based candidates is called *strong bidirectional OT*.

An additional variant of combining the outcome of the two optimizations was pioneered by Blutner (1998, 2000). With a so-called *weak bidirectional optimization*, not only the optimal form-meaning pairs from a competition play a role in defining meaningful expressions. The "runner-up" form-meaning pair after removing the overall winner from the competition is defined to express a more specialized form-meaning relation, and this can continue down a scale of expressions. The idea is best illustrated with the well-known example (30):[48]

(30) a. John killed the sheriff.
b. John caused the sheriff to die.

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[48] Although the competitions assumed in bidirectional OT accounts in pragmatics like the one sketched here are inspired by the OT systems used to characterize the grammar of a language, it should be noted that a weak bidirectional approach would presumably not work if the full set of candidates was assumed, most of which are ungrammatical. OT pragmatics work focuses on relating grammatical expressions of different structural shape to the spectrum of potential meanings that can express.

(30a) is the unmarked way of expressing that John killed the sheriff. Logically, (30b) is equivalent; however, on hearing this sentence (and not (30a)), most listeners will take the speaker to implicate that the sheriff died in an indirect way from John's actions, assuming Gricean maxims. Weak bidirectional optimality predicts this by assuming that the overall competition will make the form/meaning pair of sentence (30a) and a proposition with a plain instance of a killing event the most harmonic candidate in both directions. The more marked form (30b), paired up with a "specialization" of the meaning is weakly optimal.[49]

The fields of OT semantics and OT pragmatics which in essence build on top of the idea of bidirectional OT are among the most prolific areas in terms of publications (see for instance the *Stanford Encyclopedia of Philosophy* entry van Rooij & Franke 2020). It has to be noted that the role that the constraints play in OT systems modeling systematic patterns in pragmatics is slightly different from the grammaticality-defining role of the constraint set in OT phonology and OT syntax; nevertheless, there are many systematic connection points between OT syntax and OT semantics/pragmatics, discussed for instance by Beaver & Lee (2004).

5 Developments after the mid-2000s

This section starts out with a discussion of the developments in the OT framework after the phase of the highest research activity in the late 1990s and early 2000s (Section 5.1) and furthermore asks how aspects of language learning are captured in OT vs. in mainstream work in Computational Linguistics and Natural Language Processing since the 2000s (Section 5.2). Section 5.3 addresses the relatively recent developments of neural modeling, i.e., the application of "deep" artificial neural networks.

5.1 Developments after the peak research activity

Müller (2012), in the conclusion to his survey paper on OT syntax, notes that after a phase of very high research activity, there have been comparatively few OT contributions in the area of syntax – contrary to the situation in morphology, semantics/pragmatics, and most notably phonology. To a certain degree, this development also holds for OT-LFG work on syntax. According to Müller's analysis of the situation, many ideas from derivationally based work in OT syntax live on

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[49] The formal properties of bidirectional OT are discussed in Jäger (2002).

in the research strand of the Minimalist Program, in which for instance the decision to apply one of a number of competing elementary operations like Agree, Merge, Move, Delete etc. is resolved in different ways across languages, which can be captured in a ranking account (Müller 2012: sec. 5).

In this section, we address the question: what was the further development in the part of the OT syntax community that assumes nonderivational candidate analyses – in particular OT-LFG? Section 4.3 above ended with the observation that the couching of LFG in an OT framework adds a plausible algorithmic account of learnability of grammars, which the original formalism was missing. Against this background, one might have expected an increase of activity rather than a reduction, for instance in the computationally oriented LFG subcommunity. One can only speculate about the exact reasons for trends in research communities, but there seem to have been framework-internal factors, which are discussed in this section, and external factors in the broader computational community, which will be discussed in Section 5.2.

Looking at the framework itself, the introduction of a competition-based definition of grammaticality in syntax research, or in a subcommunity of syntax research, did not go along with a fixed catalogue of new principles that readily leads to the formation of a homogeneuous and focused research paradigm. Rather, the introduction of OT can be seen as the starting point for addressing a broad bundle of phenomena and conceptual aspects that conventional formal grammar models were not able to capture. These aspects include quantitative aspects of linguistic knowledge that draw the strictly binary notion of grammaticality and the established split of grammatical competence and performance into question.[50] The fanning out of community activities into a whole range of development lines should probably not be seen as a failure of the new framework, but as a sign of the true complexity of empirical interrelations that transcended the scope of the convential approach due to its strategic idealizing assumptions. Under such circumstances, new developments committed to the elimination of overly far-reaching idealizations cannot be couched in a single formal framework. Regarding the quantitative aspects for instance, extensions like stochastic OT (Section 4.1) provide certain alternatives, but in particular work by Bresnan (2007), Bresnan & Ford (2010), Bresnan & Nikitina (2010) went on to explore a broader range of modeling options. For other aspects, bidirectional optimization and other extensions of the architecture promise the most explanatory account.

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[50] In her acceptance speech of the Lifetime Achievement Award by the Association for Computational Linguistics, Joan Bresnan shares her view of the development of the various descriptive frameworks that points in this direction (Bresnan 2016).

In parallel to these architectural considerations, linguistic work continues to study empirically robust grammatical patterns for which symbolic abstractions have been established – exploring a phenomenon in new languages and/or interactions among phenomena. It is hence quite natural that depending on the focus of particular studies, authors would choose to use an OT-LFG framework or a classical LFG setting.

5.2 The shift of computational syntax research in the 2000s

As just discussed, the OT approach unlocked a diverse range of new conceptual and empirical questions, which explains in part why we did not witness the development of a single, comprehensive research paradigm that couched all competition-based work in theoretical linguistics. But in addition, there were also framework-external factors that presumably precluded a streamlining of activities into a single coherent research paradigm. One of them is that the linguistically motivated exploration of the formal OT architecture was not accompanied by major synchronized efforts in a computationally oriented community[51] – contrary to the situation in the 1980s and early 1990s where formal and computational results for linguistic grammar formalisms like LFG received significant attention at the computational linguistics conferences. At first glance, this is surprising. OT as a move to a competition-based framework in theoretical work in linguistics *did* lead to an architecture that is structurally very similar to the architectures underlying the dominant data-driven approaches in computational linguistics and natural language processing (NLP) (Eisner 2000: 287). A high-level objective in both contexts lies in developing a model framework capable of using empirical ("training") data from a natural language (in principle an arbitrary one) to induce a language-particular instantiation of the framework that replicates the competence/language behavior of a speaker of that language. This is reflected by the fact that the same families of learning algorithms could be employed (which led to interesting discussions between theoretical and computational linguistics, see Keller & Asudeh 2002, Goldwater & Johnson 2003, Jäger 2007). What differs across the research contexts despite the great similarities are three interleaved points.

First, linguistic OT work by design uses a strict constraint ranking to limit the degrees of freedom in theory development and to be able to connect to the

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[51] The use of the idea of violable constraint for postfiltering the readings predicted by a classical grammar discussed in Sections 1.2 and 2.6 is so different conceptually from OT as a grammaticality-defining device that many of the implications of the latter do not arise for the former.

long tradition of work on linguistic generalizations at the level of symbolic descriptions of linguistic structures.[52] In practically motivated machine learning approaches in NLP however, there is no reason for positing such restrictions on the learnable input-output functions. Hence, the actual learning processes for some given language input are quite different in the two research areas. Key insights from decades of research on the theory of grammar have nevertheless been incorporated in most NLP modeling efforts of the time, since supervised learning on annotated corpora ("treebanks") is the most effective approach, and the annotation categories in available corpora reflect many of the important distinctions from theoretical linguistics. Again however, the processes of generating new insights in theoretical vs. computational work is somewhat disconnected: improvements in NLP are based on enrichments of the competition and evaluation models – which is excluded by assumption in linguistic OT work.

Second, while both in linguistics and in NLP, competitions in both processing directions play a role, it is the production-based view that plays the defining role (for grammaticality) in linguistics, whereas it is the comprehension-based view (=disambiguation in parsing) that is the most fundamental in NLP.[53]

Finally, third – and related to the first and second point – there is a difference in the scope of empirical phenomena related to language and text targeted by linguistic vs. contempory NLP work. A linguistic OT approach targets grammatical phenomena and therefore controls for context factors which would discriminate among candidates but are considered extralinguistic (or orthogonal to the phenomenon under consideration). This is important to be able to isolate the effect of the abstract grammatical categories responsible for systematic generalizations. NLP work on the other hand does not aim to isolate the linguistic knowledge involved in solving processing tasks – it pursues the objective of maximizing the predicted system scores for the tasks as they realistically occur (e.g., replicating the structure assignment decision human annotators made on real-life corpus sentences, where the annotators recurred to their linguistic knowledge as much as they exploited any explicit or implicit contextual clue). From the NLP perspective, it is therefore not only legitimate, but good practice to try to exploit correlations of the actual target task with any other trends reflected in the empirical training data. For instance, a syntactic parser, say, of English, trained with NLP techniques on a treebank from a certain domain will presumably make its decisions to a large part because it has picked up grammatical knowledge regarding the positioning of grammatical subjects and objects from the treebank. To a

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[52] Stochastic OT assumes oscillating rank values for a constraint, but each evalution is still based on the strict ranking from standard OT.

[53] Compare Sections 1.2 and 2.6 and the discussions in Frank et al. (2001) and Kuhn (2001, 2003).

certain degree, it will however also exploit non-linguistic domain knowledge reflected in the distribution of factual statements (e.g., a certain brand name being mentioned a lot more than others in a context like *buy a … watch*). The difference in the scope of empirical phenomena targeted across the subfields implies very different foci in the modeling work.

The three differences in the configuration details and application of competition-based learning architectures imply different key research challenges in theoretical vs. computational work and explain how separate agendas have evolved. Nevertheless, there are numerous connecting points that become particularly relevant when the (often tacit) simplifying assumptions underlying the respective standard approaches are relaxed. For example, the idea of bidirectional optimization from theoretical work can be translated straightforwardly to machine learning models applied to disambiguation in parsing and choice in generation (Cahill & Riester 2009, Zarrieß et al. 2011, Yu et al. 2019). An example of developments in which linguistic insights and considerations re-gained attention in the past years is the Universal Dependencies project (Nivre et al. 2016), which assembles treebanks for a growing number of languages in a cross-linguistically uniform dependency format (compare Haug 2023 [this volume]).

5.3 OT and recent neural models in natural language processing

Section 4.3 addressed the connectionist motivation behind the original proposal of OT. Interestingly, over the course of the 2010s successes in machine learning with artificial neural networks (Henderson 2020) and the broad availability of high-capacity computing resources brought about a major shift in NLP research (as well as most other areas of applied machine learning), often associated with the buzz word of "Deep Learning": neural network models replaced the conventional machine learning (ML) architectures discussed here in Section 5, which required the design and optimization of the set of ML features to reach the best generalizations from training data. (The machine learning features are the equivalent to the rankable constraint in OT – the only difference is that they are used in more general mathematical functions than in the strict relative ranking of OT.)

The training of "deep" neural networks does not rely on pre-designed ML features. Instead, it employs hidden layers of neurons that are densely connected with a neuron-based input or output representation and with other hidden layers. Weight parameters on all the connections are iteratively adjusted by supervised training based on input/output data, where weight adjustments for links involving hidden layers are percolated from the ends using backpropagation (which can be thought of as spreading out the activation of some neuron to all connected neurons in the neighboring layers). The effect is that during empirical learning, the hidden layers receive the role of couching emerging internal representations of systematic patterns observed in the training data. For instance, when certain input neurons tend to be activated when a specific output occurs, some neuron in the next hidden layer can take over the role of an internal "feature" recording the constellation. With appropriately chosen network architectures that capture task-specific properties of the input and output representation (e.g., cross-talk among neighboring elements in a sequential input such as character or word token sequences), the neural approach led to substantial improvements over conventional ML approaches for a great variety of learning tasks.

The conceptual relationship between recent computational neural networks and the OT approach as popularized in the 1990s has not been discussed prominently in the research literature, but it is worthwhile comparing the major components in these architectures – in particular since the inherent black-box characteristics of neural models have prompted wide-spread efforts into making the emerging model representations scientifically interpretable (see, e.g., Belinkov & Glass 2019). At first glance, the move away from human-designed ML feature sets, which parallel OT constraint sets, seems to have widened the gap between NLP work and a linguistic notion of OT competition. Moreover, the effective ability of neural models to induce task-relevant generalizing representations which bridge between some input and some output representation has made it possible to train neural architectures for complex input/output mapping tasks for which a conventional approach would have crucially involved a linguistically informed intermediate representation. An illustrative example is machine translation. Conventionally, it was considered unquestionable that the best possible machine translation approach would for instance exploit a parser on the source side and a generator on the target side, which take advantage of all accumulated insights regarding the grammatical systems in these languages (potentially mediated through ML-based parsers/generators trained on treebanks that capture the linguistic knowledge). Now, neural models for translation can be trained on very large numbers of pairs of input/output sentences without providing any abstract characterization of linguistic properties or composing a pipeline of substeps such as parsing, transfer and generation (for an overview, see Zhang & Zong 2015). The model parametrization resulting for the end-to-end translation process captures many of the relevant grammatical regularities in the hidden layers. The great advantage of the free induction of internal representations as systematic patterns occur in the observed input/output relation is that the model will capture not only regularities along the major dimensions underlying established modular descriptions of knowledge of language, but any other trends that are manifest in the data. And since all aspects are incorporated in a single, densely connected model architecture, cross-talk among the various knowledge sources and contextual clues is captured very effectively.[54]

But how could then a comparison with the classical OT architecture be of any use or lead to new insights? OT was designed to have an abstract symbolic representation level (OT constraints) in a quasi-connectionist model architecture that implements an input/output function with supervised training. However, with the assumed fixed set of grammatically relevant constraints, one of the key strengths of current connectionist models – the free induction of internal representations at hidden levels, without preconceived features or violable constraints – is excluded by design. Accommodating for the tension between OT's fixed set of symbolic constraints and the current neural model's completely unrestricted representational space could be the key to advances on both the linguistic and the computational side. The unrestricted neural models lack scientific interpretability, but they can use representation learning to capture cross-talk among any factors influencing the observed input/output behavior, while the OT approach enforces the exclusion of non-linguistic factors as an influence on the competitions. It is conceivable to reconcile the shortcomings on either side by building up symbolically informed diagnostic tools operating on trained neural models: such tools would in a first step allow researchers to inspect in a controlled way how a neural model trained on corpus data captures known symbolic generalizations. In a second step, it could be explored empirically how factors from additional, non-linguistic knowledge sources affect the model's "own account" of the symbolic generalizations beyond the controlled setup. Recent work in NLP has started looking at various techniques (probing tasks, causal intervention) that can serve as such diagnostic tools for inspecting neural models (Ettinger et al. 2016, Gulordava et al. 2018).

To give an idea of the potential that lies in symbolically guided analysis of the internal representations of trained neural models, Figure 7 shows an analysis of the behavior of a neural syntactic parser from Falenska & Kuhn (2019). The parser, a neural graph-based dependency parser, is trained in a supervised way to predict dependency arcs (essentially representing the grammatical relation between the words in a sentence). The model can build up and exploit its own internal representation to capture emerging systematic patterns that guide

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[54] Recent advances in the neural modeling of text, in particular transformer-based contextual word embeddings like BERT (Devlin et al. 2019) have led to an often surprising level of emerging generalizations. Even before the advent of this generation of models, Loula et al. (2018) reported "impressive generalization capabilities" of neural sequence-to-sequence models in phrasal composition underlying the meaning of commands like *turn left twice.*

the decision for assigning a particular dependency arc. It may for example notice the influence of intervening words (as in the contrast *some prefer water* vs. *some cold water*, where the intervening word influences what is the most likely grammatical relation between *some* and *water*).

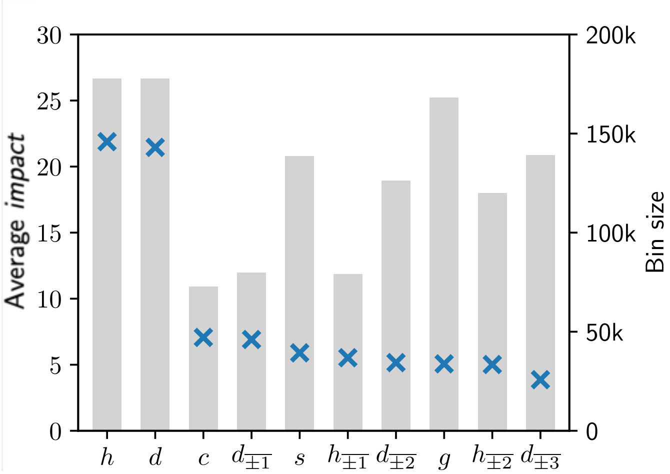

Figure 7: Analysis of trained neural dependency parsers from Falenska & Kuhn (2019), aggregating results from nine treebank training experiments (Ancient Greek, Arabic, Chinese, English, Finnish, Hebrew, Korean, Russian and Swedish): impact (blue crosses) of the information from words in various functional positions (occurring with a frequency plotted by the gray bars) on the prediction score of a multi-layer perceptron for a dependency arc in a graph-based dependency parser. The position types compared are the following: heads (h), dependents (d), children of d (c), siblings (s), grandparents (g), $h, d_{\overline{\pm i}}$ tokens at distance $\pm i$ from h or d which are none of h, d, c, s, or g.

Figure 7 shows a diagnostic analysis of the neural model that emerged from training on treebanks for nine languages. The model was specifically trained to decide whether two given tokens in a sentence should stand in a head-dependent relation, taking into account all tokens in the sentence. For the trained model, it is possible to quantify what impact on the decision the model attributes to individual tokens in the data.[55] For the analysis shown in Figure 7, the token impact was systematically aggregated based on the position of the token in the syntactic gold-standard configuration, as labeled in the treebank. (This information is not available to the model itself.) The blue crosses in the diagram indicate what impact the model itself has decided to assign to tokens in the various configurational positions. The two tokens with the greatest impact are – as one would

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[55] The paper introduces a special normalized measure for the impact of specific word representations on the prediction.

expect – the head (*h*) and the dependent (*d*) themselves. But other tokens in the sentence have an impact too. The gray bars represent the frequency of tokens in the various configurational positions in the training corpora. In a structurally uninformed model, our expectation would be that the impact of certain types of tokens correlates with their frequency, so the blue crosses should be high on the tall gray bars and low on the short bars. The diagram reveals that the parser has for instance learned from exposure to data to be substantially more sensitive to the children of dependents (*c*) than to siblings (*s*), although the latter occur much more frequently in the training data.[56] In fact, the neural model with its self-induced internal representation achieves a better prediction quality than the best classical machine learning models, for which carefully designed configurational features are provided. Since direct information about the representational configuration is not in the input representation that the parser receives in training or application, we have an indication that the emerging internal, connectionist representation does encode implicit knowledge about important aspects of functional structure.

The linguistic questions that can be addressed with the dependency parsing example are relatively limited, but it is conceivable to generalize the approach to a more complex interplay of factors affecting linguistic expressions. Diagnostic tools of this kind may thus provide an informed view on the ability of a connectionist model to pick up patterns for which a theory of syntax has posited symbolic abstractions – capturing their systematic significance. A central challenge for theoretical interpretability of the models' predictive capacity is to further develop the diagnostic machinery for disentangling the overlaid effects of very different knowledge sources.[57]

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[56] It should be noted that there is no delimitable locus in the model's parameter space where this information is represented – but based on the theoretically informed diagnostic tests, we can observe that whatever the model has learned correlates with the distinction.

[57] To make progress in this process of disentangling, it is necessary to cross long-established disciplinary boundaries that provided clear-cut subspaces in the study of language, text and corpora of discourses from specific contexts: theory of grammar with its subdisciplines, psycholinguistics, sociolinguistics, but also literary studies, media studies, etc.; many relevant patterns fall into the realm of scholarly disciplines that do not study language and text *per se*, such as cultural studies, history and social science. The delimited subspaces have so far justified convenient idealizations in the working assumptions – in the theory of grammar for example the idealizing assumption of a shared body of grammatical and lexical knowledge that makes up the linguistic competence of all native speakers of language X. An extra challenge comes from the divergent methodologies that have developed in the subfields as a response to the very distinct idealizations; this becomes clear in work in subareas of digital humanities and computational social science which has recently explored corpus-based modeling techniques for addressing research questions from literary studies (Kuhn 2019) or political science (Padó et al. 2019). Considerable effort is needed to appropriately incorporate findings from computational models in the respective question contexts and theoretical frameworks (Reiter et al. 2020).

6 Conclusion: Epistemological considerations

Optimality Theory was introduced to the study of language in the 1990s as a symbolic description framework for linguistic representations which can make stronger empirically testable predictions about the human language faculty than a classical formal grammar. It can be seen as an attempt to overcome an epistemological limitation of the established formalisms underlying most work in linguistics. The limitation affects plain rewrite systems from the Chomsky hierarchy as much as extensions such as for instance transformational systems, tree-adjoining grammars and unification-based grammars.

With a classical framework, the predictions that can be tested "directly"[58] against empirical observations are always tied to the formal grammar for a particular language, i.e., a specific instantiation of the class of formal systems, for example, a specific context-free grammar $G_{137} = \langle N_{137}, \Sigma_{137}, P_{137}, S_{137} \rangle$ with a concrete set of non-terminal symbols, terminal symbols, rewrite rule productions and start symbol (and similarly for more expressive grammar formalisms).

One such instantiation is typically viewed as a scientific model for (aspects of) the grammatical competence of speakers of, say, Japanese, Swahili or English. The formal system predicts a set of terminal strings, which can be experimentally compared against the linguistic behavior of competent speakers. A grammatical theory about a range of phenomena, e.g., in Japanese, is then falsifiable in the sense of Popper (1959)[59] because it is conceivable that relevant types of terminal strings predicted to be excluded from the formal language according to the theory *do* in fact occur in an experiment (potentially using corpus studies that compare against very similar string types predicted to be included).[60] The theoretical scope is however rather limited: if G_{137} fails to predict an empirically observable opposition of acceptable vs. unacceptable data in Japanese, all that the theorist can conclude is that some aspect in the specification of this formal grammar has

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[58] "Directly" is set in scare quotes, since what goes through as direct empirical evidence in linguistic work always depends on methodological preassumptions that a community agrees on. The nature of language data in communication is such that very few event types are truly observable in a direct way. However, appeal to certain theoretical constructs and certain contextually triggered inferences is typically considered uncontroversial since they are orthogonal to research questions under debate.

[59] Falsifiability is a prerequisite for a theory with any predictive power.

[60] Most theories of grammar work with the stronger assumption that (some part of) the internal symbolic structures used by the formalism also represent relevant aspects of meaning, i.e., they can be viewed as logical forms. This provides an additional basis for testable predictions; the experiment then has to access speakers' (and listeners'/readers') interpretation of given strings. What is directly testable are however still the system's predictions for one fully parametrized (language-particular) instance of the grammar formalsm.

been inappropriate. When there are multiple ways of fixing the problem (e.g., by different strategies of introducing additional non-terminal symbols in a variant G'_{137} and by modifying some existing productions and adding some new ones in G''_{137}), there is no theoretically forceful way of distinguishing between them. Assume for the sake of the argument that only one of the modified grammars makes structural similarities with Korean, which is modeled in some grammar G_{214}, explicit. As long as the other modified formal grammars predict the same formal language, a theoretically well-founded statement differentiating between the options cannot be made (for lack of falsifiability).

In contrast to classical formal systems, an OT system can make testable predictions for quite a different type of experiment: the theory implemented in a particular OT system, with a spelled-out candidate generation function *Gen* and a set of rankable constraints *Con*, does not predict a single formal language, but – via the factorial typology implied by all possible rankings of *Con* – a whole class of formal language approximations of natural languages. Fully formalized OT systems come with a spelled-out empirical learning algorithm (Tesar & Smolensky 1998 and subsequent work in the community), which provides the basis for falsifiability of a theory about the human language faculty as such: a formal OT system predicts how a learner of any specific language in their learning behavior responds to exposure to language behavior by adult speakers of the language in question.[61] A concrete OT system can thus be falsified by evidence from *any* of the languages of the world: a particular observed adult language behavior could in principle trigger a sequence of constraint rerankings that make it impossible for the learner to converge on the constraint ranking needed for this language. If this is the case for some conjectured theory (with a constraint set, etc.) and observed language data, then the theory of some part of the human language faculty counts as falsified.

Of course, most research communities employing classical formalisms, including the LFG community, have established agreed-upon meta principles and methodological research practices which effectively ensure that empirical evidence from a particular natural language is accepted by the community as evidence affecting *all* formal systems adhering to the shared conventions (to continue with our context-free grammar illustration, the theory could be characterized as the set of formal grammars $\{G_i \mid$ the components of G_i satisfy all meta principles $\}$). There are countless examples of such meta principles: X-bar theory, extended projections, the concept of lexical redundancy rules, constraints

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[61] Adult behavior is assumed to be observed in contexts that provide enough extra-linguistic clues to support inferences about the intended meaning where there is ambiguity.

on legitimate transformations in a derivational framework, a universal layering of functional projections, etc. With such principles it becomes possible that the grammatical theory constituted by the meta principles is falsified by language-particular evidence. Even the language learning/acquisition problem has been formulated on the basis of such framework, presumably most prominently in the Principles-and-Parameters theory (Chomsky 1981): the learner (guided by some language acquisition device that is assumed to be part of the cognitive equipment) has the task of adjusting a number of free parameters in an otherwise highly constrained innate grammatical system – in response to observed linguistic behavior by adult speakers. (A rigorous formalization as for OT learning algorithms is typically not provided.)

However, although sophisticated research practices have been established that ensure a far-reaching consensus about plausible meta principles assumed in a community, the epistemological relationship between a particular instantiation of the meta framework (say, formal grammar G_{137} for Japanese) and the framework itself, with its meta principles, remains contestable. Typically, the representational constructs developed to capture generalizations across natural languages have been established in a long process of cautious plausible reasoning – yet it is almost always conceivable that there are alternative, empirically indistinguishable ways of predicting surface-level divergences across languages. To explain unexpected patterns in some language X, a modification in the formulation of one or another meta principle could be made, or idiosyncratic lexical knowledge could be posited. The falsifiability issue of general theoretical statements is not completely resolved by the assumption of meta principles. This circumstance explains in part why there have been many controversial debates about the representational locus for capturing cross-linguistic variation in a phenomenon – take for instance Binding Principles, which one might construe along a configurational tree structure or along a functional hierarchy (Asudeh & Dalrymple 2006). In the same vein, a re-occurring type of argument against specific linguistic accounts is the accusation for overly strong theory-internal assumptions. In other words, it happens quite frequently that members of a research community develop reservations with respect to the falsifiability of parts of the established consensus framework.[62]

As just noted, OT can be technically seen as the move towards an approach that meets higher standards of falsifiability (when fully formalized). One may

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[62] Given the underdetermination of theories of grammar by direct empirical evidence, aesthetic arguments regarding the simplicity of a theory are often advanced, most notably in Minimalism (Chomsky 1995). But even this strategy cannot escape controversies, since there are different possible starting points for seeding a theoretical accounts in fundamental propositions.

ask oneself then why it has not replaced classical formalisms in mainstream linguistic research? Section 5.1 discussed this question under the perspective of the concrete course of research activities in the 1990s and 2000s. But there are also relevant meta-theoretical considerations: since most aspects of representational choice in linguistic modeling are not directly observable (only the linear sequence of surface units of expression and semantic entailments of the content of utterances are directly observable), the space of possible OT theories remains vastly underdetermined. This means that (unless a community decides to change their research paradigm completely), plausible argumentation for abstract intermediate representations remains an important part of linguistic theorizing. And since substantial groundwork in linguistic research has always lain in the systematic capturing of regularities in variation patterns for particular languages, the justification for the use of classical formalisms has not disappeared. By choosing a strict ranking approach over violable constraints captured in terms of established symbolic representations, the OT endeavor was from the outset designed to stay connected with work using the classical formalisms; the effect of relevant constraints on a phenomenon under consideration can be calculated in manually constructed tableaux.[63] Insights from a specific OT account may thus feed back into the more general debate of what are appropriate theoretical constructs for systematically capturing a particular aspect of linguistic knowledge.

Against this background, the most important contribution of OT to generative linguistics might have been to increase the awareness in (part of) the community that a comprehensive, falsifiable account of the human language faculty has to include a formalized account of learnability of language from exposure to data.

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[63] As was discussed in Section 5, recent machine learning approaches open up alternative avenues for modeling human language behavior. Computational models incorporating a very large parameter space can be trained on large corpora to achieve higher prediction accuracy on most tasks; however, the emerging representations (in the hidden layers of "deep" neural network models) provide no direct basis for a falsifiable theory of aspects of linguistic competence. Some connection to hypotheses that can be expressed symbolically seems to be indispensible.

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Part V

Formal and computational issues and applications

Chapter 22

Formal and computational properties of LFG

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This chapter first reviews the basic architectural concepts that underlie the formal theory of Lexical-Functional Grammar. The LFG formalism provides a simple set of devices for describing the common properties of all human languages and the particular properties of individual languages. It postulates two levels of syntactic representation for a sentence, a constituent structure and a functional structure. These are related by a piecewise correspondence that permits the abstract functional structure to be described in terms of configurations of constituent structure phrases. We then survey the mathematical and computational properties of this simple framework. We demonstrate that the recognition/parsing, realization/generation, emptiness, and other more specific decision problems are unsolvable for grammars in the unrestricted LFG formalism. A first set of restrictions guarantees decidability of recognition, realization, and other problems for grammars that are still suitable for linguistic description, but the solutions to these problems in the worst case are computationally impractical. The class of LFG grammars that meet an additional set of restrictions is equivalent to the class of mildly context-sensitive grammars, and the recognition and realization problems for grammars in this class are thus not only decidable but tractable as well.

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1 Introduction

The basic features of the LFG formalism are quite simple and have remained remarkably stable since they were first introduced by Kaplan & Bresnan (1982).[1] An LFG grammar assigns to each sentence in its language at least one constituent structure (c-structure) and at least one functional structure (f-structure). The c-structure is a phrase-structure tree that represents the order of words and their grouping into phrases. The f-structure is a hierarchical attribute-value matrix that represents the underlying grammatical relations that are expressed by configurations of c-structure nodes. The c-structure is determined in the traditional way by the rules of a context-free grammar. The f-structure is a minimal model for the functional description (f-description) that is constructed from annotations associated with the categories of rules that license the nodes of the c-structure. The f-description is obtained by instantiating those annotations on the assumption that there is a piece-wise correspondence ϕ between the nodes of the c-structure and the units of a satisfying f-structure.

This simple correspondence architecture still lies at the core of LFG theory even as it has been extended and refined to provide more insightful accounts of long distance dependencies (Kaplan & Zaenen 1989), coordination (Kaplan & Maxwell 1988), and other syntactic phenomena. In this chapter we focus on the mathematical and computational properties of the basic formalism. As is well known, its expressive power goes far beyond the capabilities of the context-free c-structure grammar. This is because the annotations may associate information that originates from different (and possibly arbitrarily distant) nodes with the same f-structure unit. The result is that such a unit must satisfy requirements that come from words in the string or nodes in the tree that do not stand in a local mother-daughter relationship. A string with an otherwise well-formed c-structure is excluded from the language if such context-sensitive f-structure requirements are inconsistent. We know that some degree of context sensitivity is needed for recognizing and parsing natural languages (Bresnan et al. 1982, Culy 1985, Shieber 1985), but the basic LFG formalism may allow for more expressive power than is actually required.

Indeed, Kaplan & Bresnan (1982) used a reduction from the Turing machine halting problem to show that the recognition/parsing problem is undecidable for

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[1] Jürgen Wedekind passed away just as work on this chapter was coming to an end. Jürgen was a master of the LFG formalism, with deep insights into its mathematical and computational properties and how they relate to important principles of linguistic analysis. His early passing is a great loss to the LFG community. He will also be missed as a close friend and collaborator. RMK

unrestricted LFG grammars (see also Johnson 1988). This is the computationally important problem of determining whether or not a given string belongs to the language of the grammar and is assigned at least one c-structure and corresponding f-structure. Wedekind (2014) proved the undecidability of the realization problem, also of practical significance. This is the problem of determining whether the language contains at least one string to which an arbitrary given f-structure is assigned. Wedekind's undecidability proof used a reduction from the emptiness problem for the intersection of context-free languages. He also used that reduction to show the undecidability of the emptiness problem for unrestricted LFGs (Wedekind 1999). This is the problem of determining whether or not there are any strings at all in the language of a given LFG grammar. The emptiness problem for LFGs was previously shown to be undecidable by reductions from Hilbert's Tenth Problem (Roach 1983) and Post's Correspondence Problem (Nishino 1991).

We revisit these undecidability results in Section 4. We provide alternative proofs within a single, conceptually simple, framework. In Appendix A we use this framework to show that other more specific decision problems are also unsolvable.

We consider in Section 5 some formal conditions that are sufficient to guarantee decidability of the recognition and realization problems. Kaplan & Bresnan (1982) showed that recognition is decidable if c-structures with non-branching dominance (NBD) chains and/or unlimited empty nodes are excluded, and they argued that this is a reasonable restriction for LFG grammars that describe natural languages. This parsing-oriented limitation does not reduce the complexity of generation (Wedekind 2014), but an unrelated restriction has been shown to ensure the decidability of that problem (Wedekind & Kaplan 2012). This raises the question whether there is a single, linguistically plausible, condition that applies indifferently to both parsing and generation. We introduce in Section 5 such a uniform condition, proper anchoring, but we also demonstrate that this particular condition is not strong enough to guarantee that these problems can be solved with practical efficiency. In the worst case recognition and generation may take an amount of time that is exponential in the length of an input sentence or f-structure.

This leads us to examine in Section 7 a stronger set of restrictions that not only guarantee decidability of recognition and realization as well as emptiness but also ensure that those problems can be solved in polynomial time. This follows from the fact that LFG grammars that meet these additional restrictions are mildly context-sensitive in their expressive power and thus also have the known mathematical and computational properties of that class of formal grammars.

2 Basic LFG formalism

We show in Figure 1 the c-structure and f-structure that the annotated c-structure rules in (1) and lexical entries in (2) would assign to the sentence *He sees the girl.*

(1)
$$\begin{array}{lll} \mathrm{S} \rightarrow & \mathrm{NP} & \mathrm{VP} \\ & (\uparrow \textsc{subj}) = \downarrow & \uparrow = \downarrow \\ & & (\uparrow \textsc{tense}) \end{array}$$

$$\begin{array}{lll} \mathrm{NP} \rightarrow & (\mathrm{Det}) & \mathrm{N} \\ & \uparrow = \downarrow & \uparrow = \downarrow \end{array}$$

$$\begin{array}{lll} \mathrm{VP} \rightarrow & \mathrm{V} & \mathrm{NP} \\ & \uparrow = \downarrow & (\uparrow \textsc{obj}) = \downarrow \end{array}$$

(2)

he	N	$(\uparrow \textsc{pred}) = \text{‘}\textsc{pro}\text{’}$ $(\uparrow \textsc{agr pers}) = 3$ $(\uparrow \textsc{agr num}) = \textsc{sg}$
sees	V	$(\uparrow \textsc{pred}) = \text{‘}\textsc{see}\langle\textsc{subj obj}\rangle\text{’}$ $(\uparrow \textsc{tense}) = \textsc{pres}$ $(\uparrow \textsc{subj agr pers}) = 3$ $(\uparrow \textsc{subj agr num}) = \textsc{sg}$
the	Det	$(\uparrow \textsc{spec}) = \textsc{def}$
girl	N	$(\uparrow \textsc{pred}) = \text{‘}\textsc{girl}\text{’}$ $(\uparrow \textsc{agr pers}) = 3$ $(\uparrow \textsc{agr num}) = \textsc{sg}$ $(\uparrow \textsc{spec})$

The correspondence function ϕ is indicated by the arrows between the c-structure nodes and the f-structure units and also, redundantly, by the columns of node identifiers *root*, $n_1, n_2, \ldots$ attached to the f-structure units. We see even in this simple example that the function ϕ is typically many-to-one (heads and coheads of grammatical constituents are mapped into the same f-structure) but is not onto (the AGR/agreement f-structure units are not the image of any node). The function ϕ may also be partial, if nodes necessary for c-structure well-formedness have no f-structure significance.

The phrasal categories of this c-structure obviously meet the node admissibility conditions of the annotated rewriting rules (1). Lexical entries are interpreted also as annotated rewriting rules that relate the lexical categories of the c-structure to the words of the sentence. The entry for *the*, for example, is interpreted as the rule

(3)
$$\begin{array}{ll} \mathrm{Det} \rightarrow & \mathrm{the} \\ & (\uparrow \textsc{spec}) = \textsc{def} \end{array}$$

and the normal node admissibility conditions also license the proper lexical expansions for the tree.

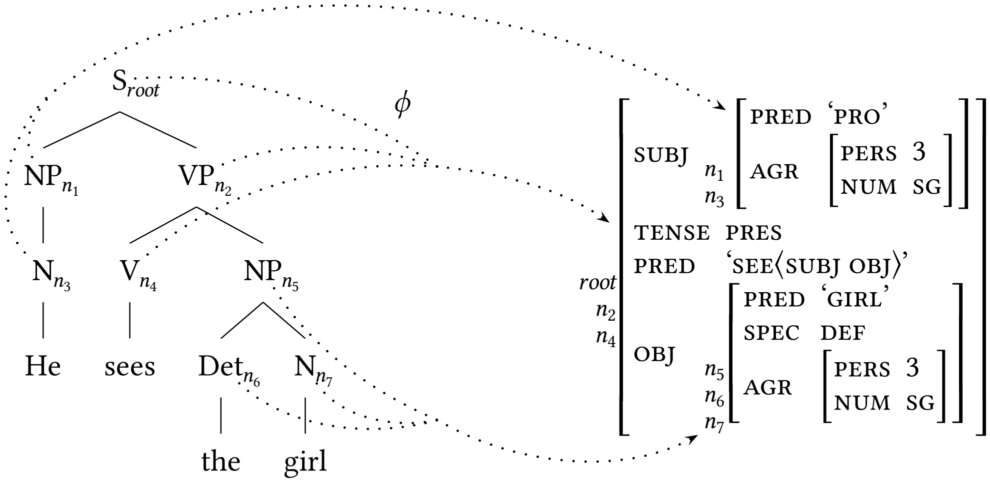

Figure 1: Illustration of the basic LFG architecture: A c-structure c and f-structure f related by the correspondence function ϕ from the nodes of c to the units of f. The f-structure units are indexed by the nodes to which they correspond.

The description that the f-structure must satisfy is constructed from the annotations associated with the daughter categories of the rules that license particular nodes in the c-structure. Each side of an equation designates an element of a corresponding f-structure, and the equation is satisfied if both sides designate the same element. The metavariable $\downarrow$ in an annotation designator instantiates to the f-structure corresponding to the node that matches the associated rule category (n_1 for $\downarrow$ in the annotation $(\uparrow \textsc{subj}) = \downarrow$ attached to the NP in the S rule), and the metavariable $\uparrow$ denotes the f-structure corresponding to the mother of that node (the node *root* for that rule). To be precise, if $*$ instantiates to the matching node and $M(*)$ instantiates to its mother, then $\downarrow$ and $\uparrow$ are abbreviations for $\phi(*)$ and $\phi(M(*))$ respectively. The metavariable instantiations are easy to read from the *annotated c-structure* in Figure 2. This is a phrase-structure tree whose nodes are labeled with the category-annotation pairs that appear in grammar rules and lexical entries.

The first NP is identified as n_1 and its mother is *root*, so the annotation $(\uparrow \textsc{subj}) = \downarrow$ instantiates directly to $(\phi(root)\ \textsc{subj}) = \phi(n_1)$. Since a parenthesized designator denotes the element reached by traversing a path of attributes from a starting f-structure, the f-structure in Figure 1 satisfies this equation because $\phi(n_1)$ is the SUBJ of $\phi(root)$ under the illustrated ϕ correspondence. The full f-description for this annotated c-structure is the conjunction of instantiated equations collected from all of its nodes, shown in (4).

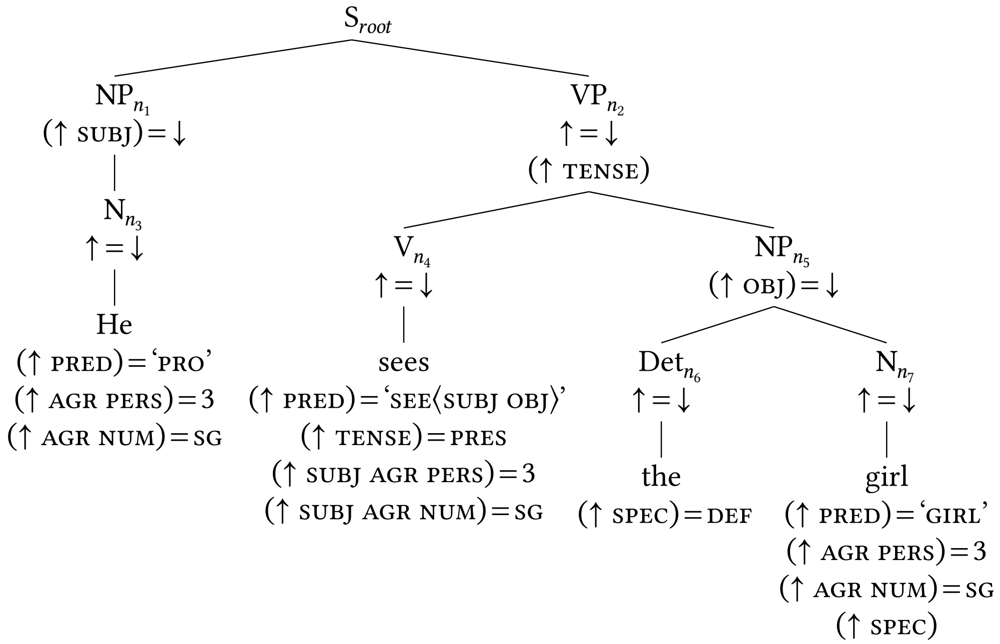

Figure 2: Annotated c-structure for *He sees the girl* with the rules in (1) and lexicon in (2).

(4) $(\phi(root)\ \textsc{subj}) = \phi(n_1)$
$\phi(root) = \phi(n_2)$
$(\phi(root)\ \textsc{tense})$
$\phi(n_1) = \phi(n_3)$
$(\phi(n_3)\ \textsc{pred}) = \text{‘}\textsc{pro}\text{’}$
$(\phi(n_3)\ \textsc{agr pers}) = 3$
$(\phi(n_3)\ \textsc{agr num}) = \textsc{sg}$
$\phi(n_2) = \phi(n_4)$
$(\phi(n_4)\ \textsc{pred}) = \text{‘}\textsc{see}\langle\textsc{subj obj}\rangle\text{’}$
$(\phi(n_4)\ \textsc{pred}) = \textsc{pres}$
$(\phi(n_4)\ \textsc{subj agr pers}) = 3$
$(\phi(n_4)\ \textsc{subj agr num}) = \textsc{sg}$
$(\phi(n_2)\ \textsc{obj}) = \phi(n_5)$
$\phi(n_5) = \phi(n_6)$
$\phi(n_5) = \phi(n_7)$
$(\phi(n_6)\ \textsc{spec}) = \textsc{def}$
$(\phi(n_7)\ \textsc{pred}) = \text{‘}\textsc{girl}\text{’}$
$(\phi(n_7)\ \textsc{agr pers}) = 3$
$(\phi(n_7)\ \textsc{agr num}) = \textsc{sg}$
$(\phi(n_7)\ \textsc{spec})$

We can test each equation separately to verify that the f-structure in Figure 1 meets all the specifications in (4). The equation $(\phi(n_4)\ \textsc{subj agr num}) = \textsc{sg}$ is satisfied, for example, because ϕ maps n_4 to the outermost f-structure, and that f-structure has a path from SUBJ through AGR to NUM, ending in the atomic value SG. That value is consistent with the requirement that the equation $(\phi(n_3)\ \textsc{agr num}) = \textsc{sg}$ imposes on the f-structure of n_3. In contrast, this grammar would assign no f-structure to the string *They sees the girl* because the f-description for its c-structure would require its subject f-structure to have inconsistent values for AGR NUM, a violation of the *Uniqueness Condition* of Kaplan &

Bresnan (1982). The correspondence ϕ and the instantiated metavariables ensure that the properties of the subject NP are consistent with the verb's agreement specification even though they do not appear together in a local mother-daughter configuration.

The f-structure in this configuration also meets the additional well-formedness conditions of LFG theory. We see that it is a *minimal* model of the f-description in the sense that at least one equation or combination of equations will no longer be satisfied if any attribute or value is removed (for example $(\phi(n_6)\ \textsc{spec}) = \textsc{def}$ fails without the SPEC feature of the OBJ).[1] Conversely, a structure with any features beyond those already present, say if the SUBJ is extended with TENSE PAST, is not minimal, because the f-description is still satisfied when that feature is removed. The minimal model is unique[2] for a given annotated c-structure and contains all and only the linguistically relevant features that are expressed by the words of a sentence.

The minimal model is important in LFG theory for another reason. It is the basis for the distinction between *defining annotations* and *constraining annotations.* The defining annotations are the simple equalities between two designators whose instantiations determine the attributes and values of the minimal model. That f-structure must then also satisfy the instantiations in the f-description of any constraining annotations. The grammar in (1) contains two constraining annotations, the positive existential constraints $(\uparrow \textsc{tense})$ and $(\uparrow \textsc{spec})$. The instantiation $(\phi(\mathit{root})\ \textsc{tense})$ is satisfied because the conjunction of defining equations in the f-description specify a particular value (PRES) for the attribute TENSE in the f-structure corresponding to the S node. This constraint excludes strings whose main verb is a participle instead of a tensed form (e.g. **He seeing the girl*) without depending on participles setting up a uniqueness clash by also adding a TENSE feature with an otherwise unnecessary and uninformative value (e.g. NONE). Similarly the instantiation $(\phi(n_7)\ \textsc{spec})$ excludes singular common nouns that have no specifier (e.g. **He sees girl*). The formalism also allows for con-

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[1] Strictly speaking, a minimal model of the f-description includes not only the attributes and values of the f-structure but also the association of those elements with the nodes of the c-structure as instantiated via the ϕ correspondence, as depicted in Figure 1. Technically, what we usually regard as the f-structure is the restriction of such a model to just those attributes and values.

[2] As a notational convenience, the LFG formalism allows for primitive annotations to be embedded in disjunctive formulas that then might have several solutions. There is an obvious transformation of the grammar that converts disjunctions of annotations within a rule to an equivalent set of alternative rules with annotations that are no longer disjunctive. The minimal models are unique for the annotated c-structures assigned by the rules of such a transformed grammar.

straints that test the minimal model for the absence of a feature, e.g. ¬(↑ OBJ); for the presence or absence of a specific attribute value, e.g. (↑ VOICE) $=_c$ PASSIVE or (↑ VOICE) ≠ ACTIVE; for the identity of two f-structures, e.g. (↑ SUBJ) $=_c$ (↑ OBJ); and for any value other than a specific one, e.g. (↑ SUBJ NUM) ≠ SG. Constraining annotations help to avoid clutter in the f-structure by assigning syntactic significance to the presence or absence of unmarked or default features and also by capturing the difference between constituents that provide values for features and constituents that check those values. See Kaplan (2019) for a fuller discussion of underspecified values in LFG.

The quoted values of the PRED attributes in Figure 1 carry the subcategorization restrictions of the predicates they represent, and they characterize the essential interaction between syntax and semantics while staying agnostic about the details of any particular underlying semantic theory. The semantic form 'SEE⟨SUBJ OBJ⟩' contains a list of grammatical-function designators that the predicate subcategorizes for. The *Completeness Condition* requires that all listed functions appear locally in the minimal f-structure, and the *Coherence Condition* precludes the local appearance of any governable functions (COMP, OBL, XCOMP…) not included in the list. The semantic form also indicates that SEE is the semantic relation and, by virtue of their order in the list, that SUBJ and OBJ respectively map to the first and second arguments of that relation. Semantic forms do not require special treatment in our formal analysis because they can be interpreted as succinct abbreviations for collections of other annotations. Thus the positive and negative constraints (5a-b) express the subcategorization requirements of 'SEE⟨SUBJ OBJ⟩'. The semantic relation and the mapping of functions to arguments can be coded with distinguished attributes REL, ARG1, ARG2 as in (5c-d).[3]

(5) a. Completeness: (↑ SUBJ) (↑ OBJ)
b. Coherence: ¬(↑ COMP) ¬(↑ OBL) ¬(↑ XCOMP) …
c. Semantic relation: (↑ REL) = SEE
d. Argument mapping: (↑ ARG1) = (↑ SUBJ)
(↑ ARG2) = (↑ OBJ)
e. Instantiation: (↑ PRED SOURCE) = $*$

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[3] Halvorsen & Kaplan (1988) introduced a separate semantic projection, σ, as an alternative to distinguished attributes in formulating these essential properties of the syntax-semantics interface. In that more explicit arrangement σ would be a qualifier on the (5c-d) designators. In Glue Semantics they are elaborated in collections of linear logic premises (Dalrymple et al. 1993, Dalrymple 1999).

Semantic forms are instantiated in LFG theory to mark the difference between syntactically-implied semantic coreference (as in constructions of functional control) and unrelated repetitions of similar expressions. Equation (5e) records as the value of the additional distinguished attribute SOURCE the daughter node at which a particular PRED is introduced. This makes each occurrence unique, and also supports a precedence order that can be used in regulating long distance dependencies (see Kaplan 2023 [this volume]).

3 Technical preliminaries

In preparation for the mathematical analysis in the following sections we now introduce more precise specifications of the LFG derivation machinery.

The annotated c-structure is often described as the result of a special derivation process for an LFG grammar G that treats categories and annotations separately. But it is helpful for formal reasoning to regard it as a normal derivation of the *annotated c-structure grammar* for G, an ordinary context-free grammar with a systematically modified set of rules. Suppose $X{:}A$ is an annotated category in the right side of a rule in the traditional LFG grammar format. Then for every rule expanding X the annotated grammar contains a version in which the left side is also decorated with those particular annotations. For example, because NP in (1) is annotated in S with the SUBJ assignment and in VP with the OBJ assignment, the NP rule is replaced by the rules in (6).

(6)

$$\begin{array}{cccc} \text{NP} & \rightarrow & \text{(Det)} & \text{N} \\ (\uparrow \textsc{subj}){=}\downarrow & & \uparrow{=}\downarrow & \uparrow{=}\downarrow \end{array}$$

$$\begin{array}{cccc} \text{NP} & \rightarrow & \text{(Det)} & \text{N} \\ (\uparrow \textsc{obj}){=}\downarrow & & \uparrow{=}\downarrow & \uparrow{=}\downarrow \end{array}$$

With this reformulation the normal category matching of context-free derivations allows us to make direct use of all established properties (decidability, closure, pumping) of context-free grammars and their derivations. The traditional LFG c-structure in Figure 1 is obviously just the annotation-free projection of the annotated c-structure in Figure 2.

For every annotated c-structure there is an instantiated f-description that defines a function ϕ mapping its nodes to their corresponding minimal-model f-structure units, if the f-description is satisfiable. There is also a function *Yield* that maps its nodes to the substrings of the sentence that they dominate. The set of G's derivations is then characterized by the relation Δ_G defined in (7).

(7) $\Delta_G(s, c, f)$ iff c is an annotated c-structure of G, s is the terminal string of c, and f is the minimal model for the satisfiable f-description instantiated from c.

Note that an annotated c-structure c uniquely determines both the string s and f-structure f in a derivation triple. Moreover, without further stipulation we know that the length of the string $|s|$ and the number of units $|f|$ in the f-structure are both bounded by (functions of) $|c|$, the number of nodes in the c-structure. That is, there are grammar-dependent functions $\overleftarrow{b}_G$ and $\overrightarrow{b}_G$ such that

(8) For all $(s, c, f) \in \Delta_G$, $|s| \leq \overleftarrow{b}_G(|c|)$ and $|f| \leq \overrightarrow{b}_G(|c|)$.

The function $\overleftarrow{b}_G$ depends on the number of daughters in the longest c-structure rule and $\overrightarrow{b}_G$ depends on the most complicated annotated category.

The language, f-structure, parsing, and generating projections of Δ_G are defined in (9).

(9) $L(G) = \{s \mid \Delta_G(s, c, f)$ for some c and $f\}$ = the language of G
$F(G) = \{f \mid \Delta_G(s, c, f)$ for some s and $c\}$ = the f-structures of G
$Par_G(s) = \{f \mid \Delta_G(s, c, f)$ for some $c\} \subseteq F(G)$
$Gen_G(f) = \{s \mid \Delta_G(s, c, f)$ for some $c\} \subseteq L(G)$

A parser for an LFG grammar G provides for any given string s the set of f-structures (if any) that are related to it by the grammar, and a generator provides all the strings that the grammar relates to a given f-structure (if any).

These projections allow for succinct statements of the emptiness, recognition, and realization decision problems (10).

(10) Emptiness: is $L(G)$ empty? (equivalently, are $F(G)$ or Δ_G empty?)
Recognition: for any string s is $Par_G(s)$ empty?
Realization: for any f-structure f is $Gen_G(f)$ empty?

We show in the next section that the emptiness, recognition, and realization problems are all undecidable for unrestricted LFG grammars. This implies immediately that the parsing and generation are also unsolvable. Our demonstrations involve simple phrase-structure rules with elementary defining annotations as exemplified in (11).

(11)	$(\uparrow/\downarrow\ \textsc{subj num}) = \textsc{sg}$	assign an atomic value
	$(\uparrow\ \textsc{subj}) = \downarrow$	assign a function to a daughter f-structure
	$(\downarrow\ \textsc{obj}) = (\uparrow\ \textsc{subj})$	daughter-mother control
	$(\uparrow\ \textsc{xcomp subj}) = (\uparrow\ \textsc{subj})$	traditional functional control

Annotations of these types are not exceptional, they are commonly found in linguistic grammars.

4 Undecidable problems

A standard method for showing that a formal problem of interest is undecidable is the reduction technique. A problem P is said to be *reducible* to problem P' if for any instance of P an instance of P' can be constructed such that solving the instance of P' will solve the instance of P as well. Thus, if P reduces to P' and P is undecidable, then P' must also be undecidable. As noted, this general strategy has been applied with reductions from different source problems (Turing machine halting, Hilbert's Tenth, Post Correspondence, emptiness of context-free intersection) to address the LFG emptiness, recognition, and realization problems. Here we present a single reduction-source framework, based on the emptiness problem of context-free intersection, that recapitulates these previous results.

4.1 The emptiness problem

The emptiness problem for context-free intersection is the problem of determining whether or not the languages generated by two given context-free grammars G_1 and G_2 have an empty intersection ($L(G_1) \cap L(G_2) = \varnothing$). This problem is known to be undecidable. The reduction of this emptiness problem to questions of the LFG formalism depends on the ability to construct for every context-free grammar G an LFG grammar whose f-structures contain encodings of all and only the strings of $L(G)$. We show in (12) one way in which a string pqr can be encoded in the attributes and values of an f-structure, as a H(ead)-T(ail) list representation.

(12)
$$\begin{bmatrix} \textsc{h} & \text{p} \\ \textsc{t} & \begin{bmatrix} \textsc{h} & \text{q} \\ \textsc{t} & \begin{bmatrix} \textsc{h} & \text{r} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Without loss of generality, let G be an arbitrary context-free grammar in Chomsky Normal Form, that is, a context-free grammar with only binary branching rules of the form $A \rightarrow B\ C$ for nonterminal expansions and unary rules $A \rightarrow a$ for terminals. The schematic rules in (13) provide a template for an LFG grammar *String*(G) that creates head-tail encodings (12) for the strings of $L(G)$.

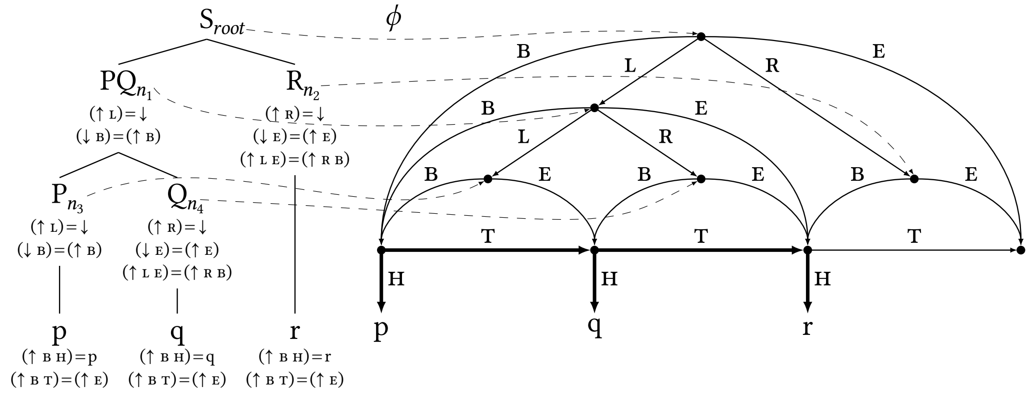


Figure 3: An annotated c-structure and f-structure derived with head-tail string encoding rules of the form in (13). Thick lines show the string encoding, thin lines show the construction scaffolding. The ϕ correspondence is depicted with dashed lines.

(13) a. $A \rightarrow \begin{array}{cc} B & C \\ (\uparrow \textsc{l})=\downarrow & (\uparrow \textsc{r})=\downarrow \\ (\downarrow \textsc{b})=(\uparrow \textsc{b}) & (\downarrow \textsc{e})=(\uparrow \textsc{e}) \\ & (\uparrow \textsc{l e})=(\uparrow \textsc{r b}) \end{array}$ b. $A \rightarrow \begin{array}{c} a \\ (\uparrow \textsc{b h})=a \\ (\uparrow \textsc{b t})=(\uparrow \textsc{e}) \end{array}$

The annotations on the binary rules (13a) transmit the string encodings from their daughter f-structures to their mother f-structure. The attributes L(eft) and R(ight) are the scaffolding needed to concatenate the encodings from the daughters by linking the end of the left-daughter encoding to the beginning of the right. Rules of the form (13b) create for each terminal the one-element head-tail encoding of their right side, with B and E attributes marking its beginning and end. Control equations such as $(\downarrow \textsc{b})=(\uparrow \textsc{b})$ and $(\uparrow \textsc{b t})=(\uparrow \textsc{e})$ are the essential ingredient in this and other string-encoding formulations: Crucially, they allow terminal-string information to propagate transparently through all intermediate nodes to the f-structure of the root. Figure 3 shows the annotated c-structure and a graphical f-structure representation for a derivation containing a head-tail encoding of a single string.

Now suppose that G_1 and G_2 are arbitrary context-free grammars in Chomsky Normal Form and assume without loss of generality that their nonterminals are disjoint and that the strings of each language end with a marker # distinct from all other terminals. We construct a new LFG grammar G by combining the rules of $String(G_1)$ and $String(G_2)$ with root categories S_1 and S_2 respectively and introducing a new root category S with start rule (14).

(14) $\mathrm{S} \rightarrow \begin{array}{cc} \mathrm{S}_1 & \mathrm{S}_2 \\ (\downarrow \textsc{b})=(\uparrow \textsc{b}) & (\downarrow \textsc{b})=(\uparrow \textsc{b}) \end{array}$

By construction of the string grammars and the B annotations of the start rule, only the string encodings of the two derived f-structures can interact. Because the string encodings are compatible only if the derived strings are identical, the LFG language $L(G)$ contains all and only strings ss for $s \in L(G_1) \cap L(G_2)$. The emptiness of context-free intersection is undecidable so the question whether $L(G)$ is empty must also be undecidable.

4.2 The recognition problem

We prove that the LFG recognition problem is undecidable by exhibiting one particular string that belongs to $L(G)$ only if $L(G_1) \cap L(G_2) \neq \emptyset$. We modify the string grammars for G_1 and G_2 by treating each terminal a other than # as a nonterminal category and adding for each of them a trivial rule

(15) $a \rightarrow \epsilon$

The effect is that only the string # belongs to the language of each of the modified string grammars, but that single string is assigned all and only the f-structures that respectively encode the original context-free languages. Again with the starting rule (14) the concatenation ## belongs to the language of the modified grammar if and only if $L(G_1) \cap L(G_2) \neq \emptyset$, that is, if and only if $Par_G(\#\#)$ is not empty.

Empty nodes are disfavored in some modern versions of LFG, particularly when long-distance dependencies are characterized by functional uncertainty rather than traces (Kaplan & Zaenen 1989, Dalrymple et al. 2015). But the undecidability of recognition can also be demonstrated with grammars $String(G_1)$ and $String(G_2)$ redefined so as to produce the same head-tail string encodings from nonbranching dominance chains without the benefit of empty nodes.

For each binary rule $A \rightarrow B\ C$ the string encoding grammars will now contain a nonbranching rule of the form (16a). This immediately derives only the left daughter B but pushes the right-daughter category C on a simulated stack for expansion lower in the derivation. Since B is the left daughter of A, the encodings of their terminal strings have a shared B(eginning).

(16)

$$\begin{array}{llllll}
\text{a. } A \rightarrow & \begin{array}{c} B \\ (\downarrow \textsc{stk cat}) = C \\ (\downarrow \textsc{stk nxt}) = (\uparrow \textsc{stk}) \\ (\downarrow \textsc{b}) = (\uparrow \textsc{b}) \\ \end{array} &
\text{b. } A \rightarrow & \begin{array}{c} C \\ (\uparrow \textsc{stk cat}) = C \\ (\uparrow \textsc{stk nxt}) = (\downarrow \textsc{stk}) \\ (\uparrow \textsc{b t}) = (\downarrow \textsc{b}) \\ (\uparrow \textsc{b h}) = a \end{array} &
\text{c. } A \rightarrow & \begin{array}{c} \# \\ (\uparrow \textsc{b h}) = \# \\ \\ \\ \end{array}
\end{array}$$

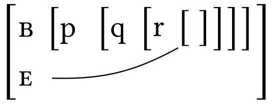
Corresponding to each terminal rule $A \rightarrow a$, for $a \neq \#$, there is a collection of rules of the form (16b), one for each right-daughter category C whose expansion may have been deferred until it reemerges at the top of the stack. The annotations pop that category from the stack while adding the terminal *a* to the front of the head-tail encoding of the terminal string under *C*. Finally, for each unary rule $A \rightarrow \#$ the string grammar contains a rule of the form (16c) to terminate the NBD derivations and install # as the final item of every string encoding. Because # is the distinguished end-of-string marker, these preterminals never appear as left daughters of binary rules and are thus always the last categories to be removed from the stack. As before, if NBD string grammars $String(G_1)$ and $String(G_2)$ are combined into an LFG grammar *G* with rule (14), then $Par_G(\#\#) \neq \emptyset$ if and only if $L(G_1) \cap L(G_2) \neq \emptyset$.

The complexity of recognition arises from the fact that, in order to assign f-structures to the strings of infinite languages, annotated c-structure grammars must include rules for recursive subderivations (rule sequences that derive a node labeled with an annotated category *A* from an *A*-labeled dominating node), and such recursive subderivations must be allowed to stack one above another. The string grammars in our undecidability proofs show that recursive subderivations can assign to a single string (#) a set of f-structures each encoding one of the strings of an infinite context-free language. Unlike the f-structures that correspond to the sentences of natural languages, those f-structures are determined only by the annotations on nonterminal categories without regard to any lexical information carried by the input string or even its length (there is no function of $|s|$ that bounds the sizes of c and f in all derivation triples).

4.3 The realization problem

We turn now to the realization problem. Also using a reduction from the emptiness of context-free intersection, Wedekind (2014) proved that realization is undecidable for unrestricted LFG grammars if there are cyclic paths in the input f-structure.[4] Whereas the emptiness and recognition demonstrations are based on head-tail string encodings, Wedekind's proof is formulated in terms of an alternative way of encoding the strings of a language, a descending chain of attributes as illustrated in (17).

(17)



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[4] Wedekind & Kaplan (2012) established that the realization problem is decidable if the input f-structure f contains no cycles. For an acyclic f-structure the string-set $Gen_G(f)$ can be described by a context-free grammar, and the emptiness problem for context-free grammars is decidable.

The beginning of the encoding for string pqr is still accessible as the value of the B attribute, but now the end is identified by the reentrant value of the top-level E attribute. Grammars that encode context-free languages in this way are created by replacing the annotations on the terminal rules (13b) with functional control annotations as in (18).

(18) $$A \rightarrow \begin{array}{c} a \\ (\uparrow \textsc{b}\ a) = (\uparrow \textsc{e}) \end{array}$$

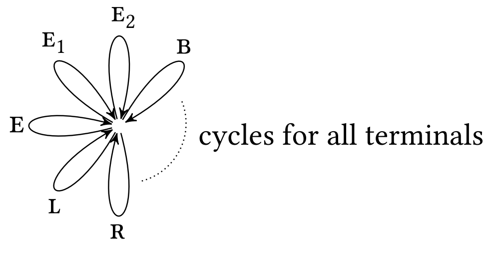
The scaffolding illustrated in Figure 3 is unchanged but the H attributes at the bottom are removed and the sequence of T attributes is replaced by the sequence of terminal-attributes.

The essence of Wedekind's (2014) proof is then captured by combining attribute-chain string-encoding grammars for arbitrary context-free grammars G_1 and G_2 into an LFG grammar G with start rule (19).

(19) $$\mathrm{S} \rightarrow \begin{array}{ccc} \mathrm{S}_1 & \mathrm{S}_2 & \# \\ (\uparrow \textsc{l}) = \downarrow & (\uparrow \textsc{r}) = \downarrow & (\uparrow \textsc{e}_1\ \textsc{e}_1) = \uparrow \\ (\downarrow \textsc{b}) = (\uparrow \textsc{b}) & (\downarrow \textsc{b}) = (\uparrow \textsc{b}) & \bigwedge (\uparrow \textsc{e}_2\ \textsc{e}_1) = (\uparrow \textsc{e}_2\ \textsc{e}_1\ x) \\ (\downarrow \textsc{e}) = (\uparrow \textsc{e}_1) & (\downarrow \textsc{e}) = (\uparrow \textsc{e}_2) & x \text{ an attribute} \end{array}$$

In the absence of atomic values there can be no atom-value clashes to exclude mismatching combinations, and the language $L(G)$ therefore contains all strings $s_1 s_2\#$ for $s_1 \in L(G_1)$ and $s_2 \in L(G_2)$. However, strings belonging to the intersection of $L(G_1)$ and $L(G_2)$ are distinguished by the fact that the end points $\textsc{e}_1$ and $\textsc{e}_2$ of their descending attribute-chain encodings are the same. In that case $(\phi(root)\ \textsc{e}_1) = (\phi(root)\ \textsc{e}_2)$ and the annotations on the terminal # entail by simple substitutions that $(\phi(root)\ x) = \phi(root)$ for all attributes x. Thus all and only strings $ss\#$ for $s \in L(G_1) \cap L(G_2)$ receive the one-element cyclic f-structure f in (20).

(20)



The realization problem is undecidable because $Gen_G(f) \neq \emptyset$ if and only if $L(G_1) \cap L(G_2) \neq \emptyset$. This shares with the recognition proof the property that infinitely many annotated c-structures of arbitrary size may have to be inspected to determine whether there is at least one that is related to a single input of a fixed size (a cyclic f-structure in this case).[5]

The undecidability results we have demonstrated here, together with other simple reductions from the emptiness problem of context-free intersection, can be used to show that other properties of the unrestricted LFG formalism are also undecidable. The following is a partial list of these undecidable questions.

(21)
a. Generation from underspecified f-structures: Is there a sentence that realizes an f-structure with more features than a given one? (Wedekind 1999)
b. Ambiguity-preserving generation: Is there a single string that realizes two different f-structures? (Wedekind & Kaplan 1996)
c. Finite versus infinite ambiguity: Is any string in the language infinitely ambiguous? (Jaeger et al. 2005)
d. Ranking in Optimality-theoretic LFG: Can an optimal derivation always be identified? (Kuhn 2003)
e. Economy of Expression: Can the smallest c-structure for a given f-structure be identified?[6]

Appendix A includes simple proofs showing that a number of more specific questions are also undecidable. Additional restrictions are clearly necessary to provide a linguistic formalism that is mathematically manageable.

5 Conservation and decidability

The recognition and realization problems are undecidable for unrestricted LFG grammars because there is no finite number of (size-bounded) annotated c-structures whose inspection is sufficient to determine whether there is a valid derivation for a given input string/f-structure. As a consequence, there is no systematic relationship between the length of a string and the sizes of its f-structure parses or the size of an f-structure and the lengths of its generated strings. Moreover, a grammar can assign infinitely many f-structures to a single string and

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[5] Cyclic f-structures have been proposed in the analysis of complex adjunction and coordination constructions (Zweigenbaum 1988, Fang & Sells 2007, Haug & Nikitina 2012, Przepiórkowski & Patejuk 2012) and thus cannot be excluded from the LFG formalism. More to the point, example (52b) in the Appendix A shows that it is undecidable whether an arbitrary LFG grammar produces cyclic f-structures.

[6] This follows from the fact that realization is undecidable in the general case (as just sketched): if it cannot be decided whether there are any c-structures at all for an f-structure input, then the smallest such structure cannot be determined.

infinitely many strings to a single f-structure. These properties seem implausible for language as a medium of communication.

From a broader perspective, these excesses can be cast in terms of the “grammatical mapping problem”, the problem of characterizing in an explanatory and computable way the relation Γ between the sentences of a language and representations of their meanings (presumably logical formulas that can be interpreted in a representation of the world) (Kaplan & Bresnan 1982, Kaplan 1987). If s is a sentence of a language and m represents one of its meanings (that is, $(s, m) \in \Gamma$), then pretheoretically we expect the derivational machinery that translates between s and m to be information-conserving in the following sense.

(22) *Principle of Conservation*
For all $(s, m) \in \Gamma$, $|m|$ is bounded by $|s|$ and $|s|$ is bounded by $|m|$.

The size of the meaning representation can be defined in any reasonable way. The crucial claim is that the derivational machinery does not by itself add or subtract, in either direction, arbitrary amounts of information. The additional linguistically appealing property of bidirectional finite ambiguity follows as an immediate corollary.

(23) *Finite Ambiguity*
If Γ is conservative, then each sentence expresses only a finite number of meanings and each meaning is expressed by only a finite number of sentences.

In LFG-based approaches the grammatical mapping Γ is typically conceptualized as the composition of the grammar-defined syntactic derivations Δ_G and the semantic derivations Σ that map primarily between syntactic f-structures and corresponding representations of meaning.[7]

(24) $(s, m) \in \Gamma_G$ iff $(f, m) \in \Sigma$ and $(s, c, f) \in \Delta_G$ for some c-structure c.

An end-to-end mapping $(s, m) \in \Gamma_G$ is conservative if the semantic derivation $(f, m) \in \Sigma$ has grammar-dependent bounds in both directions and is thus information-conserving, and s and f of the triple $(s, c, f) \in \Delta_G$ are also co-bounded (the syntactic derivation is also conservative). Recalling that $|s|$ and $|f|$ are both bounded by $|c|$ in any derivation triple (8), it follows that

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[7] This is not to discount the influence of linguistic features that may be formalized in other projections within the LFG correspondence architecture. The bounding requirements of the Conservation Principle would also govern mappings that include those other projections.

(25) An LFG syntactic derivation $(s, c, f) \in \Delta_G$ is *conservative* if also $|c|$ is bounded by both $|s|$ and $|f|$.

The syntactic recognition/parsing and realization/generation problems are solvable if only conservative derivations are defined to be linguistically relevant, in accordance with principle (22). In each direction only a finite number of size-limited annotated c-structures must be enumerated and inspected to determine whether a derivation belongs to Δ_G.[8]

With respect to Σ, Glue Semantics (Dalrymple et al. 1993, Dalrymple 1999) determines a meaning representation m for a string by a linear-logic deduction applied to a collection of premises associated with an f-structure f assigned to that string. The resource-sensitive nature of linear logic suggests that m will naturally be bounded by $|f|$, but that has not yet been clearly established. It is also unknown whether or under what additional conditions the f-structures that correspond to a given meaning representation m are bounded by $|m|$.[9] With the expectation that those issues will be resolved in future research, we return here to our focus on Δ_G, the syntactic component of Γ_G.

Kaplan & Bresnan (1982) were the first to show the undecidability of the recognition problem for unrestricted LFG grammars and the first to address it by imposing an information-conserving constraint on the derivations in Δ_G. Their constraint restricts the derivations of the annotated c-structure grammar so as to limit the distribution of empty nodes and nonbranching dominance chains.[10] The effect is to include as NBD-valid c-structures only those where every recursive subderivation contains at least one pair of terminal-dominating sisters. This specifically excludes the derivations that our demonstrations of recognition undecidability rely on. All NBD-valid derivations are conservative in the parsing direction, since the annotated c-structure is bounded by the length of the string, and the recognition and parsing problems are therefore solvable.

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[8] However, the emptiness problem remains undecidable even if attention is confined only to conservative derivations. All derivations for the grammars constructed with rules (13) and (14) are conservative in the sense of (25). Emptiness requires consideration of all possible string or f-structure inputs, not just particular ones that are presented for parsing or generation. By the same token, it is undecidable whether all derivations for a given grammar are conservative.

[9] Generation from an f-structure not bounded by $|m|$ can be reduced to the undecidable problem of generating from an arbitrarily underspecified f-structure (Wedekind 1999).

[10] The NBD constraint in LFG was a specific and early example of a family of what have become known generically as *Off-line Parsability* conditions. A number of variants of Off-line Parsability have been proposed for other grammatical frameworks. See Jaeger et al. 2005 for a survey.

By a symmetrical argument, syntactic derivations will be conservative in the generation direction if they are restricted so that the size of the annotated c-structure is bounded as a function of the size of the f-structure. Unfortunately, the NBD condition is not sufficient to pick out just those information-conserving derivations and thus to ensure also that the realization and generation problems are decidable (cf. Wedekind (2014), Wedekind & Kaplan (2020)). The attribute-chain string-encoding grammars and the combining start rule (19) used in the undecidability proof for realization are ϵ-free, and it is only (nonrecursive) terminal rules that do not branch. A condition stronger than the NBD restriction is needed to guarantee that generation is conservative and thus decidable.

It has also been noted, on the other hand, that the original NBD condition may be too strong. It disallows recursive nonbranching dominance chains in every context, even when an errant subderivation is a component of a discontinuous constituent supported intuitively by an element elsewhere in the string. For example, Johnson (1986) observed that it proscribes the straightforward analysis of the Dutch double infinitive construction as provided by the grammar of Bresnan et al. (1982) and illustrated in (26).

(26) (dat) hij het boek heeft kunnen lezen
(that) he the book has able read
'(that) he has been able to read the book'

Recursive applications of the nonbranching VP rule (27) would be required to match the level of the obj 'het boek' with the level of its governing predicate in the discontinuous, extended-head configuration.[11]

(27) VP → VP
(↑ xcomp) = ↓

We address these shortcomings of Kaplan and Bresnan's NBD restriction by introducing an alternative way of identifying a subclass of conservative derivations that is better attuned to the natural flow of linguistic information. It takes into

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[11] Johnson's particular example does not violate the very early refinement of the constraint wherein functional annotations are also taken into account in determining whether a category is recursive. This was introduced soon after the original formulation and later described by Kaplan & Maxwell (1996) and Dalrymple 2001. But this slightly weaker version would still disallow the intended analyses of sentences with more intransitive verbs and deeper xcomp embeddings as in

(dat) hij het boek moet haben kunnen lezen
(that) he the book must have able read
'(that) he must have been able to read the book'

account the architectural correspondence between c-structures and f-structures to impose a new bound on the size of generation c-structures while relaxing the bound in the parsing direction. Our new condition makes use of the following definitions.

Let c be an annotated c-structure and let n and n' be two distinct nodes in c with n dominating n'. The *subderivation from n to n'*, denoted by $c^{n}_{n'}$, is the derivation that we obtain from c by removing from the subderivation rooted by n the subtree under n'. Two subderivations $c^{n}_{n'}$ and $c^{\check{n}}_{\check{n}'}$ are said to be *stacked* if the bottom node of one dominates the top node of the other. A subderivation $c^{n}_{n'}$ is *recursive* if n and n' are both labeled with the same annotated category.

The admissibility of recursive subderivations is then defined in terms of f-structure and string anchors.

(28) Let c be an annotated c-structure with terminal string s and f-structure f. We say that a recursive subderivation $c^{n}_{n'}$ is

a. *f-anchored in f_k* if there is a node $\bar{n}$ of $c^{n}_{n'}$ such that $\phi(\bar{n}) = f_k$ and

b. *s-anchored in s_j* if there is a node $\bar{n}$ of $c^{n}_{n'}$ such that $\bar{n}$ or a node in $\phi^{-1} \circ \phi(\bar{n})$ dominates s_j.

We refer to f_k and s_j as the f- and s-anchors of $c^{n}_{n'}$. The subclass of properly anchored derivations is then defined as follows.

(29) A derivation $(s, c, f) \in \Delta_G$ is *properly anchored* iff

a. every recursive subderivation $c^{n}_{n'}$ of c is f- and s-anchored and

b. the f-anchors of any two recursive subderivations in a stack are distinct, and so are their s-anchors.

If (s, c, f) is a properly anchored derivation, then every recursive subderivation is anchored in both a functional unit of the f-structure and an element of the string (29a). Moreover, requirement (29b) ensures that the anchoring for stacked recursive subderivations is one-to-one. The anchoring of stacked recursive subderivations of such a c-structure is illustrated in Figure 4.

If N is the set of annotated nonterminal categories for a grammar G, any subderivation $c^{n}_{n'}$ with a path length equal to $|N|$ must be recursive. The annotated c-structures of properly anchored derivations are thus bounded by the respective sizes of their corresponding strings and f-structures, as stated in the following lemma.

(30) The depth of the c-structure c of all properly anchored derivations $(s, c, f) \in \Delta_G$ is bounded by $|N|(|s| + 1)$ and $|N|(|f| + 1)$, respectively, for a string of length $|s|$ and an f-structure of $|f|$ units.

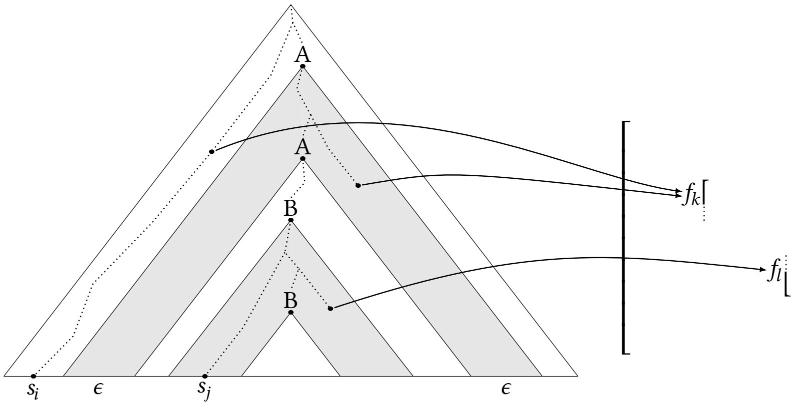

Figure 4: A c-structure with two stacked subderivations, highlighted in gray. The subderivations are f- and s-anchored at f_k, s_i and f_l, s_j, respectively, with $k \neq l$ and $i \neq j$. The upper subderivation is discontinuously string-anchored because none of its internal nodes dominates a terminal (it derives the empty string ϵ) while the lower subderivation is continuously string-anchored.

Lemma (30) implies that the properly anchored derivations for an unrestricted LFG grammar are conservative, and that the recognition and realization problems are therefore decidable if unanchored derivations are excluded from linguistic consideration. This is because only a finite number of size-bounded annotated c-structures need to be inspected in order to solve these problems.

The conditions for proper anchoring include derivations that the NBD condition does not admit and exclude derivations that NBD classifies as valid. NBD and proper anchoring, however, do agree on the status of derivations for the schematic grammars in (31).

(31) a. S → S a S → a NBD-valid
(↑ GF) = ↓ (↑ PRED) = ‘P⟨GF⟩’ (↑ PRED) = ‘A’ anchored

b. S → S S → a NBD-invalid
(↑ GF) = ↓ (↑ PRED) = ‘A’ shared s-anchor
(↑ PRED) = ‘P⟨GF⟩’

The recursive subderivations for (31a) are branching and they are thus both valid and properly string-anchored. Each subderivation is also f-anchored to a distinct unit in its f-structure's GF hierarchy. If GF is a governable grammatical function, then the f-structures of all derivations are complete and coherent and correspond to the *lexical* meanings carried by the repetitively longer strings. The grammar (31b) provides the same set of complete and coherent f-structures but associates all of them to the single one-element string. That string is infinitely ambiguous and there is no bound on the size of the constructional meaning representations determined by the recursive subderivations. These linguistically implausible subderivations are nonbranching and their string anchors cannot be distinct (29b). They are appropriately excluded as neither NBD-valid nor properly anchored.

In (32) we show grammars that provide branching derivations for every string in the set $\{a^n \mid n > 1\}$, and every derivation is thus NBD-valid but properly anchored only with respect to strings. The recursive subderivations of these grammars are excluded because they do not meet the f-anchoring conditions of (29).

(32) a. $\mathrm{S} \rightarrow \mathrm{S}\quad \mathrm{a} \qquad \mathrm{S} \rightarrow \mathrm{a}$ NBD-valid, no f-anchor

b. $\mathrm{S} \rightarrow \underset{\uparrow=\downarrow}{\mathrm{S}}\quad \mathrm{a} \qquad \mathrm{S} \rightarrow \underset{(\uparrow\ \textsc{pred})=\text{‘}\textsc{a}\text{’}}{\mathrm{a}}$ NBD-valid, shared f-anchor

The subderivations of (32a) have no f-anchors (28a) while the f-anchors for the subderivations of (32b) are not pairwise distinct (29b). The effect of the proper anchoring conditions for these configurations is consistent with other exclusionary proposals, in particular, the Different-Words version of Economy of Expression (Dalrymple et al. 2015).

As a final point of comparison, we note that the branching requirement of the NBD condition is essentially a special case of the string-anchor conditions (29) when recursive subderivations are stacked. The string anchors for valid derivations must be dominated by nodes contained within each particular subderivation. In contrast, (28b) admits stacked recursive subderivations whose distinct anchors may be dominated by nodes elsewhere in the c-structure. The linguistically significant relationship is captured in the composition $\phi^{-1}\circ\phi$. It requires only that the dominating node is an extended (co-)head of a node in a recursive subderivation, a component of the same discontinuous constituent (Zaenen & Kaplan 1995, Bresnan et al. 2016). The situation is schematized by the grammar (33).

(33) $\mathrm{S} \rightarrow \underset{\uparrow=\downarrow}{\mathrm{A}}\quad \underset{\uparrow=\downarrow}{\mathrm{P}}$ NBD-invalid, anchored

$\mathrm{A} \rightarrow \underset{(\uparrow\ \textsc{gf})=\downarrow}{\mathrm{A}} \qquad \mathrm{P} \rightarrow \underset{(\uparrow\ \textsc{gf})=\downarrow}{\mathrm{P}}\quad \underset{(\uparrow\ \textsc{pred})=\text{‘}\textsc{p}\langle\textsc{gf}\rangle\text{’}}{\mathrm{p}}$

$\mathrm{A} \rightarrow \underset{(\uparrow\ \textsc{pred})=\text{‘}\textsc{a}\text{’}}{\mathrm{a}} \qquad \mathrm{P} \rightarrow \underset{(\uparrow\ \textsc{pred})=\text{‘}\textsc{p}\langle\textsc{gf}\rangle\text{’}}{\mathrm{p}}$

The highest A and P nodes each dominate a separate stack of recursive subderivations. The subderivations of the P stack contain their distinct p string anchors, but the A stack is a nonbranching (invalid) chain over the single terminal. Because of the parallel GF function assignments, the P nodes serve as extended heads for the A nodes of the A–P discontinuous constituents, and the p terminals can thus act as distinct s-anchors for the A subderivations.[12] The number of A subderivations in each properly anchored derivation is thus bounded by the length of the p substring, and only those finitely-many derivations are made available for further filtering by the Completeness and Coherence subcategorization conditions. Derivations of this type are the basis for a natural account of the discontinuous constituents in Johnson's (1986) Dutch double infinitive examples.[13]

The proper anchoring condition (29) establishes a manageable relationship between strings and f-structures by virtue of the mediating role that recursive c-structures play in the LFG syntactic architecture. This relationship is information-conserving in the sense of (22) and (25). It crucially depends on the ϕ correspondence and the linguistically motivated notion of extended heads to correlate the depth of c-structure recursion with the sizes of strings and f-structures, as indicated by Lemma (30). The set of properly anchored derivations for a given string or f-structure is finitely enumerable. It follows that recognition and realization are decidable for that restricted subset of derivations and so are other input-specific problems as listed in (21) and in Appendix A. It is possible, for example, to identify the most economical (properly anchored) derivation for a given f-structure because there are only a finite number of candidates whose c-structures must be compared. Proper anchoring, however, is not sufficient to ensure decidability of the emptiness problem (the demonstration in Section 4.1 involves only properly anchored derivations), and other questions that require consideration of all possible string and f-structure inputs also remain undecidable.

6 Intractability of parsing and generation

The recognition/parsing, realization/generation, and other problems are decidable for the conservative, properly-anchored derivations of arbitrary LFG grammars. But the fact that the number of derivations for a given input is finite does

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[12] This arrangement of parallel function assignments gives rise to the so-called "zipper" configuration discussed below and by Maxwell & Kaplan (1996) and Kaplan & Wedekind (2020).

[13] Note also that the same verbs could be reused as anchors for a different stack of recursive subderivations, for example, in the hypothetical case that the language allows an elaboration of this construction with a ditransitive lower verb and a dislocated OBL NP. This is because pairwise distinctness (29b) applies on a per-stack basis.

not mean that it is small, and indeed the computational cost of solving these problems may be very high. We show in this section that recognition and realization are intractable in the worst case, that is, for arbitrary grammars they cannot be solved in a number of processing steps polynomial in the size of a given input. Their intractability is demonstrated by the usual technique of reducing these problems to another problem that is already known to be intractable. The technique requires that the reduction itself is computable in polynomial time so that we know that the reduction procedure does not hide the complexity of the problems of interest.

The 3-SAT problem is the problem in the NP-complete complexity class often used for polynomial-time reductions that establish the intractability of other problems. This is the problem of determining the satisfiability of a Boolean formula in conjunctive normal form where each of the conjoined clauses is a disjunction of three literals. That is, each formula is a conjunction of the form $C_1 \wedge .. \wedge C_n$, each clause C_j is a disjunction of the form $l_{j_1} \vee l_{j_2} \vee l_{j_3}$, and each literal l_{j_i} is a propositional variable p_k or a negated variable $\neg p_k$. The question is whether there is at least one way of assigning truth values to the variables that makes all the clauses be true. The three-clause formula in (34a) is a simple problem that is satisfiable under several assignments among which is the one in (34b).

(34) a. $(p_1 \vee p_2 \vee p_3) \wedge (\neg p_1 \vee \neg p_2 \vee p_3) \wedge (\neg p_1 \vee p_2 \vee \neg p_3)$
b. p_1=TRUE, p_2=FALSE, p_3=FALSE

We show that the recognition problem is intractable by providing a small LFG grammar G such that the set of f-structures $Par_G(s) \neq \emptyset$ if and only if the string s is an encoding of a satisfiable Boolean problem in conjunctive normal form. A formula is presented as a sequence of substrings one corresponding to each clause. The substring for the i^{th} clause begins with the letter c followed by the string of digits $d_1 .. d_j$ that represents the integer i. This is followed by substrings that identify the literals that make up that clause. Every occurrence of a positive literal p_k is encoded as the character + followed by the digits representing the integer k, and every occurrence of a negative literal $\neg p_k$ is represented as the character − followed by the digits for k. According to this scheme the formula (34a) is presented as the string of characters (35).[14]

(35) c1 +1+2+3 c2 −1−2+3 c3 −1+2−3

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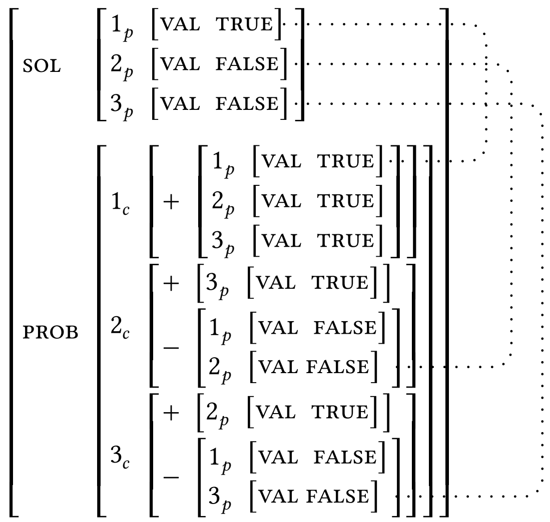
[14] We would of course see longer digit strings, not just singletons, for problems with ten or more clauses or variables.

There is a simple information-conserving LFG grammar *G* that maps a string representing any satisfiable Boolean problem into f-structures that recapitulate the problem and make explicit the truth-value assignments that solve it. The linear order of clause and literal substrings is recast into descending chains of digit attributes in the f-structure. The sequences for the signed propositional variables of all literals are attached at the bottom of the attribute chain of their containing clause, and the grouping of literals within clauses is thus maintained. The lower PROB(lem) substructure shown in (36)[15] corresponds to the problem string (35).

(36)



$$\left[\begin{array}{ll}
\textsc{sol} & \left[\begin{array}{ll} 1_p & [\textsc{val}\ \textsc{true}] \\ 2_p & [\textsc{val}\ \textsc{false}] \\ 3_p & [\textsc{val}\ \textsc{false}] \end{array}\right] \\
\textsc{prob} & \left[\begin{array}{ll}
1_c & \left[\begin{array}{ll} + & \left[\begin{array}{ll} 1_p & [\textsc{val}\ \textsc{true}] \\ 2_p & [\textsc{val}\ \textsc{true}] \\ 3_p & [\textsc{val}\ \textsc{true}] \end{array}\right] \end{array}\right] \\
2_c & \left[\begin{array}{ll} + & \left[3_p\ [\textsc{val}\ \textsc{true}]\right] \\ - & \left[\begin{array}{ll} 1_p & [\textsc{val}\ \textsc{false}] \\ 2_p & [\textsc{val}\ \textsc{false}] \end{array}\right] \end{array}\right] \\
3_c & \left[\begin{array}{ll} + & \left[2_p\ [\textsc{val}\ \textsc{true}]\right] \\ - & \left[\begin{array}{ll} 1_p & [\textsc{val}\ \textsc{false}] \\ 3_p & [\textsc{val}\ \textsc{false}] \end{array}\right] \end{array}\right]
\end{array}\right]
\end{array}\right]$$

The upper SOL(ution) substructure corresponds to the truth-value assignment (34b) that makes all clauses be true.

Let $\mathrm{S}_{\mathrm{num}}$ be the root category of a descending attribute-chain grammar for the regular language Digit^{+} of arbitrarily long digit sequences, with the scaffolding attributes B and E giving access to the top and bottom of the descending chains (as in (17) above). Then the rules in (37) provide a c-structure and an f-structure for the string encoding of every well-formed and satisfiable Boolean formula. In particular, the f-structure for one of the derivations for string (35) appears as (36) when the innocuous scaffolding attributes are not displayed.

(37) a. $\mathrm{S} \rightarrow \quad \mathrm{Clause}^{+}$

$(\uparrow \textsc{prob}) = (\downarrow \textsc{b})$

$(\uparrow \textsc{sol}) = (\downarrow \textsc{sol})$

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[15] The clause and propositional variable subscripts *c* and *p* are provided just for readability; they are not actually part of the formal structure.

b. $$\text{Clause} \rightarrow \begin{array}{ccccc} \text{c} & \text{Snum} & \text{Lit}^* & \text{Lit} & \text{Lit}^* \\ & (\uparrow \textsc{b}) = (\downarrow \textsc{b}) & (\uparrow \textsc{ce}) = \downarrow & (\uparrow \textsc{ce}) = \downarrow & (\uparrow \textsc{ce}) = \downarrow \\ & (\downarrow \textsc{e}) = (\uparrow \textsc{ce}) & & (\uparrow \textsc{sol}) = (\downarrow +) & \\ & & & (\uparrow \textsc{sol}) = (\downarrow -) & \end{array}$$

c. $$\text{Lit} \rightarrow \left\{ \begin{array}{cc|cc} + & \text{Snum} & - & \text{Snum} \\ & (\uparrow +) = (\downarrow \textsc{b}) & & (\uparrow -) = (\downarrow \textsc{b}) \\ & (\downarrow \textsc{e val}) = \textsc{true} & & (\downarrow \textsc{e val}) = \textsc{false} \end{array} \right\}$$

The start rule (37a) recognizes the conjunction of arbitrarily many clause constituents.[16] Every clause consists of one or more literals, and every literal consists of a positive or negative marking followed by the identifier of its propositional variable. The $(\uparrow \textsc{prob}) = (\downarrow \textsc{b})$ annotation promotes all the clause attribute chains to the problem substructure. The additional clause-ending scaffolding attribute ce makes it possible to connect the positive and negative literals to the bottom of their containing-clause chains. The truth-value assignments in (37c) attach the value true at the bottom of the variable chains of positive literals and false at the bottom of negative literals, thereby encoding the truth-value assignments that make each literal be true. Finally, just one of the true literals is selected to make the clause true, and the sol annotations incorporate the variable and truth-assignment of that literal (whether it happens to be positive or negative) into the global solution.

A derivation in G will succeed only if the literals chosen locally and independently for each clause result in sol truth-value assignments that are globally consistent. If a problem is unsatisfiable, then the f-description for every c-structure derivation will be inconsistent. Thus for a string s encoding an arbitrary Boolean problem, the set $Par_G(s) \neq \emptyset$ if and only if that problem is satisfiable for at least one consistent set of truth-value assignments.[17]

With this abstract formal grammar it is easy to see the potential source of computational complexity for LFG recognition. For each literal of every clause, rule (37b) produces an alternative annotated c-structure that makes a different contribution to sol. The number of properly anchored derivations that must be inspected for global consistency thus grows in the worst case as an exponential in

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[16] For succinctness and clarity we use LFG's traditional Kleene $^+$ and * notations to specify repeating category sequences rather than their right-recursive equivalents. For example, the single rule (37a) is equivalent to the two rules $\text{S} \rightarrow \begin{array}{c} \text{Clause} \\ (\uparrow \textsc{prob}) = (\downarrow \textsc{b}) \\ (\uparrow \textsc{sol}) = (\downarrow \textsc{sol}) \end{array}$ and $\text{S} \rightarrow \begin{array}{cc} \text{Clause} & \text{S} \\ (\uparrow \textsc{prob}) = (\downarrow \textsc{b}) & \uparrow = \downarrow \\ (\uparrow \textsc{sol}) = (\downarrow \textsc{sol}) & \end{array}$.

[17] Berwick (1982) provided the first NP-completeness proof for the LFG recognition problem and Stanley Peters (p.c. 1982) offered a different argument. The demonstration here uses far less of the LFG machinery than those earlier proofs and generalizes to problems with arbitrary numbers of clauses and variables.

the number of clauses. For example, there will be 3^n derivations to consider in the case of a 3-SAT problem with *n* clauses each of which has three literals. Linguistic grammars will also have this exponential complexity profile if their fixed number of rules describe morphosyntactic agreement dependencies that range over the full length of the input string. We can also see, schematically, a configuration that is sufficient to guarantee tractability while still allowing for input strings of arbitrary length. Suppose there is a constant *k* that limits the number of clauses that a single S can expand to, as in (38), but with a new starting category S′ that allows for the concatenation of an arbitrary number of *k*-limited S's.

(38) $$\mathrm{S}' \rightarrow \mathrm{S}^{+} \qquad \mathrm{S} \rightarrow \begin{array}{c}\text{Clause}^{\leq k}\\ (\uparrow \textsc{prob})=(\downarrow \textsc{b})\\ (\uparrow \textsc{sol})=(\downarrow \textsc{sol})\end{array}$$

Crucially, there are no annotations on S′ to link the f-structures of the S nodes, and thus there can be no interaction among the truth assignments of the embedded clauses. The worst case complexity for a string of *n* 3-literal clauses is proportional to $\frac{n}{k} \cdot 3^k$. This is exponential in the grammar-dependent constant *k* but polynomial in the length of the input. This foreshadows the tractability of *k*-bounded LFG grammars that we discuss in the next section.

For recognition the Boolean problem string and f-structure are organized so that the signed propositional variables are grouped within clauses, and the grammar checks for consistency of variable truth values in the global SOL structure. For the reduction of the LFG realization problem to Boolean satisfiability, the string and corresponding f-structure are transposed so that a Boolean problem is presented with its clauses grouped within its propositional variables. We again provide a small LFG grammar G' now with the property that the string set $Gen_{G'}(f) \neq \emptyset$ if and only f is the encoding of a satisfiable Boolean problem.[18] The transposed string presentation and equivalent f-structure for problem (34a) are shown in (39).

(39) a. p1 +1−2−3 p2 +1−2+3 p3 +1+2−3

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[18] See Wedekind & Kaplan (2021) for a fuller discussion of the technical issues particularly concerning the realization problem.

b.
$$\left[\begin{array}{ll}
1_p & \left[\begin{array}{ll} + & \left[1_c\right] \\ - & \left[\begin{array}{l} 2_c \\ 3_c \end{array}\right] \end{array}\right] \\
2_p & \left[\begin{array}{ll} + & \left[\begin{array}{l} 1_c \\ 3_c \end{array}\right] \\ - & \left[2_c\right] \end{array}\right] \\
3_p & \left[\begin{array}{ll} + & \left[\begin{array}{l} 1_c \\ 2_c \end{array}\right] \\ - & \left[3_c\right] \end{array}\right]
\end{array}\right]$$

The string indicates that variable 1 occurs in a positive literal in the first clause but in negative literals in the second and third clauses. The linear order of variables and clauses in the string is reflected in the f-structure's descending attribute chains. The clause identifiers are grouped according to the signed propositional variables of the literals that they contain.

The LFG grammar G' in (40) establishes the relationship between the equivalent string and f-structure expressions of any well-formed Boolean formula, whether satisfiable or not.

(40) a.
$$\begin{array}{ll}
\text{S} \rightarrow & \text{Var}^{+} \\
 & (\uparrow \textsc{prob}) = (\downarrow \textsc{b}) \\
 & (\uparrow \textsc{sol}) = (\downarrow \textsc{sol})
\end{array}$$

b.
$$\begin{array}{lllllll}
\text{Var} \rightarrow \text{p} & \text{Snum} & \{+ & \text{Snum} & \mid - & \text{Snum} & \}^{+} \\
 & (\uparrow \textsc{b}) = (\downarrow \textsc{b}) & & (\uparrow \textsc{ve}\ +) = (\downarrow \textsc{b}) & & (\uparrow \textsc{ve}\ -) = (\downarrow \textsc{b}) & \\
 & (\downarrow \textsc{e}) = (\uparrow \textsc{ve}) & & & & &
\end{array}$$

A sentence consists of a sequence of proposition-variable substrings each of which begins with a variable identifier followed by any number of digit substrings representing the clauses in which that variable appears. Each clause is prefixed with + and − to indicate whether the variable appears in a positive or negative literal. The annotations promote the variable's descending digit-chain to the top and attach the clause identifiers under the + or − attributes at the bottom of each variable chain, according to whether the clause is positively or negatively marked. This produces the f-structure displayed in (39b) (again with omission of the scaffolding attributes B/E and now VE). If f is an input f-structure for realization that expresses an arbitrary Boolean problem in this way, then the set $Gen_{G'}(f)$ includes a string of the form (39a).

Both the input f-structure and the grammar must be elaborated so that LFG realization distinguishes between satisfiable and unsatisfiable Boolean problems.

Along with the encoding of a particular problem the f-structure must specify the necessary and sufficient conditions for a solution, namely, that every clause is true under at least one consistent assignment of truth values to the variables. The input f-structure represents this requirement by attaching a value TRUE at the bottom of every clause identifier in the top-level SOL substructure and wherever the clause appears in the problem encoding under PROB. F-structure (41) is the elaboration of (39b) with this additional information.

(41)
$$\begin{bmatrix} \textsc{sol} & \begin{bmatrix} 1_c & [\textsc{val true}] \\ 2_c & [\textsc{val true}] \\ 3_c & [\textsc{val true}] \end{bmatrix} \\ \textsc{prob} & \begin{bmatrix} 1_p & \begin{bmatrix} + & \begin{bmatrix} 1_c & [\textsc{val true}] \end{bmatrix} \\ - & \begin{bmatrix} 2_c & [\textsc{val true}] \\ 3_c & [\textsc{val true}] \end{bmatrix} \end{bmatrix} \\ 2_p & \begin{bmatrix} + & \begin{bmatrix} 1_c & [\textsc{val true}] \\ 3_c & [\textsc{val true}] \end{bmatrix} \\ - & \begin{bmatrix} 2_c & [\textsc{val true}] \end{bmatrix} \end{bmatrix} \\ 3_p & \begin{bmatrix} + & \begin{bmatrix} 1_c & [\textsc{val true}] \\ 2_c & [\textsc{val true}] \end{bmatrix} \\ - & \begin{bmatrix} 3_c & [\textsc{val true}] \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

In this depiction the dotted line shows that the clause identifiers and their truth values in the solution are equated to all of their occurrences in the problem-statement substructure.

F-structure (41) is correctly assigned to the satisfiable problem string (39a) if the single Var expansion rule above is replaced by the alternatives in (42).

(42)

a.
$$\begin{array}{llllll} \text{Var} \rightarrow \text{p} & \text{Snum} & \{+ & \text{Snum} & \mid - & \text{Snum}\ \}^{+} \\ & (\uparrow \textsc{b})=(\downarrow \textsc{b}) & & (\uparrow \textsc{ve}\ +)=(\downarrow \textsc{b}) & & (\uparrow \textsc{ve}\ -)=(\downarrow \textsc{b}) \\ & (\downarrow \textsc{e})=(\uparrow \textsc{ve}) & & (\uparrow \textsc{sol})=(\downarrow \textsc{b}) & & (\uparrow \textsc{sol})=(\downarrow \textsc{b}) \\ & & & (\downarrow \textsc{e val})=\textsc{true} & & \end{array}$$

b.
$$\begin{array}{llllll} \text{Var} \rightarrow \text{p} & \text{Snum} & \{+ & \text{Snum} & \mid - & \text{Snum}\ \}^{+} \\ & (\uparrow \textsc{b})=(\downarrow \textsc{b}) & & (\uparrow \textsc{ve}\ +)=(\downarrow \textsc{b}) & & (\uparrow \textsc{ve}\ -)=(\downarrow \textsc{b}) \\ & (\downarrow \textsc{e})=(\uparrow \textsc{ve}) & & (\uparrow \textsc{sol})=(\downarrow \textsc{b}) & & (\uparrow \textsc{sol})=(\downarrow \textsc{b}) \\ & & & & & (\downarrow \textsc{e val})=\textsc{true} \end{array}$$

The SOL annotations in both versions lift all the clause identifiers, whether positive or negative, to the top-level. The rules differ in that (42a) also attaches the value TRUE only at the bottom of every positive-clause chain while (42b) attaches TRUE only to the bottom of every negative clause. Thus for every variable there is a choice in every derivation between the two expansions, corresponding to a guess of consistent truth-value assignments for every variable.

If a problem is satisfiable, then each clause will be assigned TRUE under at least one variable, that value will be carried with the clause identifier into the SOL structure, and it will propagate by equality to all of the other (positive or negative) occurrences of that clause. The result will be an f-structure configured as in (41), and the string corresponding to the problem substructure will be a realization of that f-structure.

Grammar G' will also derive annotated c-structures and f-structures for a string that represents an unsatisfiable problem, but each of those f-structures will be missing a required truth value for at least one of the clauses. For the trivially unsatisfiable problem $p_1 \wedge \neg p_1$ the input f for realization is the f-structure (43a) and (43b) is its corresponding string expression.

(43) a.
$$\begin{bmatrix} \textsc{sol} & \begin{bmatrix} 1_c & [\textsc{val true}] \\ 2_c & [\textsc{val true}] \end{bmatrix} \\ \\ \textsc{prob} & \begin{bmatrix} 1_p & \begin{bmatrix} + & \begin{bmatrix} 1_c & [\textsc{val true}] \end{bmatrix} \\ - & \begin{bmatrix} 2_c & [\textsc{val true}] \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

b. p1 +1−2

With just one variable there is only one choice between the alternative Var expansion rules, giving rise to two derivations. Assigning TRUE to the positive literal produces f-structure (44a) and (44b) results if the negative literal is selected. Neither of these is complete for all the attributes and values of (43a) and thus string (43b) (and any other string that corresponds to the problem substructure) does not belong to $Gen_{G'}(f)$.

(44) a.
$$\begin{bmatrix} \textsc{sol} & \begin{bmatrix} 1_c & [\textsc{val true}] \\ 2_c & \end{bmatrix} \\ \\ \textsc{prob} & \begin{bmatrix} 1_p & \begin{bmatrix} + & \begin{bmatrix} 1_c & [\textsc{val true}] \end{bmatrix} \\ - & \begin{bmatrix} 2_c & \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

b.
$$\begin{bmatrix} \textsc{sol} & \begin{bmatrix} 1_c & \\ 2_c & [\textsc{val true}] \end{bmatrix} \\ \\ \textsc{prob} & \begin{bmatrix} 1_p & \begin{bmatrix} + & \begin{bmatrix} 1_c & \end{bmatrix} \\ - & \begin{bmatrix} 2_c & [\textsc{val true}] \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Any Boolean satisfiability problem can thus be reduced to the realization problem for the simple LFG grammar G' if the problem is translated to an input f-structure that encodes the problem and the requirement of truth for all clauses. A derivation for G' will map a string to that f-structure if and only if the Boolean problem is satisfiable. As for recognition, realization is intractable because the number of derivations whose f-structures must be compared to the input is exponential in the size of the problem, in this case the number of variables it contains.

7 *k*-bounded LFG grammars and tractability

These intractability results for the conservative, properly anchored derivations of arbitrary grammars raise the question whether there are other formal restrictions that will guarantee that the computationally important problems of recognition and realization can be solved in polynomial time. Seki et al. 1993 first established the connection between a much more restricted subclass of LFG grammars and Linear Context-Free Rewriting Systems (LCFRS), formal systems that can describe only mildly context-sensitive dependencies and for which the recognition problem is tractable (Kallmeyer 2010). The Seki et al. *finite-copying grammars* permit rules with the very limited functional annotations in (45a) provided that all their derivations also satisfy the bounding condition (45b).

(45) a. Each category on the right-side of a rule can be annotated with at most one function assignment of the form $(\uparrow \textsc{f}) = \downarrow$ and any number of atom-value assignments only of the form $(\uparrow \textsc{a}) = \textsc{v}$.
b. There is a constant k such that no more than k nodes map to the same f-structure element f in any derivation. That is, $|\phi^{-1}(f)| \leq k$ for every f.[19]

Structure sharing in finite-copying grammars can only be achieved through instantiated function-assigning annotations. This specific type of structure sharing is occasionally referred to as "zipper" unification. That is, if two distinct nodes n_1 and n_2 map to the same f-structure in a derivation, then there must always be a node $\hat{n}$ dominating these nodes such that the sequences of function-assigning annotations on the paths from $\hat{n}$ to n_1 and n_2, respectively, must be identical, that is, form a "zipper".

The bounding condition (45b) limits the number of non-local dependencies that can arise through structure sharing and thus proscribes c-structure recursions that give rise to zippers of size greater than the constant k. Indeed, Seki et al. have shown that the recognition problem is NP-complete for grammars

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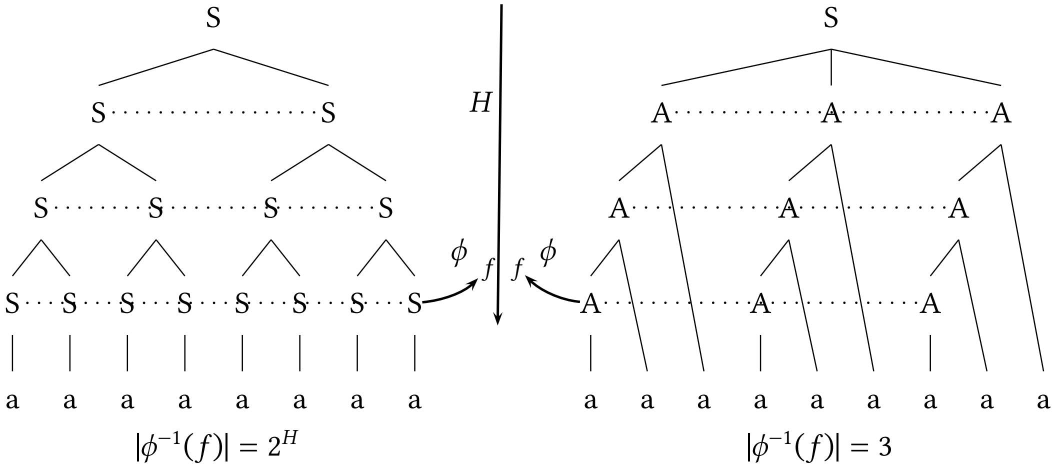
[19] This condition can also be expressed in terms of an extended-head formulation: $|\phi^{-1} \circ \phi(n)| \leq k$ for every c-structure node n. The parameter k may also be regarded as a formal characterization of the linguistic notion *degree of discontinuity* (Chomsky 1953).



a. C-structure for grammar (46a)   b. C-structure for grammar (46b)

Figure 5: Zipper nodes in depth-balanced c-structures

that meet the notational restrictions (45a) but do not satisfy the bounding condition (45b). Thus the bounding condition is crucial for tractable performance even with the severe notational restrictions of the finite-copying formalism.

Grammars with these limited annotations are expressive enough to specify the kinds of derivations depicted in Figure 5. The derivation on the left is produced by the simple recursive rules in (46a) while the one on the right is derived with the grammar (46b).

(46) a. $\text{S} \rightarrow \underset{(\uparrow \textsc{l}) = \downarrow}{\text{S}} \quad \underset{(\uparrow \textsc{l}) = \downarrow}{\text{S}}$ $\qquad$ $\text{S} \rightarrow \underset{(\uparrow \textsc{l}) = \#}{\text{a}}$

b. $\text{S} \rightarrow \underset{(\uparrow \textsc{l}) = \downarrow}{\text{A}} \quad \underset{(\uparrow \textsc{l}) = \downarrow}{\text{A}} \quad \underset{(\uparrow \textsc{l}) = \downarrow}{\text{A}}$ $\qquad$ $\text{A} \rightarrow \underset{(\uparrow \textsc{l}) = \downarrow}{\text{A}} \ \text{a}$ $\qquad$ $\text{A} \rightarrow \underset{(\uparrow \textsc{l}) = \#}{\text{a}}$

These grammars both meet the finite-copying notational restrictions (45a), and the derivations of both grammars have nodes that share structure in the zipper configurations indicated by the dotted lines. But the difference in these structure-sharing configurations corresponds to a difference in computational complexity. For all derivations of grammar (46a) the number of nodes in the set $\phi^{-1}(f)$ is an exponential in the height H of those nodes, as indicated in Figure 5a. In contrast, for all derivations of grammar (46b) the number of nodes in a structure-sharing set is bounded by a constant (3 in this case) that is independent of their height (Figure 5b). Grammar (46b) but not (46a) meets the finite-boundedness property

(45b), and this is a decidable property for all derivations of such notationally restricted grammars. Note that the string and f-structure sizes are correlated in the derivations of both grammars. They are thus not distinguished by the conditions of proper anchoring.

The restrictions (45a) are obviously too severe for linguistic description. The notation disallows, for example, the trivial ↑ = ↓ annotations that mark the heads and coheads in the functional domain of a predicate, the (↑ xcomp subj) = (↑ obj) equations of functional control, and all other ways of relating the f-structures of different nodes. They also exclude multi-attribute value specifications, such as (↑ subj num) = sg, that encode agreement requirements, and any direct specification of feature values on daughter nodes, as in (↓ case) = nom.

Wedekind & Kaplan 2020 take the Seki et al. 1993 finite-copying grammars as the starting point for developing a subclass of LFG grammars that are more suitable for linguistic description but are similarly limited in their expressive power. The *k-bounded* LFG grammars of Wedekind and Kaplan allow the richer set of annotations in (47).

(47)

Basic annotations	
↑ = ↓	(co)head identifier
(↑ f) = ↓	function assignment
(↑/↓ a b c ⋯) = v	general atom-value assignments
Reentrancies	
(↑ f) = (↑ h)	local-topic link
(↓ g) = (↑ h)	daughter-mother control
(↓ g) = (↓ h)	daughter sharing
(↓ g) = ↑	promotion
(↑ f) = ↑	mother cycle
(↓ g) = ↓	daughter cycle
(↑ f g) = (↑ h)	functional control

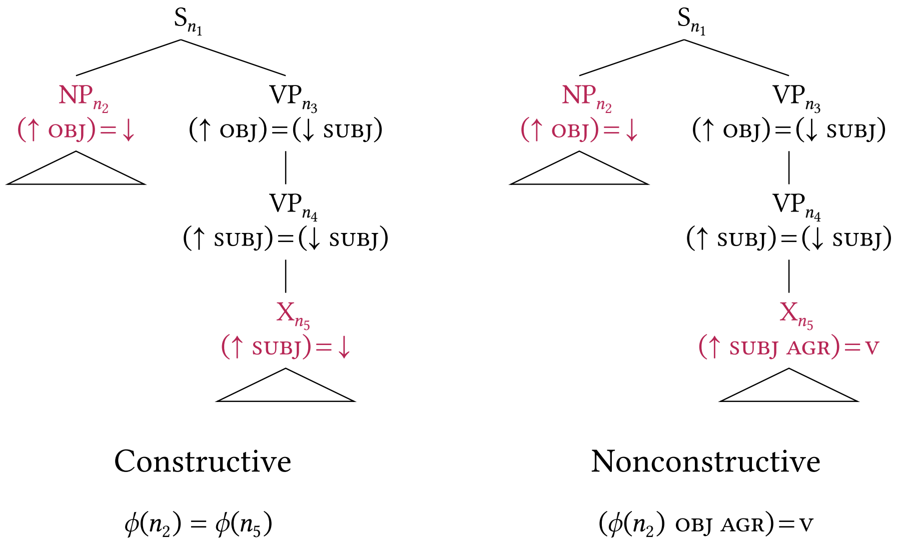
The annotations in this enlarged set include those that are commonly used in natural language grammars and that remain compatible with theoretical conventions such as the Principle of Functional Locality (Kaplan & Bresnan 1982). In *k*-bounded grammars these more flexible annotations are accompanied with additional conditions that also limit the number of non-local dependences that can arise through structure sharing. The *k*-bounded LFG grammars thus enjoy the same mathematical and computational properties that Seki et. al identified: They characterize only mildly context sensitive languages for which recognition is tractable. The additional conditions that a *k*-bounded grammar *G* must meet are listed in (48).

(48)
a. Each right-side category is annotated with at most one function assignment ($(\uparrow \text{F}) = \downarrow$), and (co)head identifiers $\uparrow = \downarrow$ and function assignments always appear in complementary distribution (to keep separate the properties of heads and their complements).
b. The *functional domains* of G (the collections of $\uparrow = \downarrow$-annotated nodes that map to the same f-structure) are bounded by a grammar-dependent constant h (so G can be converted to an equivalent grammar $G^{\backslash\uparrow=\downarrow}$ that is free of $\uparrow = \downarrow$ annotations).
c. The derivations of the grammar formed by removing all reentrancies from $G^{\backslash\uparrow=\downarrow}$ are bounded by a grammar-dependent constant k, as in (45b). (Wedekind & Kaplan 2020 call this the *reentrancy-free kernel* of G.)
d. Reentrancies are nonconstructive.

Nonconstructivity is an implicit property of derivations in broad coverage LFG grammars that has been mentioned (but not well formalize) in the LFG literature as a requirement for functional uncertainty and off-path constraints (Crouch et al. 2011, Zaenen & Kaplan 1995) (Dalrymple et al. 1995: page 133). The reentrancies of a grammar are nonconstructive if they cannot extend the ϕ mapping from c-structure nodes to f-structure units beyond the correspondences established by simple function assignments (the zipper-forming annotations of finite-copying grammars).

The difference between constructive and nonconstructive reentrancies is illustrated in Figure 6. On the left side the reentrancies are constructive because they cause the nodes n_2 and n_5 to map to the same f-structure element. If reentrancies are nonconstructive, as in the derivation on the right side, they do not introduce node-to-f-structure mappings that are not entailed by function assignments alone, and thus they do not affect the bounds that function assignments establish on the ϕ^{-1} node classes. Nonconstructive reentrancies only propagate the limited atom-value information that the grammar attaches to individual nodes and not the unregulated amount of information that might be associated recursively with entire subtrees.

Wedekind & Kaplan 2020 have shown that the nonconstructivity condition (48d) is decidable if the ϕ^{-1} node classes of a grammar are k-bounded and if any two-attribute functional control annotations can be reduced to shorter ones (e.g. shrinking $(\uparrow \text{XCOMP SUBJ}) = (\uparrow \text{OBJ})$ to $(\downarrow \text{SUBJ}) = (\uparrow \text{OBJ})$ when conjoined with $(\uparrow \text{XCOMP}) = \downarrow$). While it is undecidable in general whether every functional control annotation can be shortened (see example (52c) in Appendix A), they can



Constructive

$\phi(n_2) = \phi(n_5)$

Nonconstructive

$(\phi(n_2)\ \textsc{obj agr}) = \textsc{v}$

Figure 6: Constructive and nonconstructive reentrancies.

always be reduced to daughter-mother controls in derivations that meet the requirements of the Coherence Condition. Wedekind & Kaplan 2020 provide a formal specification of nonconstructivity, this expected consequence of Coherence, and other technical requirements that are sufficient to decide whether an arbitrary LFG grammar belongs to the k-bounded subclass and therefore describes only mildly context-sensitive languages.

Wedekind & Kaplan 2020 also prove that for any LFG grammar G with the properties defined in (47) and (48) there is a linear context free rewriting system that accepts all and only the strings in $L(G)$ and allows recovery of the f-structures that G assigns to each such string. The tractability of LCFRS recognition thus establishes for k-bounded LFG grammars that recognition of individual input strings can be accomplished in time polynomial in their length. Here we sketch a simpler demonstration that is framed entirely within the LFG formalism. This is based on a line of argument that Lang 1994 and others have developed for the recognition problem of context-free grammars.

On this approach to context-free recognition the solution is partitioned into two phases. Given an input string s and an arbitrary context-free grammar G with $|G|$ rules, the first step is to specialize G to a context-free grammar G_s with the property that $s \in L(G)$ if and only if $L(G_s) \neq \emptyset$. The second step then is to determine whether or not the language $L(G_s)$ is empty. In the context-free case the procedure for specializing G to s and the size of the resulting grammar are both polynomial in the length of the input, and for context-free grammars the emptiness problem is bounded by a polynomial in grammar size. It follows on this particular argument (among many others) that context-free recognition is bounded by a polynomial in $|s|$.

This two-part strategy immediately carries over to LFG recognition. The specialization of an arbitrary LFG grammar G to a given input s can be extracted from the chart data structures provided by any number of context-free parsing algorithms modified to keep track of the annotations of matching c-structure categories (equivalently, to operate unmodified on left-side annotated rules as in (6) above). This is a polynomial process that results in an annotated LFG grammar G_s of size also polynomial in $|s|$ that assigns to s all and only the f-structures that G assigns to s. In particular, $Par_G(s) = \emptyset$ if and only if $Par_{G_s}(s) = \emptyset$, and this is equivalent to the question whether $L(G_s) = \emptyset$.

We noted above that the emptiness problem for arbitrary LFG grammars remains undecidable even if only properly anchored derivations are taken into account. However, if G belongs to the subclass of k-bounded grammars then so does G_s, and the emptiness problem for arbitrary k-bounded grammars is not only decidable but solvable with worst-case complexity that is polynomial in grammar size. A proof of this property is outlined in Appendix B. Thus, following the context-free argument, for any input string s and k-bounded LFG grammar G, in time polynomial in $|s|$ it can be determined whether $s \in L(G)$.

Wedekind & Kaplan 2012 applied a similar two-phase strategy to prove that the realization problem is decidable for an arbitrary LFG grammar G and an arbitrary acyclic input f-structure f (see also Kaplan & Wedekind (2000)). They specialized G to a grammar G_f with the property that the string-set $Gen_G(f) = \emptyset$ if and only if $L(G_f) = \emptyset$. The grammar G_f is context-free and its emptiness is therefore decidable. In the general case the specialization phase is not tractable and the resulting G_f may be exponentially larger than G. If G is k-bounded, however, the consistency and completeness of all LFG derivations for any f, even cyclic ones, can be simulated with an annotation-free polynomial expansion of the categories and rules of G.

Thus the recognition and realization problems for k-bounded grammars can be solved in polynomial time: for arbitrary inputs it can be determined whether the sets $Par_G(s)$ and $Gen_G(f)$ are empty. But the k-bounded restrictions are not sufficient to guarantee that those sets contain only a finite number of elements. The context-free grammar G_f, for example, can describe a language with arbitrarily long strings, if G allows for unlimited morphological markers in subtrees with nodes that are not in the domain of the ϕ projection. And the f-structures for a given string can also be arbitrarily large, if the grammar permits stacked recursive subderivations. If useless rules are removed from G_f and if annotations are carried along in the grammar G_s^* as described in Appendix B, then the generation algorithm for context free grammars can be used to enumerate the elements of $Gen_G(f)$ and $Par_G(s)$, one after the other and each in linear time. But obviously the generation and parsing enumerations will never terminate in the face of infinite ambiguity. The derivations for a k-bounded grammar are not necessarily conservative in the sense of (25), even though the emptiness tests for recognition and realization have tractable solutions.

The proper-anchoring/conservation and k-bounded restrictions target different sources of mathematical and computational complexity. Proper anchoring limits the height of recursive subderivations in a stack but imposes no constraint on the number of stacks in a single derivation. The k-bounded restrictions limit the degree of discontinuity but say nothing to relate the sizes of strings and f-structures. The combination of constraints provides for conservative, finitely-ambiguous, derivations with tractable recognition and realization. We have suggested above that conservation is a plausible pretheoretic property of natural communication, and we have also argued that the k-bounded patterns of information flow are compatible with other linguistic principles (Kaplan & Wedekind 2019, Wedekind & Kaplan 2020). The k-bounded restrictions (47-48) and the proper anchoring condition (29) are different ways of moderating the excessive mathematical and computational power of the basic LFG formalism while preserving in different ways its suitability for linguistic description.

8 Summary

Lexical-Functional Grammar is equipped with a simple architecture that formalizes a piecewise correspondence between structures of different types, the phrase-structure trees of the constituent structure and the attribute-value matrices of the functional structure. We have shown that f-structure encodings of the strings of arbitrary context-free grammars can be produced by straightforward application of the formalism's most primitive annotations. From that it follows that recognition/parsing, realization/generation, and other mathematical and computational questions are easily proved to be undecidable.

One source of this excessive power, at least for the recognition and realization problems, is the fact that an unrestricted grammar may establish no systematic relationship between the sizes of input strings and the sizes of corresponding f-structures. This is inconsistent with the Principle of Conservation (22) that we suggest is a pretheoretic property of language as a medium of communication: the derivational machinery that maps in both directions between strings and their f-structures does not add or subtract arbitrary amounts of information.

Problems that relate to specific inputs, including recognition/parsing and realization/generation, become decidable if unconservative derivations are excluded from consideration.

The annotated c-structure is the generative component of the LFG formalism and serves as the intermediary between strings and f-structures. Thus we have proposed a condition on recursive c-structure subderivations that ensures that strings and f-structures stand in a conservative relationship. A derivation is properly anchored if each recursive subderivation is anchored in elements of both the string and f-structure and recursive subderivations in a stack do not share the same anchors. For parsing this condition improves on the original prohibition of derivations with nonbranching dominance chains but applies to the generation problem as well.

The proper anchoring condition is strong enough to ensure decidability but we show that it is not strong enough to guarantee tractability. Tractability for recognition and realization is the computationally important property of the k-bounded LFG grammars and derivations. These grammars are in the class of mildly context-sensitive grammars, even though their derivations are not necessarily conservative. The subclass of LFG grammars and derivations that meet the conditions of both proper anchoring and k-boundedness has attractive mathematical and computational properties and may serve as a better foundation for a formal theory of natural language syntax.

Appendix A: Other undecidable questions

In Section 4 we used the descending attribute-chain string encoding (17) for arbitrary Chomsky Normal Form context-free grammars to prove the undecidability of the realization problem. We apply that same encoding here to show that several more specific properties are undecidable for unrestricted LFG grammars. The start rule (49) follows the pattern laid out earlier in (19). It denotes the ends of the S_1 and S_2 substrings as E_1 and E_2 respectively and includes a place-holder P for grammatical fragments that we will use to encode other decision problems. As noted before, there are no atomic values and therefore no atom-value clashes in the attribute-chain string encodings, and the set of derivations can only be filtered by properties spelled out in P.

(49)
$$\begin{array}{llccc}
\mathrm{S} & \rightarrow & \mathrm{S}_1 & \mathrm{S}_2 & P \\
 & & (\uparrow \textsc{l}) = \downarrow & (\uparrow \textsc{r}) = \downarrow & \\
 & & (\downarrow \textsc{b}) = (\uparrow \textsc{b}) & (\downarrow \textsc{b}) = (\uparrow \textsc{b}) & \\
 & & (\downarrow \textsc{e}) = (\uparrow \textsc{e}_1) & (\downarrow \textsc{e}) = (\uparrow \textsc{e}_2) &
\end{array}$$

If any realization of P expresses a particular property that is satisfied only if $F(G)$ contains f-structures with equal E_1 and E_2 values, then that property must be undecidable.

As a first example, the alternative annotations on the terminal # in (50) shows that it is undecidable whether a minimal model satisfies either defining or constraining equalities between two f-structure units.

(50)
$$\mathrm{S} \rightarrow \quad \begin{array}[t]{c} \mathrm{S}_1 \\ (\uparrow \textsc{l}) = \downarrow \\ (\downarrow \textsc{b}) = (\uparrow \textsc{b}) \\ (\downarrow \textsc{e}) = (\uparrow \textsc{e}_1) \end{array} \quad \begin{array}[t]{c} \mathrm{S}_2 \\ (\uparrow \textsc{r}) = \downarrow \\ (\downarrow \textsc{b}) = (\uparrow \textsc{b}) \\ (\downarrow \textsc{e}) = (\uparrow \textsc{e}_2) \end{array} \quad \begin{array}[t]{c} \# \\ \left\{ \begin{array}{c} (\uparrow \textsc{e}_1) = (\uparrow \textsc{e}_2) \\ (\uparrow \textsc{e}_1) =_c (\uparrow \textsc{e}_2) \\ (\uparrow \textsc{e}_1) \neq (\uparrow \textsc{e}_2) \end{array} \right\} \end{array}$$

The function assignments on X and Y in (51) show that it is in general undecidable whether there are derivations with nodes that ϕ maps to the same f-structure.

(51)
$$\mathrm{S} \rightarrow \quad \begin{array}[t]{c} \mathrm{S}_1 \\ (\uparrow \textsc{l}) = \downarrow \\ (\downarrow \textsc{b}) = (\uparrow \textsc{b}) \\ (\downarrow \textsc{e}) = (\uparrow \textsc{e}_1) \end{array} \quad \begin{array}[t]{c} \mathrm{S}_2 \\ (\uparrow \textsc{r}) = \downarrow \\ (\downarrow \textsc{b}) = (\uparrow \textsc{b}) \\ (\downarrow \textsc{e}) = (\uparrow \textsc{e}_2) \end{array} \quad \begin{array}[t]{c} \mathrm{X} \\ (\uparrow \textsc{e}_1) = \downarrow \\ (\uparrow \textsc{e}_1) = (\uparrow \textsc{e}_2) \end{array} \quad \begin{array}[t]{c} \mathrm{Y} \\ (\uparrow \textsc{e}_2) = \downarrow \end{array}$$

It follows from this that any other property that depends on nodes mapping to the same f-structure is also undecidable.

Thus, expanding the nonterminals X and Y with the rules (52a) shows that the satisfiability of existential constraints or constraints between atomic values is undecidable and, as a consequence, that Completeness and Coherence are also undecidable. The annotations (52b) establish that it is undecidable whether an arbitrary LFG grammar gives rise to cyclic f-structures, and (52c) shows that functional control annotations cannot decidably be reduced to combinations of function assignments and daughter-mother controls.

(52) a.
$$\mathrm{X} \rightarrow \begin{array}[t]{c} x \\ (\uparrow \textsc{f}) = \textsc{v} \end{array} \qquad \mathrm{Y} \rightarrow \begin{array}[t]{c} y \\ \left\{ \begin{array}{c} (\uparrow \textsc{f}) \\ \neg(\uparrow \textsc{f}) \\ (\uparrow \textsc{f}) =_c \textsc{v} \\ (\uparrow \textsc{f}) \neq \textsc{v} \end{array} \right\} \end{array}$$

b.
$$\mathrm{X} \rightarrow \begin{array}[t]{c} x \\ (\uparrow \textsc{f g}) = (\uparrow \textsc{h}) \end{array} \qquad \mathrm{Y} \rightarrow \begin{array}[t]{c} y \\ (\uparrow \textsc{f}) = (\uparrow \textsc{h}) \end{array}$$

c.
$$\mathrm{X} \rightarrow \begin{array}[t]{c} x \\ (\uparrow \textsc{f g}) = (\uparrow \textsc{h}) \end{array} \qquad \mathrm{Y} \rightarrow \begin{array}[t]{c} y \\ (\uparrow \textsc{f}) = \downarrow \end{array}$$

Appendix B: Emptiness of k-bounded LFG grammars

We sketch here the proof that the complexity of the emptiness problem for an arbitrary k-bounded LFG grammar G is polynomial in $|G|$, the size of its rule set. The argument makes use of the three grammar transformations listed in (53). Each of these can be carried out in polynomial time, as indicated below, and each guarantees that G and the transformed grammar G' are *co-empty*, that is, that the set of derivations $\Delta_G = \emptyset$ if and only $\Delta_{G'} = \emptyset$.

(53)
a. $\uparrow = \downarrow$ removal: For any k-bounded LFG grammar G there is a co-empty $\uparrow = \downarrow$-free k-bounded grammar $G^{\backslash\uparrow=\downarrow}$.
b. Zipper removal: For any $\uparrow = \downarrow$-free k-bound LFG grammar G there is a co-empty 1-bounded (zipper-free) LFG grammar G^{z}.[20]
c. Annotation removal: For any 1-bounded LFG grammar G there is a co-empty annotation-free grammar G^{a}, and G^{a} is context-free.

Applying these transformations in sequence to an arbitrary k-bounded LFG grammar G results in a co-empty context free grammar $G^{*} = G^{\backslash\uparrow=\downarrow,z,a}$ whose size $|G^{*}|$ is a polynomial function of $|G|$. The string-set $L(G) = \emptyset$ if and only if the context free language $L(G^{*}) = \emptyset$, and this can be determined by the well-known emptiness algorithm for context free grammars, which is polynomial in the size of the grammar.

For (53a), the $\uparrow = \downarrow$ annotations in an arbitrary k-bounded grammar G are eliminated by replacing each $\uparrow = \downarrow$-annotated category in one rule with the right-side of each of the rules that expand that category. Let R be the smallest set that includes the rules of G and is closed under the convention (54). In this template δ, θ, and ψ are strings of annotated categories, and α may be a set of annotations with $\uparrow$ substituted for $\downarrow$.

(54) If R contains rules of the form

$$\mathrm{A} \rightarrow \delta \underset{\alpha}{\underset{\uparrow=\downarrow}{\mathrm{B}}} \theta \quad \text{and} \quad \mathrm{B} \rightarrow \psi$$

then R also contains the rule $\mathrm{A} \rightarrow \delta \underset{\alpha}{\psi} \theta$

The $\uparrow = \downarrow$-free grammar $G^{\backslash\uparrow=\downarrow}$ is constructed by removing from R any rules with $\uparrow = \downarrow$ annotations. Note that a replacement sequence can never be longer than the

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[20] Unlike the transformations that are often used in proofs of other formal-language properties, zipper removal does not preserve the language $L(G)$: the grammars G and G' generally are not weakly equivalent.

limit on the number of nodes in a functional domain, the parameter h of condition (48b). As a consequence, the growth of the grammar is bounded by a polynomial in $|G|$. Moreover, the resulting grammar $G^{\backslash\uparrow=\downarrow}$ accepts exactly the same strings as G and assigns them the same f-structures, although with c-structures that are not as deep.

For (53b), the rules of a zipper-free 1-bounded grammar are created from sets of up to k rules of a $\uparrow=\downarrow$-free k-bounded grammar G. The zipper daughters, occurrences of right-side categories with the same function assignments, are replaced with a single new daughter labeled by the concatenation (notated with $\cdot$) of the labels of the zipper daughters and annotated with the union of the zipper-daughter annotations. Let R now be the smallest set that includes the rules of a $\uparrow=\downarrow$-free grammar G and is closed under the following:

(55) a. If $\mathrm{A}_1 \rightarrow \delta_1,\ \ldots,\ \mathrm{A}_j \rightarrow \delta_j\quad (1 \leq j \leq k)$ are rules in R,

then R also contains the rule $\mathrm{A}_1 \cdot \ldots \cdot \mathrm{A}_j \rightarrow \delta_1 \ldots \delta_j$

b. If R contains a rule of the form

$$\begin{array}{ccccccc} \mathrm{A} & \rightarrow & \delta & \mathrm{B}_1 & \theta & \mathrm{B}_2 & \psi \\ & & & (\uparrow \text{F}){=}\downarrow & & (\uparrow \text{F}){=}\downarrow & \\ & & & \alpha_1 & & \alpha_2 & \end{array}$$

then R also contains the rule $$\begin{array}{cccc} \mathrm{A} & \rightarrow & \mathrm{B}_1 \cdot \mathrm{B}_2 & \delta\ \theta\ \psi \\ & & (\uparrow \text{F}){=}\downarrow & \\ & & \alpha_1\ \alpha_2 & \end{array}$$

The zipper-free grammar G^z is then created by removing from R any rule with multiple assignments for the same function or with annotations that are locally unsatisfiable. Local (within-rule) satisfiability of a rule with n daughters is tested by instantiating all metavariables with distinct constants $b_0, b_1, \ldots, b_n$ that stand for a putative mother node and its daughters. b_0 is substitute for $\uparrow$ in all annotations and b_i is substituted for $\downarrow$ in the annotations of the i^{th} daughter. The local f-description thus created is then solved using standard deductive-closure techniques.

The size of a zipper-free grammar G^z is exponential in k but polynomial in $|G|$, because there are at most $|G|^k$ rule combinations that must be considered. For every derivation in G of a string s with discontinuous subtrees for a particular grammatical function there is a corresponding derivation in G^z that assigns the same f-structure to a string s^z. The two strings contain the same words but not necessarily in the same order: the words are permuted so that the words of discontinuous subtrees for s are contiguous in s^z.

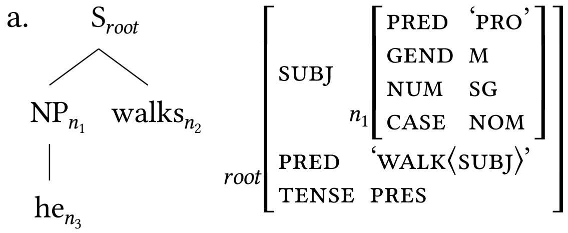
The annotation-removal transformation (53c) is based on the fact that atomic values in a 1-bounded grammar can only propagate between mothers and daughters within a single subtree. This is because, by definition, there are no nodes n and n' in separate subtrees with $\phi(n) = \phi(n')$. Atomic values in sister subtrees may have different values for a particular feature, but that can only result in an overall unsatisfiable f-description if annotation chains relative to a common mother put them in contact. Chains of atom-value annotations carried by the categories of a 1-bounded LFG derivation can be simulated by an elaborated set of refined c-structure categories in a corresponding annotation-free derivation. An annotation-free derivation is context-free and will fail if and only if the f-description for the 1-bounded LFG derivation is unsatisfiable.

The ↑ = ↓-free and zipper-free rules in (56) provide the derivation (57a) for the sentence *He walks.*

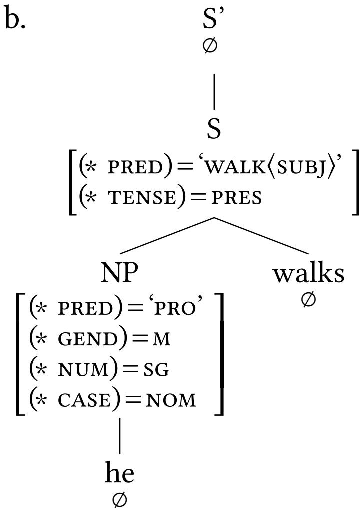
(56)	S →	NP	walks	NP →	he
		(↑ SUBJ) = ↓	(↑ PRED) = ‘WALK⟨SUBJ⟩’		(↑ PRED) = ‘PRO’
		(↓ CASE) = NOM	(↑ TENSE) = PRES		(↑ GEND) = M
			(↑ SUBJ NUM) = SG		(↑ NUM) = SG
					(↑ CASE) = NOM

The f-description is satisfiable because the case assigned to the subject NP matches the case of *he*, and the subject's number, entailed by the combination (↑ SUBJ) = ↓ and (↑ SUBJ NUM) = SG, also matches the number of *he*. The connection between the S and NP feature annotations is simulated by the refined NP category in (57b).

(57) a.



b.



Starting from a new category S’, tree (57b) is the context free derivation provided by the category-refined, annotation-free rules in (58).

(58)

$$\underset{\varnothing}{\text{S'}} \rightarrow \underset{\left[\begin{array}{l}(*\ \textsc{pred})=\text{‘}\textsc{walk}\langle\textsc{subj}\rangle\text{’}\\ (*\ \textsc{tense})=\textsc{pres}\end{array}\right]}{\text{S}}$$

$$\underset{\left[\begin{array}{l}(*\ \textsc{pred})=\text{‘}\textsc{walk}\langle\textsc{subj}\rangle\text{’}\\ (*\ \textsc{tense})=\textsc{pres}\end{array}\right]}{\text{S}} \rightarrow \underset{\left[\begin{array}{l}(*\ \textsc{pred})=\text{‘}\textsc{pro}\text{’}\\ (*\ \textsc{gend})=\textsc{m}\\ (*\ \textsc{num})=\textsc{sg}\\ (*\ \textsc{case})=\textsc{nom}\end{array}\right]}{\text{NP}} \quad \underset{\varnothing}{\text{walks}} \qquad \underset{\left[\begin{array}{l}(*\ \textsc{pred})=\text{‘}\textsc{pro}\text{’}\\ (*\ \textsc{gend})=\textsc{m}\\ (*\ \textsc{num})=\textsc{sg}\\ (*\ \textsc{case})=\textsc{nom}\end{array}\right]}{\text{NP}} \rightarrow \underset{\varnothing}{\text{he}}$$

Note that the c-structure derivation for the string *Him walks* would have an unsatisfiable f-description. The corresponding category mismatch excludes a derivation with refined categories.

For an arbitrary 1-bounded grammar G the co-empty annotation-free grammar G^a produces derivation trees whose nodes are labeled with refined categories of this form. A refined category is a pair $c{:}m$ consisting of a c-structure category label c of G together with a refinement matrix m of atom-value feature specifiers $(*\ \textsc{p q r} \ldots)=\textsc{v}$. The feature specifiers simulate in a G^a derivation the possible interactions of atomic values in the f-description of a corresponding G derivation, as illustrated. Importantly, Wedekind & Kaplan 2020 show that a finite set of specifiers is sufficient to simulate all possible atom-value interactions. These are the specifiers containing no more than ℓ of G's attributes, where ℓ is the number of attributes in the longest atom-value assignment in G.

Let N be the smallest set of refined categories and let R be the smallest set of refined rules, rules with refined-category labels, that are closed under the following conditions (see Wedekind & Kaplan 2020 for additional technical details).

(59)
a. If S is the start symbol of G and S' is a category distinct from other G categories, N contains S:∅ and S':∅ and R contains S':∅ → S:∅.
b. If *term* is a terminal symbol of G, N contains *term*:∅.
c. If r is a refinement of a rule $A_0 \rightarrow \underset{\alpha_1}{A_1} \ldots \underset{\alpha_n}{A_n}$ of G with a sequence of refined categories $A_0{:}m_0, \ldots, A_n{:}m_n$ in N, then R contains r and N contains the refined categories of r.

The refinement of a rule $A_0 \rightarrow \underset{\alpha_1}{A_1} \ldots \underset{\alpha_n}{A_n}$ of G with a sequence of refined categories $A_0{:}m_0, \ldots, A_n{:}m_n$ is produced by instantiating the ↑ and ↓ metavariables with distinct mother-daughter constants $b_0, b_1, \ldots, b_n$, as above, but also including in the local f-description atom-value equations instantiated from the feature-specifier matrices. The additional equations are created by substituting b_i for all of the asterisks in each m_i. A refined rule r is constructed if this augmented f-description is satisfiable. Each category A_i in the original G rule (including the mother category) is replaced by a refined category $A_i{:}m_i'$ where the feature specifiers of m_i' are formed by substituting * for b_i in each length-limited atom-value equation (b_i P Q R...) = V that the f-description entails. The newly refined categories are added to N.

The annotation-free grammar G^a is then constructed in the following way. S':∅ is its starting category, its terminals categories are of the form *term*:∅ for each terminal *term* of G, and its context-free rules are constructed from the refined rules in R by using standard context-free algorithms to eliminate useless rules, those that cannot participate in successful derivations, and then removing their functional annotations. The context-free derivations in G^a correspond to all and only the c-structures of G with satisfiable f-descriptions. Because the feature specifiers in a refined category are limited in length by the grammar parameter ℓ, $|G^a|$ is only polynomially larger than $|G|$ and its emptiness can be determined in polynomial time. We also note that if the annotations are not removed from the useful rules of R, the set of f-structures for a grammar with those still-annotated rules will be exactly the f-structures of G.

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Chapter 23

Computational implementations and applications

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Computational implementations of LFG are computer programs composed of LFG annotated c-structure rules and lexical entries. LFG was designed to be computationally tractable and has a strong history of broad-coverage grammar implementations for diverse languages. As with theoretical LFG, implemented grammars primarily focus on c-structure and f-structure, but the resulting f-structures are used as input to semantics and abstract knowledge representation, and some work has focused on the integration of morphological and phonological information as well as argument structure. From a theoretical linguistic perspective, implemented grammars allow the linguist to test analyses and to see interactions between different parts of the grammar. From an application perspective, applications such as machine translation and question answering take advantage of the abstract f-structures and the ability of LFG grammars to parse and generate as well as to detect (un)grammaticality.

Computational implementations of LFG are computer programs composed of LFG annotated c-structure rules and lexical entries. When parsing, they take as input a natural language sentence and output c-structures and f-structures and potentially other projections such as semantics. When generating, they take as input an f-structure and generate a grammatical natural language sentence. As with theoretical LFG, these implemented grammars obey the fundamental premises of LFG such as completeness, coherence, and uniqueness.[1] LFG was de-

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[1] This contrasts with approaches which produce f-structure-like representations but do not use LFG principles or machinery. See Section 3 and Cahill et al. 2002.

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signed from the outset to be computationally tractable and has a strong history of broad-coverage implementations for multiple languages, primarily through the ParGram project (Butt, King, et al. 1999) which is built on the XLE grammar development platform (Crouch et al. 2011).

Grammar engineering involves the implementation of linguistically-motivated grammars so that natural language utterances and text can be processed to produce deep syntactic, and sometimes semantic, structures. As with theoretical LFG, implemented grammars primarily focus on c-structure and f-structure. The resulting f-structures have been used extensively as input to semantics and abstract knowledge representation. Other work has focused on the integration of morphological and phonological information, as well as argument structure, but in general these areas have lagged behind the proposals in the theoretical literature. In addition, implemented LFG grammars have been used to create large-scale tree and dependency banks, mapping a corpus of sentences to a set of f-structures or related dependency structures.

We first introduce the computational implementations of LFG, presenting specific platforms and touching upon aspects such as core components, grammar development tools, modularity, and runtime performance (Section 1). We then discuss implications for theoretical issues (Section 2) and the ParGram grammar resources (Section 3). Finally, we outline existing and potential applications for LFG implemented grammars (Section 4).

1 Computational implementations

Computational implementations of LFG grammars focus on annotated phrase structure rules and lexical entries. These implementations concentrate on creating high-quality f-structures since most applications use f-structures as their input (Section 4). This section first introduces the major platforms that support LFG implementations. The core components provided by these platforms are then outlined, followed by some specific grammar development tools. Finally two computational notions, modularity and performance, are discussed.

1.1 Platforms

Since the inception of LFG as a grammar framework several platforms aimed at processing text according to the LFG formalism have been created. These platforms range from an M.Sc. project (Minos 2014) and introductory French implementation (Zweigenbaum 1991) to an industrially funded grammar development and processing platform which was actively developed for over two decades: the Xerox Linguistic Environment (XLE). In between those in terms of breadth of applicability and technical maturity are systems developed in academic research institutions, in particular XLFG, SxLFG, and the Free Linguistic Environment (FLE). Active development on many of these systems is limited: for current status and documentation the platform owners should be consulted.

1.1.1 XLFG and Elvex

XLFG (Clément & Kinyon 2001) is a parsing platform that was first implemented for didactic purposes.[2] It has been used to verify the soundness of several proposals to handle a variety of linguistic phenomena (Section 2), e.g. zeugmas, particle verbs, and non-constituent coordination (Clément 2019).

XLFG uses an Earley parser (Earley 1970) for context-free parsing, and then resolves the f-structure constraints on packed c-structure representations (Maxwell & Kaplan 1989, 1993). It expects tokenized sentences as input and uses full-form lexicons for lexical lookup (Section 1.2). XLFG does not facilitate the use of external components like finite-state transducers for preprocessing tasks such as tokenization or morphological analysis (Section 1.2). It has primarily been applied to parsing French and English, i.e. analyzing French or English text into f-structures. Recently, work was started on a generator, i.e. mapping f-structures to text, using XLFG-style grammars for the production of surface realizations from f-structures. This generator is named Elvex.[3]

1.1.2 SxLFG

SxLFG (Boullier & Sagot 2005) was also developed with the participation of Lionel Clément, but its main authors are Pierre Boullier and Benoît Sagot of INRIA. The primary focus of SxLFG is on the deep non-probabilistic parsing of large corpora (Sagot & Boullier 2006) by means of robustness techniques for input sentences for which no spanning c-structure can be produced. The underlying context-free parser is the Earley parser of the SYNTAX project. Like XLFG and XLE, SxLFG resolves f-structure constraints on packed c-structure representations. The French broad-coverage LFG implementation that has been used extensively with SxLFG includes a large full-form lexicon for French, the Lefff 2 (Sagot et al. 2006). Like XLFG, SxLFG does not facilitate the use of external components

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[2] XLFG is available at http://www.xlfg.org

[3] Elvex is available at https://github.com/lionelclement/Elvex

like finite-state transducers for preprocessing tasks such as tokenization or morphological analysis (Section 1.2). SxLFG was developed for parsing. Generation has not been in the scope of SxLFG.

1.1.3 XLE (and GWW as precursor) and XLE-Web

The Xerox Linguistic Environment (XLE) was developed by the Natural Language Theory and Technology (NLTT) group at the Xerox Palo Alto Research Center (PARC). It started as a reimplementation in C of the earlier Grammar Writer's Workbench (GWW) (Kaplan & Maxwell 1996), which was implemented in Lisp and is still available. XLE was used by several academic and industry teams for the development of LFG implementations for more than a dozen languages (see Section 3 on the ParGram project). XLE, in conjunction with a customized broad-coverage grammar, was used to parse the English Wikipedia in the Powerset search engine (Kaplan 2009).

XLE has mostly been used for parsing, but it includes a generator that can efficiently produce surface realizations from f-structures and even packed f-structure charts (Maxwell 2006). Thanks to this bidirectionality, it has powered applications such as machine translation and sentence condensation (Section 4), and it has been used in research projects on stochastic realization ranking (Cahill & Forst 2009).

From its inception, XLE was designed to use finite-state transducers for low-level processing steps such as (de)tokenization and morphological analysis and generation (Section 1.2). The interface can readily be used with transducers in Xerox's finite-state transducer format including ones converted from the Foma finite-state transducers, and with relatively little programming effort, other external components can be integrated into an XLE grammar (e.g. see Fang & King 2007 on integrating a non-finite state Chinese word breaker into an XLE Chinese grammar).

In addition to the ϕ-projection from c-structures to f-structures, the XLE parser supports further projections from either of those representations. One of them, the optimality structure, is hard-coded to guide the parsing and generation process on the basis of optimality marks (Section 1.5). The use of optimality marks as a robustness mechanism is one of the many extensions of XLE born out of a joint effort of the group at PARC and its ParGram partners.

Other extensions of the parser and generator are aimed at reducing latency and at ranking the (top n) parses or realizations. For the former, the most notable mechanism is c-structure pruning (Cahill et al. 2008). C-structure pruning relies on corpus data annotated with (partial) constituent bracketing and learns to eliminate highly unlikely c-structures before the computationally expensive resolution of f-annotations. For the latter, a component for training[4] and applying maximum-entropy models based on a large variety of features is provided as part of XLE (Riezler et al. 2002).

Beyond the parser and the generator, XLE also contains a term-rewriting component which was first developed for transfer-based machine translation but has been used for a number of other purposes: identifying and deleting modifiers in f-structures that can be deleted without changing the meaning of the corresponding sentences too much (Riezler et al. 2003); treebank (Rosén 2023 [this volume]) conversion from one dependency-oriented format into another (Forst 2003); further normalization of f-structures and/or construction of semantic representations (Crouch & King 2006, Bobrow et al. 2007); extraction of features for parse ranking (Forst 2007) and realization ranking (Cahill & Forst 2009).

Currently XLE is used by the academic members of the ParGram initiative (Section 3) as well as by individual researchers. It can be used online with LFG implementations for a number of languages via XLE-Web,[5] a web interface for XLE developed at the University of Bergen, and is used as part of the INESS infrastructure developed there (Rosén et al. 2009, 2012). See Rosén 2023 [this volume] for details on using INESS for parsebanking and more generally the uses of LFG parsebanks. XLE is available for non-commercial research purposes.[6] Uses beyond that require a license agreement with PARC and Xerox.

1.1.4 FLE

The Free Linguistic Environment (FLE) (Ćavar et al. 2016) aims to create an LFG-oriented grammar-development and parsing environment with a license less restrictive than XLE's. It is implemented in C++ and uses the same grammar syntax as XLE, but it is subject to the Apache 2.0 license. In addition to the context-free grammar format of XLE, it supports two probabilistic context-free grammar formats. For tokenization and morphological analysis, FLE provides an interface to Foma transducers.[7] FLE uses open-source components when possible. FLE provides basic parsing functionality but does not contain a generator capable of producing surface strings for input f-structures.[8]

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[4] Training data comprises sentences with labeled bracketing, which can be derived from treebanks or created manually (Riezler et al. 2002).

[5] XLE-Web is available at http://clarino.uib.no/iness/xle-web

[6] XLE is available at https://ling.sprachwiss.uni-konstanz.de/pages/xle/redmine.html

[7] Foma supports the import from and the export to XFST formats and XFST supports Foma transducers.

[8] FLE is available at https://gorilla.linguistlist.org/fle/

1.2 Core components

The LFG systems described above allow grammar writers to implement LFG grammars with annotated phrase structure rules and lexical entries similar to those in theoretical LFG. The main difference is that the formatting is specified with easier-to-type variants, e.g. symbols like ↑ and ↓ are replaced with ^ and !.

(1) Example theoretical and implemented annotated c-structure rules:

Theoretical notation:			Implementation (XLE system) notation:	
S ⟶	NP	VP	S -->	NP: (^ SUBJ)=!;
	(↑ SUBJ)=↓	↑=↓		VP: ^=!.

1.2.1 Preprocessing

In order to implement an LFG grammar, it is necessary to preprocess the text that the grammar will parse. Minimally the preprocessing contains a tokenizer which breaks the text into tokens (i.e. words) and canonicalizes the capitalization if necessary (e.g. lowercasing sentence initial capitalized words in English unless they are proper nouns). These canonicalized tokens are then looked up in the lexicon. Implemented lexicons are similar to their theoretical counterparts, comprising the word, its part of speech, and f-structure annotations such as PRED, CASE, and NUMBER. This information is integrated into the grammar via the annotated c-structure rules, as in theoretical LFG. Many implementations integrate a morphological analyzer which associates inflected forms of words with their lemma and morphological information. When using a morphological analyzer, the text is first tokenized and canonicalized for capitalization and then processed by the morphology. The output of the morphology (lemmata and morphological tags) are looked up in the lexicon. This simplifies the lexicon which only has to contain the lemmata and the morphological tags instead of containing all the inflected forms. These morphologies are often finite-state transducers (FSTs; Beesley & Karttunen 2003) which can be used for both parsing and generation.[9] For more details on using FSTs for preprocessing for LFG grammars see Kaplan et al. 2004 and Bögel et al. 2019, for integration of externally developed morphologies and lexicons within LFG grammars see Kaplan & Newman 1997.

A given inflected form can have multiple morphological analyses. Often all the analyses are provided as input to the LFG grammar, and the c-structure rules

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[9] Parsing goes from a string (e.g. a natural language sentence) to a c- and f-structure. Generation goes from an f-structure to a natural language string. Most theoretical LFG focuses on parsing, although some accounts, especially OT-LFG ones (see papers in Sells 2001), discuss generation.

Original text:	Dogs barked.		
Tokenization:	Dogs	barked	.
	dogs		
Morphology:	dog +Noun +Pl	bark +Verb +Past	. +Punct
	dog +Verb +3Sg		

Figure 1: Example preprocessing: Tokenization and morphological analysis

and f-structure constraints are used to eliminate analyses which are not feasible in the context of the sentence (e.g. the verbal analysis of *dogs* in figure 1). Preprocessing with a part-of-speech (PoS) tagger marks each word with its part of speech, as in (2). This information can be used to prune the morphological analyses and thus constrain the c-structure built over the sentence. Since PoS taggers are not perfect even for well-edited text, only certain tags are kept, or fall-back techniques are used when no analysis is found. See Kaplan & King 2003 and Dalrymple 2006 for more details on integrating PoS taggers into LFG and other symbolic grammars.

(2) Dogs/Noun barked/Verb and/Conj the/Det cat/Noun left/Verb ./Punct

1.2.2 Projections

Theoretical LFG posits projections beyond the original lexicon, c-structure and f-structure. The exact number and combination of these projections is a subject of lively debate (Belyaev 2023 [this volume]). These include Lexical Mapping Theory (LMT) to map between underlying argument structure and grammatical functions in the lexicon (Findlay et al. 2023 [this volume]), phonological and prosodic projections (Bögel 2023 [this volume]), semantics and semantic structure (Asudeh 2023 [this volume]), and information structure for discourse function information (Zaenen 2023 [this volume]). Most LFG implemented grammars do not include these additional projections because f-structures are sufficient for the applications they target. Even when other projections are included, they are often different from their theoretical counterparts both in their format and in how they are projected or derived. The primary additional component that is included is the semantic component. This component is based on the f-structure and is generally not a projection but instead is a separate post-processing step, although in some stages of its development the Norwegian ParGram grammar NorGram (Dyvik et al. 2016, 2019) included a semantic projection (Halvorsen 1983, Kaplan 1987, Halvorsen & Kaplan 1995) whose representations were in Minimal

Recursion Semantics (Copestake et al. 2005). Semantic components include Glue semantics (Dalrymple et al. 1993, Meßmer & Zymla 2018) and ordered rewriting rules (Crouch & King 2006). The ordered rewriting rules have been extended into abstract knowledge representations (Bobrow et al. 2007). XLE-based implementations have been created for morphological structure (Butt et al. 1996) and prosodic structure and information structure (Butt & King 1998), although none of these are used in large-scale grammars. Instead, they focus on testing theoretical hypotheses and determining the complex interactions among different grammar components (Section 2). The lack of an implementation of LMT has resulted in issues for the parsing of morphologically rich languages like Turkish and Urdu, where interactions between passive and causative constructions cannot be easily captured in LFG implementations (Section 2; Çetinoğlu et al. 2009).

1.2.3 Ambiguity

Implemented grammars often include components to handle ambiguity (see Section 1.5). There are three broad areas around managing ambiguity: computing all the analyses efficiently; representing the ambiguities compactly; resolving the ambiguity so that it does not need to be computed and represented. The first two are discussed in Kaplan & Wedekind 2023 [this volume] and Rosén 2023 [this volume]. Within the grammar writer's control are components including preprocessing by PoS taggers and named entity recognition systems, Optimality-Theory marks to prefer some constructions over others, and stochastic ranking of analyses.

1.2.4 Configuration

The determination of which components (e.g. which tokenizer, morphology, lexicons, and annotated c-structure rules) to use in an implemented grammar need to be specified in a configuration (see Crouch et al. 2011 on how this is done in XLE). These may have default values, e.g. a tokenizer which simply splits sentences at spaces and does not deal with capitalization or punctuation, but large-scale grammars require customized components for the specific language and often the type of text (e.g. newspaper text, tweets). In addition, to allow for rapid extension to specific applications which may have new vocabulary and unusual constructions, these configurations allow the grammar writer to specify lexicons and rules that add to or override those in a standard base grammar (King & Maxwell 2007). For example, to parse English academic biology papers, special lexicons of biological terms as well as special c-structure rules for section titles might be added to a grammar of standard written English.

1.3 Grammar development tools

To aid the grammar writer in managing a large-scale, broad-coverage LFG grammar, specialized variants of standard software development tools are needed. These grammar development tools are part of any LFG platform (Section 1.1). Throughout this chapter we rely on examples from XLE (Crouch et al. 2011), which is the most broadly adopted LFG grammar development framework and is used in the ParGram project (Section 3).

1.3.1 Grammar writer interface

Grammar-development tools for the creation of LFG implementations facilitate the creation of c-structure rules and lexicon entries that are annotated with LFG functional annotations. Some platforms, e.g. Xerox's Grammar Writer's Workbench and XLFG, provide special interfaces for rules and lexicon entries. Others, e.g. XLE, use editors such as Emacs or the Eclipse-based eXLEpse (Rädle et al. 2011). The interfaces provide a way to apply the rules (i.e. the grammar) to a given input string and to output a c-structure and an f-structure graph in human-readable and machine-readable formats. They also generally provide tools to help debug issues such as why a well-formed input sentence does not receive an analysis or why the analysis is incorrect.

1.3.2 Macros and templates

Since grammar engineers want to efficiently encode patterns across lexicon entries and grammar rules, some platforms support additional notations. XLE, for example, supports regular-expression macros that can expand to anything from a piece of f-annotation to an entire rule as well as f-annotation templates, e.g. to allow for like-category coordination over any c-structure category. Using a shared definition of templates across parallel LFG implementations for various languages and domains considerably facilitates the adherence to the agreed-upon f-structure conventions (King et al. 2005). For example, using a template NUMBER wherever number on nouns is assigned ensures that the same attribute (e.g. NUMB) is used and that it only needs to be changed in one place if later another name of the attribute is used (e.g. NUM instead of NUMB). See Section 2 for discussion of the role of macros and templates in theoretical LFG.

1.3.3 Feature table and feature space

In a grammar formalism with untyped attribute-value matrices such as LFG, it is not strictly necessary to declare the valid values for the attributes used in f-structures and potential other levels of representation. However, from an engineering standpoint, it is highly desirable to make sure that only valid values are used; this way, unintended deviations due to typos can be caught easily (Crouch & King 2008). This need to enforce the adherence to a set of conventions is heightened in efforts to develop parallel LFG implementations for various languages such as ParGram (Section 3). XLE therefore supports feature declarations which state all the features, i.e. attributes, and their values that are allowed in the grammar. Multiple feature declarations can be combined to check the grammar code for adherence to them. In ParGram, each grammar combines the common feature declaration with a language-specific one which adds additional language-specific features and declares which subset of values are allowed, e.g. for English the *dual* value of the NUM attribute is removed.

1.3.4 Treebanks as test suites

Treebanks, and more specifically f-structure banks (Rosén 2023 [this volume]), can be used as a form of detailed, LFG-specific test suite for the grammar's coverage. Creating the treebank highlights missing constructions and vocabulary in the grammar. The INESS-based Parsebanker (Rosén 2023 [this volume]) provides infrastructure for rapidly selecting the best parse from an XLE analysis by making use of c- and f-structure discriminants (Rosén et al. 2007). These discriminants are stored as part of the parsebanking to allow for rapid updating as the grammar evolves. The grammar is then enhanced to account for these and the treebank is reparsed with the updated grammar and the new version of the treebank is inspected. This aids both in improving coverage and in ensuring that changes to the grammar do not break constructions that were previously covered. This approach has been used extensively in the development of the Norwegian (Dyvik et al. 2016), Polish (Patejuk & Przepiórkowski 2012), and Wolof (Dione 2014) grammars.

1.3.5 Version control

Version control is used in software development to track changes to the software being developed. As with software development more generally, version control in grammar development allows the grammar writer to compare two versions of a rule, lexical entry, or any other part of the grammar, to revert to a previous version if needed, and to view conflicting changes. Version control systems also record who made a particular change, which makes it easier for multiple people to work on a grammar simultaneously by highlighting recent changes, especially conflicting ones. To our knowledge, eXLEpse (Rädle et al. 2011) is the only LFG-oriented editor that offers support for a variety of version-control systems. Since eXLEpse is based on Eclipse, all version-control plugins for Eclipse can be used. However, although XLE does not provide a version control system, most large scale grammars use a standard software version control system such as SVN or Git. In addition, regression testing by providing sentences and analyses known to be parsable by the grammar help in determining whether new versions of a grammar function properly (Chatzichrisafis et al. 2007, de Paiva & King 2008).

1.3.6 Documentation

As with any software development project, it is important to document what each part of the implemented grammar does. This takes the form of comments in the lexicon and annotated phrase structure rules, including examples of sentences which that part of the grammar can parse. Dipper 2003 designed a self-documenting grammar system whereby the comments are extracted into proper, stand-alone documentation and example test suites of constructions covered by the grammar.

1.4 Modularity and integration of systems

LFG is an inherently modular linguistic theory, with different representations and components for the lexicon, phrase (constituent) structure, functional structure, semantics, etc. This is highlighted in implemented systems which introduce two other types of modularity: modularity for the grammar components, which correlates with the linguistic modularity, and modularity within those components, which enables better grammar engineering practices. LFG implementations are software systems and hence modularity of the different components is important for developing, scaling, maintaining and debugging the system. This section describes how the modularity of the grammar components helps with grammar implementation.

A core tenet of LFG is that different parts of the grammar require different types of representations. This is echoed in the implementations where the different modules can be created by different people and use different types of technology. As with theoretical LFG, the c-structure is a tree and the f-structure an attribute-value matrix, and the two are related via annotated phrase-structure rules. These phrase-structure rules form one module of the grammar. Similarly, lexicons comprise word forms, parts-of-speech, and f-annotations. These form another module. These lexicons can be custom-created for the LFG grammar or converted from other lexical resources (Kaplan & Newman 1997, Sheil & Ørsnes 2006, Przepiórkowski et al. 2014, Patejuk & Przepiórkowski 2014). The morphological component is often implemented as a finite-state transducer (Kaplan et al. 2004, Bögel et al. 2019) but can be of any form.[10] For example, the ParGram Chinese grammar uses a combined tokenizer and part-of-speech tagger that was externally developed for non-LFG purposes (Fang & King 2007). The importance of modularity is highlighted by the treatment of semantics: there have been many implementational approaches to semantic representations based on the LFG f-structure analyses. These include projecting the semantics as an attribute-value matrix (Halvorsen 1983, Halvorsen & Kaplan 1995, Asudeh 2006, Dyvik et al. 2016, 2019), implementing Glue Semantics (Dalrymple et al. 1993, Meßmer & Zymla 2018), and using ordered rewrite rules (Crouch & King 2006). Without a modular system, this exploration of the best way to capture the semantics would be difficult.

There are three additional reasons to maintain modularity in an implemented grammar. The first is that large scale grammars often have multiple grammar writers. By having different files for the lexicon, templates, and annotated phrase structure rules, the efforts can be divided in such a way that changes can be easily merged. To further aid this, the lexicons and phrase-structure rules often comprise multiple files, e.g. the lexicon might be divided into verbs, closed-class items, and all other entries, and the phrase-structure rules might be divided into clausal and nominal. The second reason is that debugging, i.e. the process of finding and fixing errors in the grammar, is simpler in a more modular system. By having different components and different files within those components, the structure of the grammar is easier to see and the individual rules easier to locate. This debugging is further aided by the use of test suites (Chatzichrisafis et al. 2007, de Paiva & King 2008), including ones based on examples in comments in the grammar rules (Dipper 2003). Even with modularity, the inclusion of OT marks (Section 1.5) can make debugging more complex since an analysis may not surface due to competition with another analysis. A third reason is that as described in Section 1.2 and Section 1.3, in addition to a lexicon and annotated phrase structure rules, LFG implementations can have tokenizers, morphologies, templates, feature tables, etc. These are combined via configuration files that encode the different modules of the system and the way they interact.

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[10] The non-FST morphologies are referred to as library transducers in XLE.

1.5 Runtime performance

When implemented grammars are used to test linguistic hypotheses and analyses (Section 2), how quickly the grammar provides an analysis for a sentence, i.e. its latency, is generally not important. However, almost all other uses for implemented grammars (Section 4) have latency considerations. LFG implementations have provided a number of techniques to improve latency, sometimes at the cost of accuracy and coverage, e.g. certain analyses may be lost due to early elimination of possible structures (Kaplan et al. 2004). There are two main issues with runtime performance of LFG grammars: ambiguity and latency. These considerations hold for both parsing and generation; we focus on parsing here.[11]

Ambiguity concerns the multiple analyses (i.e. c- and f-structures) that are assigned to a given sentence. The ambiguity problem is accentuated when there is no semantic or pragmatic processing to guide the choice among the different analyses. The ambiguities fall into three broad categories. First, sentences can have multiple analyses, all of which are correct and equally plausible out of context, e.g. in *I saw her duck* either I saw a bird or I saw a person ducking down. Second, sentences can have correct analyses but even out of context some of them are highly improbable, e.g. in *I saw the child with the telescope* there are two plausible readings where *saw* is the past tense of the verb *see* and one implausible one where *saw* is the present tense of the verb meaning to cut with a saw, which is only plausible in a bizarre magic show. Third, ambiguities can arise when the grammar allows ungrammatical analyses, either intentionally as a fall-back mechanism or unintentionally due to an error in the implementation. Copperman & Segond 1996 provide one of the first detailed expositions of ambiguity in LFG grammars, comparing the ambiguity discussed in the theoretical linguistics literature with that in implemented grammars. King et al. 2004 discuss ambiguity in LFG grammar writing in detail, focusing on the XLE-based LFG implementations.

Language contains ambiguities at many levels, from determining word boundaries in tokenization, to morphological analysis, to syntactic attachment ambiguities, to semantic quantifier scope and beyond. This can result in thousands of analyses even for short sentences and long processing times to compute each analysis. There are two main ways to handle this ambiguity efficiently. One is to handle the ambiguity by "packing" (Maxwell & Kaplan 1989, 1993, Shemtov 1997) and operating at each level efficiently over the packed representations. Packing allows operations to apply just once to shared parts of the representation instead

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[11] See Kaplan & Wedekind 2023 [this volume] on the inherent formal and computational properties of LFG.

of enumerating all of the possibilities and processing each of them separately. For example, XLE is designed to maintain packed structures from the tokenization and morphology to the syntactic c- and f-structures and then into an ordered rule writing system that can be used to create semantic representations (Crouch & King 2006). The other way to handle ambiguity is to choose the most likely analysis at each level. For example, if there are multiple morphological analyses for a word (e.g. English *leaves*), the system can choose the most likely one given the information it has at that time (e.g. the words adjacent to *leaves* and their potential morphological analyses). This has the downside that the correct analysis may be lost due to removing information early (Dalrymple 2006).

Optimality Theory (OT) (Kuhn 2023 [this volume]) can be used to allow the grammar writer to prefer certain analyses and even to control which grammar rules are active. Frank et al. 1998, 2001 propose an extension of the classical LFG projection architecture to incorporate a constraint ranking mechanism inspired by OT. A new projection, the o-projection, specifies violable constraints, which are used to determine a “winner” among competing, alternative analyses. Many ambiguities can be filtered from the set of possible analyses for a given sentence by using this constraint ranking mechanism in the XLE system. For example, OT marks can be used to prefer verbal analyses over adjectival ones in copular clauses with passives like *They were eaten*. XLE further provides a way to cut down the search space in parsing, allowing for potentially fewer parses to search through. This is done via a special STOPPOINT feature, which is part of the Optimality Theory preference mechanism incorporated into XLE (King et al. 2000). The OT marks can be grouped with certain groups only applying if no parse is found with the original set of OT marks. That is, XLE will process the input in multiple passes, using larger and larger versions of the grammar in subsequent reparsing phases. These groupings are referred to as STOPPOINTS. STOPPOINTS are useful for eliminating ungrammatical analyses when grammatical analyses are present and for speeding up the parser by only using expensive and rare constructions when no other analysis is available. If a solution can be found with the smaller, restricted grammar, XLE will terminate with this solution. Otherwise, a reparsing phase is triggered. This approach can be used to prefer multi-word expressions, for instance so that XLE will only consider analyses that involve the individual components of the multi-word expression if there is no valid analysis involving the multi-word expression. In addition to the OT marks, c-structure pruning (Cahill et al. 2008) and part-of-speech tagging and named entity recognition (Kaplan & King 2003, Dalrymple 2006, Krasnowska-Kieraś & Patejuk 2015) can be used to eliminate unlikely c-structures before unification.

Even with the use of OT marks, a sentence may have many valid parses. However, downstream applications often expect a single analysis, i.e. a single f-structure, as input. To use LFG grammars as input to such applications, statistical methods can be used to choose the most probable analysis (Riezler et al. 2002). These stochastic models are trained on treebanks or dependency banks of known correct analyses. As a variant of this, Dalrymple 2006 and Krasnowska-Kieraś & Patejuk 2015 investigated using a stochastic part-of-speech tagger to trim potential analyses before constructing the c- and f-structure.

2 Implications for theoretical issues

LFG and HPSG (Pollard & Sag 1994 and, for an implementational perspective, Bender & Emerson 2019) are in the privileged position of having not only a community of theoretical linguists but also of grammar engineers, with significant crossover between the theoretical and grammar-engineering communities. There are four areas in which grammar engineering interacts with theoretical linguistics (King 2011, 2016). These include: using grammar engineering to confirm linguistic hypotheses; linguistic issues highlighted by grammar engineering; implementation capabilities guiding theoretical analyses; and insights into architecture issues. The positive feedback loop between theoretical and implementational efforts is a domain in which LFG and HPSG have a distinct advantage compared to many other linguistic theories, given the strong communities and resources available.

2.1 Confirming linguistic hypotheses

Grammar engineering can be used to confirm linguistic hypotheses (Bierwisch 1963, Müller 1999, Butt, Dipper, et al. 1999, Bender 2008, Bender et al. 2011, King 2011, Fokkens 2014, King 2016, Müller 2015). Encoding the hypothesis in an implemented grammar not only highlights details of the analysis that might be missed in a pencil-and-paper version but can also bring to light interesting interactions with other linguistic phenomena, especially when the hypothesized analysis is encoded in a broad-coverage grammar. Two examples of this type include the analysis of determiner agreement systems and the prosody-syntax interaction.

King & Dalrymple 2004 provide an LFG analysis of determiner agreement and noun conjunction, looking particularly at indeterminacy of agreement features. In order to test the proposed system, they implemented a toy grammar with lexical entries of each type and enough syntactic structure to encompass determiner, adjective, and verb agreement with conjoined and non-conjoined nouns. As a result, the authors were able to confirm that their analysis was formally sound and accounted for the known data. This toy grammar was relatively easy to implement in XLE because all of the necessary components, e.g. distributive features, were already available.

Implementing proposals for the prosody-syntax interaction in LFG is more challenging because not all of the mechanisms that have been proposed in the literature are available in systems like XLE. Butt & King 1998 used an existing, non-LFG analysis of Bengali clitics and implemented it in order to test whether p(rosodic)-structure could be used to capture the generalizations proposed in the theoretical analysis, focusing on where mismatches between prosodic and syntactic structure occur. A much different interface approach was pursued in Bögel et al. 2009, which built upon the finite-state transducers used for tokenization and morphological analysis within the grammars (Section 1.2). Finally, a large-scale implementation of certain phonology-syntax interactions was completed for Welsh (Mittendorf & Sadler 2006).

2.2 Implementational devices

Writing large-scale grammars highlights the interaction of different parts of the grammar and the need to be able to formally state certain types of generalizations. These needs have led to the creation of formal devices, some of which have become part of theoretical LFG analyses while others remain implementational devices. Implementation capabilities that guided theoretical analysis include the use of complex categories for auxiliary analysis in English and German, the analysis of Welsh phonology-syntax interactions through the interaction of morphological analysis via finite-state transducers and the LFG c-structure, and the introduction of templates and macros.

Complex categories (Crouch et al. 2011) are a formal c-structure device. They allow for generalizations over c-structure categories by having the category be composed of a fixed component and a variable, where the variable can pass its value to other complex categories on the right-hand side of the rule. In this way, they allow the grammar writer to capture generalizations through notation. This notation is then automatically compiled into standard c-structure rules. Complex categories are used to constrain the order and form of auxiliaries and main verbs in English (e.g. *They will have been promoted.*) by having each auxiliary state its meaning and its form (e.g. *have* is an AUX[perf,base] with perfective meaning and base form while *been* is an AUX[pass,perf] with passive meaning and pefective form) and the VP rules themselves are complex categories that reflect their head and based on that put requirements on their complement.

Welsh consonant mutations are a phenomenon whereby the initial consonant of certain words changes based on its phonological and syntactic environment (Graver 2023 [this volume]). To capture the joint requirements on the morphophonology and the syntax which trigger mutations, Mittendorf & Sadler 2006 used the finite-state morphology capabilities integrated in XLE to control where Welsh consonant mutations occur by encoding the boundary conditions in the morphological tag sequences. The modular nature of LFG combined with the implementational device of finite-state morphology provided a clean solution to the different types of triggers for the mutations.

A long standing debate in the linguistic literature, especially for constraint-based formalisms like HPSG and LFG, is whether a comprehensive and efficient grammatical theory should include a type hierarchy and what role it should play. Historically HPSG has had types as foundational to the theory while LFG has not. However, in grammar engineering, it is important to be able to efficiently capture generalizations as well as exceptions to those generalizations. The introduction of templates into the formal devices available to LFG allows for generalizations and inheritance via notation, without introducing a full type hierarchy into the formalism (Dalrymple, Kaplan & King 2004, Crouch & King 2008) and as a result, the concept of templates has become part of theoretical LFG analyses. Similar to complex categories, templates and macros allow the grammar writer to capture generalizations through notation, which is then automatically compiled into standard LFG c- and f-structure rules.

Two more minor formal devices which are gaining traction in theoretical analyses are instantiation and local variables (a third is the restriction operator discussed in the next section). Since the beginning, predicates (PRED) in LFG have not been unifiable with one another due to their unique lexical index (Kaplan & Bresnan 1982). Certain non-PRED features also need to be non-unifiable (Dalrymple 2001). This can be captured by instantiation, represented by having the value of the feature be followed by an underscore. For example, instantiating the form values of English particles blocks their occurring multiple times in a sentence (e.g. **they threw out the garbage out*) (see Figure 2 for an English example and Forst et al. 2010). Finally, local variables anchor a functional uncertainty equation to a particular f-structure and then refer to that f-structure in other annotations (Dalrymple 2001, Crouch et al. 2011). This is needed when making a set of statements about a particular element of a set or a particular type of governing element. For example Szűcs 2019 uses local variables to state constraints on topic left dislocation constructions in Hungarian.

2.3 Architectural issues

Implementing a wide variety of phenomena, as is necessary for broad-coverage grammars, brings to light architectural issues with the theory. Çetinoğlu et al. 2009 and Bögel et al. 2019 describe issues with the interaction of the passive and causative in Turkish and Urdu. These issues are the result of how lexical rules in LFG interact with complex predicate formation, where the passive is traditionally analyzed as involving a lexical rule while the causative is often analyzed as a complex predicate. The Urdu and Turkish grammars use the restriction operator (Kaplan & Wedekind 1993) in the annotated c-structure rules to model complex predication, including causatives. The restriction operator allows for features of f-structures to be restricted out, i.e. to cause the grammar to function as if these features did not exist. This allows complex predicate-argument structures to be built dynamically (Butt et al. 2003, 2010). In contrast, the passive is handled by lexical rules which apply to the predication frames in the lexicon. This predicts that passivization applies before causativization and that it is not possible to passivize a causative by demoting or suppressing the subject of the causative. However, this is the reverse of the Urdu and Turkish facts. To solve this problem in the ParGram grammars of Urdu and Turkish, both the causative and the passive are handled via restriction in the annotated phrase structure rules. In the theoretical literature, this issue had not been highlighted because for Turkish and Urdu style morphosyntax, the causative was handled in argument-structure, but the interaction between causativization and passives at the morphology-syntax interface highlighted that traditional lexical rules do not allow for the right order of application when causativization is morphological but passivization is part of the syntax.

To conclude this section, the interaction of grammar engineering and theoretical linguistics helps to confirm linguistic hypotheses, to highlight complex linguistic issues, to posit new formal capabilities, and shed light on architecture issues. The positive feedback loop between theoretical and implementational efforts is a domain in which LFG and HPSG have a distinct advantage.

3 Grammar resources: ParGram

The systems described above are used to create small- and large-scale LFG grammars. These can be used as input to applications (Section 4) or to explore theoretical hypotheses (Section 2). The Parallel Grammar (ParGram) project is a consortium of LFG researchers implementing grammars for a typologically varied set of languages in a parallel fashion (Butt, King, et al. 1999, Butt et al. 2002) using the

XLE LFG parser, generator, and grammar development platform. The parallels are most notable in the f-structure space, where common features and analyses are used wherever possible, but differ when required by the syntax of the languages. This parallelism is enabled by LFG theory, by grammar engineering components such as feature declarations, and by semi-annual meetings between the grammar writers.[12]

ParGram began with three languages: English (Riezler et al. 2002), French (Frank 1996), and German (Dipper 2003, Rohrer & Forst 2006). They developed aligned f-structure analyses for a tractor manual which existed as an aligned corpus in all three languages. Even with three closely related languages, it was clear that full f-structure alignment was not possible (Butt, Dipper, et al. 1999) due to fundamental syntactic differences in the languages. Later, the Fuji Xerox Corporate Research Group and the University of Bergen joined the initiative with a Japanese (Masuichi et al. 2003) and a Norwegian grammar (Dyvik et al. 2016, 2019) respectively. Other longer-term academic efforts participating in ParGram concern the development of Urdu (Butt & King 2002, 2007) and Polish (Patejuk & Przepiórkowski 2012) LFG implementations. Finally, further ParGram efforts have given rise to computational LFGs for Arabic (Attia 2006, 2012), Chinese (Fang & King 2007), Danish (Ørsnes 2006), Georgian (Meurer 2009), Hungarian (Laczkó & Rákosi 2008–2019), Indonesian (Arka et al. 2009, Arka 2012), Korean (Kim et al. 2003), Malagasy (Dalrymple et al. 2006), Tamil (Sarveswaran & Butt 2019), Tigrinya (Kifle 2011), Turkish (Çetinoğlu & Oflazer 2018), Welsh (Mittendorf & Sadler 2006), and Wolof (Dione 2014).

The project resulted in the creation of LFG grammars in these multiple languages and hence a greater understanding of the parallelism (or lack thereof) for the LFG analyses of particular constructions. Major issues in LFG analysis and architecture highlighted by the ParGram project included: Copular constructions and in particular whether there is a copular *be* predicate and whether the predicated argument has a subject (xcomp-like) or not (predlink) (Dalrymple, Dyvik, et al. 2004, Attia 2008); how to handle argument-changing relations such as the passive, causative, benefactives, complex predicates, and interactions thereof, including morphological and syntactic interactions (Bögel et al. 2019; see Section 2); whether auxiliaries have predicates or just supply tense and aspect features to the f-structure (Butt et al. 1996, Dyvik 1999); the interaction of tokenization and morphology with the c- and f-structures, especially around features like Welsh mutations (Mittendorf & Sadler 2006) and Urdu complex predicates (Bögel et al.

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[12] A similar approach was subsequently adopted by the HPSG DELPH-IN consortium (Bender et al. 2002).

2019). In addition, the ParGram project resulted in improvements to the grammar development platform (Section 1.2, Section 1.3 and Section 1.5) and in best practices for distributed parallel grammar development.

In addition to the traditional LFG-style ParGram grammars which use annotated phrase structure rules to create the c- and f-structure representations, the ParGram project also includes several automatically induced grammars that create ParGram compatible f-structures, i.e. f-structures using the same feature space as the grammars described above, but which are learned from tree and f-structure banks (Cahill et al. 2002). These grammars are robust in that they produce f-structures for nearly any sentence, at the cost of producing structures which sometimes violate core LFG principles such as completeness and coherence. See Section 4 for applications which require such robustness.

An influential initiative that resembles ParGram is the Universal Dependencies (UD) initiative (McDonald et al. 2013; see also Haug 2023 [this volume]). Like ParGram, it aims at parallel representations across languages, and UD follows LFG concerning many of the distinctions made at the level of syntactic dependencies and grammatical functions respectively (de Marneffe et al. 2014). This being said, surface-oriented dependency structures as used in UD cannot be as parallel as the more abstract f-structures of ParGram. Korsak 2018 and Przepiórkowski & Patejuk 2020 discuss the similarities between LFG and UD and investigate mapping between LFG f-structures and UD. Another noteworthy difference between ParGram and UD is that ParGram has been developing reversible XLE grammars whereas UD focuses solely on parsing.

4 Applications

Some applications integrating natural language processing only require parsing. For these applications, parsing should be robust to typos and grammatical errors, unusual constructions, unknown words, etc. In addition, minor issues in parsing may be unimportant for these applications because systematic errors can be compensated for within the system. Semantic search is an application that requires only parsing, needs to be robust, and can tolerate certain parsing errors.

Other applications, e.g. sentence condensation, transfer-based machine translation (MT) and conversational agents, require both parsing and generation. Applications using generation generally require highly grammatical output since users are sensitive to malformed natural language such as incorrect subject-verb agreement. Since corpus-induced grammars do not lend themselves to refinement in order to control generation, hand-crafted grammar implementations such as LFG grammars are still the means of choice for the generation of high-quality text.

Finally, there are applications that require grammaticality judgments. This is the case of grammar checkers, both general-purpose ones and grammar checkers for computer-assisted language learning (CALL). Parsers trained on general-purpose treebanks cannot be used for this purpose, so these applications are another natural fit for hand-crafted grammar implementations. In our opinion, LFG suits this purpose particularly well because its terminology is relatively close to that used in language instruction.

4.1 Applications requiring deep features and robustness

For applications that require mainly natural language understanding, parsing needs to be robust to unexpected words and constructions. To provide the robustness necessary for these applications, domain-specific grammars can be created based on a general large-scale grammar (Kim et al. 2003, King & Maxwell 2007). However, this is often not enough to cover all use cases. LFG grammars can use morphological guessers to cover unknown vocabulary (Dost & King 2009, Bögel et al. 2019), can parse fragments of the structure, e.g. provide f-structures for all the noun phrases even if they cannot be formed into a sentence (Riezler et al. 2003), and can include fall-back rules (mal-rules Schneider & McCoy 1998, Reuer 2003, Khader 2003, Fortmann & Forst 2004, Bender et al. 2004) explicitly accounting for certain types of ungrammaticality, e.g. incorrect subject-verb agreement.

Semantic search is one application which benefits from the deep LFG representations. As a search application, the goal is to find documents which are relevant to the query and, ideally, to highlight the passage in the document most relevant to the query. Semantic search moves beyond keyword matching to match the relationships between entities in the query. It can include queries that are full interrogatives as well as ones that are phrases. The ParGram XLE English grammar was used in the Powerset Inc. semantic search engine for searching Wikipedia articles. By using LFG representations for the query and the documents it can differentiate between *who acquired PeopleSoft* and *who did PeopleSoft acquire*, where PeopleSoft is the object in the first question and the subject in the second. By using a fragment grammar as a backup, longer sentences could be partially parsed, e.g. the first conjunct of a coordinated sentence could be parsed even if the second failed. This combined with the redundancy across the articles made using an LFG grammar feasible for moving beyond keyword search. The f-structures were mapped to abstract knowledge representations which went beyond grammatical functions to semantic rules, e.g. mapping *Oracle acquired PeopleSoft* and

PeopleSoft was acquired by Oracle and even *Oracle's acquisition of PeopleSoft* to the same abstract representation.

A more complex application than semantic search is question answering. Unlike search, question answering uses a document collection to find the answer to the query, which is generally in the form of a natural-language question, and present it to the user. The PARC Bridge system (Bobrow et al. 2007) used the XLE ParGram English grammar as its base and mapped the query and documents to an abstract knowledge representation using ordered rewrite rules, deep lexical resources such as WordNet (Fellbaum 1998) and VerbNet (Kipper et al. 2000, Levin 1993), and knowledge resources such as Cyc (Lenat 1995). The queries and documents were then matched against one another with a graph-based algorithm. An interesting extension of this was to perform entailment and contradiction detection (ECD) (Bobrow et al. 2007) with a graph-based module that determined whether one sentence entailed or contradicted (or neither) the other. ECD depended on understanding the roles between the entities as determined by the LFG grammar as well as detailed lexical knowledge.

Burton 2006 describes a tutorial system which uses the XLE English grammar for its language-understanding component. The tutorial system is provided by Acuitus and teaches network administration. The coursework includes a set of troubleshooting exercises where students find and fix problems. During these exercises the computer helps the students when they ask for help or based on their actions. The system asks the student a mix of multiple-choice, short-answer, and natural-language questions. The idea behind using natural-language interactions is to encourage students to think beyond what multiple-choice questions provide and to allow more complex questions and answers. The system converts the f-structures from the student input to semantic interpretations via the transfer rule system (Crouch 2006). Both the syntactic parsing and the semantics are adapted to the domain to provide more accurate and robust results.

Historically, hand-crafted LFG implementations have had a hard time competing with machine-learned constituency or dependency parsers in terms of robustness, i.e. providing a parse for all input, and speed for purely understanding-oriented applications, even though they are often superior in terms of systematicity and detail of analysis and despite the fact that machine-learned parsers often produce illogical parses for input where LFG grammars would fail to produce a parse. Because of this speed and perceived robustness, machine-learning-based dependency parsers have become increasingly popular, as is evident from the shared tasks of the Conference on Computational Natural Language Learning (CoNLL) series. Interesting though, the CoNLL tasks now often integrate UD representations (McDonald et al. 2013), which can be seen as less fine-grained f-structures (see Section 3 for more details on UD). The combination of handcrafted grammars, fall-back techniques, and statistical parser selection as described in this chapter allow LFG and other rule-based grammars to be used in applications requiring robustness (see also Ivanova et al. 2016).

4.2 Applications requiring grammaticality

Certain applications not only aim to map text to representations more amenable to the computation of meaning, but they also take abstract meaning representations, including f-structures, as input and map them to text. Among such applications are sentence condensation and transfer-based machine translation, both applications for which LFG implementations have been used because f-structures are abstract enough to facilitate transformations like the removal of certain adjuncts or the transfer from a source to a target language. Furthermore, since corpus-induced grammars do not lend themselves to refinement in order to control generation, hand-crafted grammar implementations are still the means of choice for the generation of high-quality text.

Sentence condensation is a form of summarization (Knight & Marcu 2000, Jing 2000). It takes a long sentence and produces a shorter sentence which preserves the core meaning of the original sentence. This requires the ability to identify the core part of the original sentence and to generate a grammatical shorter sentence. Riezler et al. 2003 and Crouch et al. 2004 used the ParGram XLE grammar to create a sentence condensation system for English. The LFG f-structure was used to identify the core meaning, e.g. by removing adjuncts other than negation. A new f-structure was created which contained only this core meaning. This new f-structure was then run through the grammar in the generation direction to generate the shorter, condensed sentence. This sentence was guaranteed to be grammatical since it met the well-formedness conditions of the grammar. Since multiple strings (e.g. sentences) can map to the same f-structure, more than one condensed sentence can often be generated from a single f-structure. This can be partially controlled by Optimality-Theory marks in the grammar in XLE (Frank et al. 1998). The choice between the remaining sentences can be done with a language model (Riezler et al. 2003). A related application is note taking where longer texts are condensed into legible notes (Kaplan et al. 2005).

Machine translation (MT) involves automatically translating a text from one language (the source) to another (the target). The resulting translation has to preserve the meaning and to be grammatical. LFG f-structures have been used for MT (Oepen et al. 2004, Riezler & Maxwell 2006, Avramidis & Kuhn 2009, Graham et al. 2009, Graham 2012, Graham & van Genabith 2012, Homola & Coler

2012). The idea is that the f-structure encodes the meaning of the sentence more abstractly than the surface form of the text and so can be used as the level for translation. That is, f-structure enables translation by transfer across structures and not just an interlingua across words (Kaplan et al. 1989). In theory, simply substituting the PRED values in the f-structure could produce an f-structure in the target language and the LFG grammar can then be used to generate the translation. In practice, f-structures still encode enough language-specific syntactic information that additional transfer rules need to be applied before the generation step. For example, one language may use indefinite singular determiners (e.g. English *a*) while the other may not, in which case the determiner would have to be deleted (in the source language) or inserted (in the target language). The LOGON MT project (Oepen et al. 2004) provides an interesting approach with parsing via the LFG Norwegian NorGram grammar, transfer to semantic MRS (Copestake et al. 2005) and generation via an HPSG English grammar. Although LFG-based MT systems can be brittle since there has to be a successful parse, transfer, and generation, when a translation is produced it is generally of high quality both in terms of preserving the meaning and of being grammatically well-formed.

Consider the English and German sentences in (3) and (4), for which the corresponding f-structures are displayed in Figure 2.

(3) Across the city, monuments to prosperity have sprung up.

(4) In der ganzen Stadt sind Denkmäler des Wohlstands entstanden.
in the whole city be monuments of.the prosperity up.spring
Across the city, monuments to prosperity have sprung up.

Apart from the fact that the German analysis of adjunct NPs in the genitive is not parallel to other ParGram implementations and that the German finite-state morphology decomposes the word *Wohlstand*, which gives rise to a MOD dependency under the Subj Adj-Gen, the f-structures are surprisingly parallel. (At first sight, this is obscured by the fact that in the German f-structure, the sub-f-structures under Topic and in the Adjunct set are the same.) Even though the English sentence is headed by a particle verb while the German one is not, there is a single PRED value for the head verb on either side; even though the subject of the English sentence precedes the verb while the one of the German sentence follows the verb, both appear in the respective f-structure under SUBJ; even though the auxiliary in the English sentence is *have* while the German verb *entstehen* requires the auxiliary *sein* (‘to be’) for perfect tenses, the auxiliaries contribute the same value for TNS-ASP PERF. As a result, the transfer component can concentrate on word-to-word translation equivalencies while letting the language-specific grammars take care of well-formedness conditions independent of the language pair under consideration. An example of a non-trivial translation equivalency is the one between *across the city* and *in der ganzen Stadt* (literally 'in the entire city'), as the English phrase might also correspond to *durch die Stadt* (literally 'through the city') in other contexts (especially in combination with motion verbs).

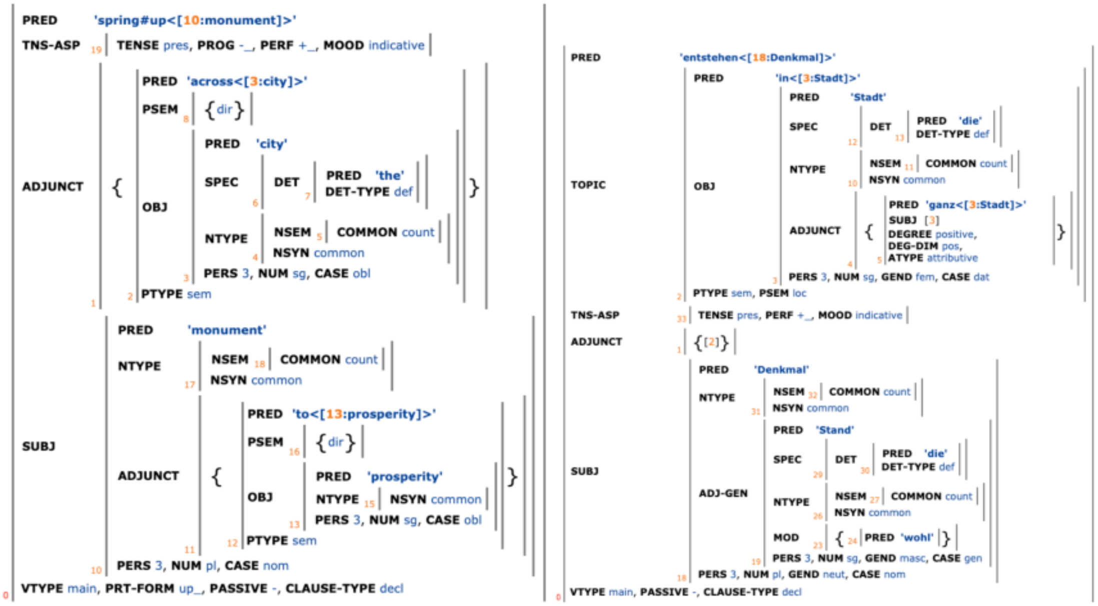

Figure 2: F-structures for English and German translation equivalents

Certain other applications do not require semantic representations or grammatical text output but do require the system to have a notion of grammaticality as their purpose is to highlight ungrammatical (or otherwise undesired) passages in text. Such systems can be directed to a general public of people producing texts or explicitly target second-language learners, sometimes even second-language learners with a specific first-language background. The latter application, in the context of Intelligent Computer-Assisted Language Learning (ICALL), has used LFG implementations, typically augmented with mal-rules (Rypa & Feuerman 1995, Reuer 2003, Khader 2003, Fortmann & Forst 2004). Mal-rules are rules or rule extensions that cover ungrammatical constructions typically produced by second-language learners, e.g. NPs where determiners or adjectives do not agree with the head noun, NPs with countable head nouns in the singular that are not preceded by a determiner, or sentences with an ungrammatical order of constituents or a violation of subject-verb agreement. As typical mistakes made by second-language learners depend significantly on their native language as well as on other languages they know, mal-rules can be optimized with respect to their coverage more easily when the linguistic background of the audience is known. A machine-learning-based approach to ICALL exploiting features provided by the English ParGram LFG implementation is described by Berend et al. 2013.

A final application we discuss is natural language understanding (NLU) components used in car computers or in personal assistants on mobile devices. Those components often combine grammar-based analysis and deep-learning-based neural networks or statistical models learned from annotated data. Moreover, machine-learning-based NLU models depend on large amounts of training data from the relevant domain. Since such data is hard to collect and costly to annotate, much of it is generated by means of grammars. For the most part, the grammars used to this end are simple, largely context-free grammars. However, as the semantic representations used for NLU become increasingly sophisticated, the use of more powerful grammar formalisms such as LFG can be used for the generation of high-quality grammatical training data.

5 Conclusion

This chapter provided an overview of computational implementations of LFG. LFG was designed from the outset to be computationally tractable and has a strong history of broad-coverage implementations for multiple languages, primarily through the ParGram project which is built on the XLE grammar development platform. As with theoretical LFG, implemented grammars primarily focus on c-structure and f-structure, but extensive work has been done on using the resulting f-structures as input to semantics and abstract knowledge representation, and some work has focused on the integration of morphological and phonological information as well as argument structure. The ParGram project is based on the theoretical LFG hypothesis that languages are more similar at f-structure, which encodes grammatical functions, than at c-structure. This f-structure similarity can then be exploited in applications such as machine translation. Other applications which take advantage of the more abstract f-structures and the ability of LFG grammars to parse and generate as well as to detect (un)grammaticality include computer-assisted language learning, question answering, and sentence condensation. From a theoretical linguistic perspective, implemented grammars allow the linguist to test analyses and to see interactions between different parts of the grammar.

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Chapter 24

Treebank-driven parsing, translation and grammar induction using LFG

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This chapter provides a summary of a range of work on probabilistic models of Lexical Functional Grammar (LFG). LFG grammars as originally conceived in Kaplan & Bresnan (1982) were defined by grammatical rules and constraints, so could not describe ill-formed strings, and they failed if confronted with well-formed strings outside their coverage. In contrast, the hybrid LFG-DOP model of Bod & Kaplan 1998 and Bod & Kaplan 2003 could generalize well-formed analyses via the *Discard* operation to allow ill-formed and previously uncovered well-formed strings to be handled. Way (1999) and Way (2001) extended LFG-DOP to handle translation, and demonstrated two advantages of his LFG-DOT models: (i) being probabilistic, LFG-DOT was able to handle a range of translation phenomena that were problematic for the description of LFG-MT (Kaplan et al. 1989); and (ii) having f-structure constraints enabled LFG-DOT to overcome problems for DOT (Poutsma 2000), a model of translation based on DOP (Bod 1992, Sima'an 1997, Bod 1998). Like most probabilistic models, LFG-DOP (and LFG-DOT) require large amounts of annotated data. In a range of seminal work on grammar induction – now a research field in its own right, but at the time quite a novelty – it was demonstrated how strings could be automatically annotated with both LFG c- and f-structure information (Sadler et al. 2000, Cahill et al. 2002a). These were then used for multilingual probabilistic parsing (Cahill et al. 2005, Cahill, Burke, O'Donovan, et al. 2008) and lexicon induction experiments (O'Donovan 2006), which we describe here.

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1 Introduction

In this chapter we summarize work on extensions to the core LFG formalism that facilitate large-scale probabilistic LFG parsing and translation models. Traditional LFG grammars (Kaplan & Bresnan 1982) are defined in terms of well-formed grammatical rules and constraints. This has two main limitations: (i) ill-formed input cannot be handled easily;[1] and (ii) when a grammar produces multiple analyses for an input, there is no inherent way of ranking the competing solutions.

We describe LFG-DOP (Bod & Kaplan 1998), a hybrid model of Data-Oriented Parsing (DOP: Bod 1992, Sima'an 1997, Bod 1998) and LFG that allows for probabilistic tree parsing, and which is beyond context-free in its generative power. We describe how this work led to the LFG-DOT framework (Way 1999, 2001) for machine translation (MT) with LFG.

Large-scale probabilistic parsing typically requires substantial amounts of annotated training data. We describe techniques developed to automatically generate large-scale LFG-annotated treebanks that provide the training data needed for probabilistic LFG parsing. We describe how this work was not only applied to English, but also several other languages including German (Cahill et al. 2005, Rehbein & van Genabith 2009), French (Schluter 2011), Spanish (O'Donovan et al. 2005, Chrupała & van Genabith 2006), Chinese (Burke, Cahill, et al. 2004, Guo 2009), Japanese (Oya & van Genabith 2007) and Arabic (Tounsi et al. 2009a). A related field of work was the automated extraction of large-scale lexical resources from these LFG-annotated treebanks (O'Donovan 2006). Although large-scale LFG-DOT experimentation has not been conducted to date,[2] these grammars and semantic forms (i.e. subcategorisation frames) are exactly what LFG-DOT requires to build its models. Accordingly, we sketch what would need to be done to conduct such experiments.

Finally, we compare this semi-automatic approach to lexicon and grammar induction to that based on the hand-crafted XLE grammars.

2 LFG-DOP

This section describes how LFG was combined with Data-Oriented Parsing (DOP) models to create a more robust, probabilistic model of language processing, LFG-

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[1] This applies equally to legitimate strings which are not covered by the grammar.

[2] Bod (2000) acknowledges that Cormons (1999) "accomplished [the] first simple experiment with LFG-DOP". Bod & Kaplan (2003) includes a large-scale evaluation of LFG-DOP against a DOP baseline. Hearne (2005) extends these experiments for DOP, demonstrating higher accuracy for the exact match metric using improved sampling techniques.

DOP. In later sections, we will show how both DOP and LFG-DOP were used to build powerful, robust models of MT.

2.1 Data-Oriented Parsing

DOP models (Bod 1992, Sima'an 1997, Bod 1998) assume that past experiences of language are significant in both perception and production. DOP prefers performance models over competence grammars, in that abstract grammar rules are eschewed in favour of models based on large collections of previously occurring fragments of language. Previously uncovered sentences are processed with reference to existing fragments from the treebank, which are combined using probabilistic techniques to determine the most likely analysis for the new fragment.

The general DOP architecture stipulates four parameters on which particular models are instantiated:

1. A formal definition of *well-formed representations* for sentence analyses;
2. A set of *decomposition* operations for splitting sentence analyses into a set of fragments;
3. A set of *composition* operations for recombination of such fragments in order to derive analyses of new strings;
4. A definition of a *probability model* indicating the likelihood of a sentence analysis based on the probabilities of its constituent parts.

DOP models typically assign a surface phrase-structure (PS) tree to strings (hence 'Tree-DOP', or 'DOP1' in Bod (1992)). However, context-free models are insufficiently powerful to deal with all aspects of human language. LFG, on the other hand, is known to be beyond context-free, and can capture and provide representations of linguistic phenomena other than those occurring at surface structure.[3]

---

[3] Note that the question of what grammar type in the Chomsky Hierarchy (Chomsky 1956) was capable of processing human language was a significant one when LFG was first proposed, but appears to be less of a concern nowadays. This was relevant for Chomsky's claims of Universal Grammar (Chomsky 1981), of course, but different languages have been demonstrated to require different grammar types; for example, Dutch cross-serial dependencies can only be handled by a context-sensitive grammar, whereas English is arguably context-free. Note that Futrell et al. (2016) claim the Amazonian language Pirahã to be finite-state, so the Chomsky Hierarchy no longer seems to be particularly helpful as a characterisation of human languages in general. Nonetheless, the fact that LFG is beyond context-free would allow it to claim that it is a general enough model to cope with languages like Dutch. Note too that a grammar formalism should be sufficiently constrained to ensure that parsing can be done in polynomial time.

2.2 Combining DOP with LFG: LFG-DOP

Accordingly, Bod & Kaplan (1998) augmented DOP with the syntactic representations of LFG to create a new, more powerful hybrid model of language processing – LFG-DOP – which adds a level of robustness not available to models based solely on LFG.

LFG-DOP is defined using the same four parameters as in Tree-DOP. We describe each of these in the next sections.

2.2.1 Representations in LFG-DOP

The LFG-DOP **representations** are those traditionally used in LFG, where each string is annotated with a c-structure, an f-structure, and a mapping ϕ between them. Well-formedness conditions operate solely on f-structure, as usual.

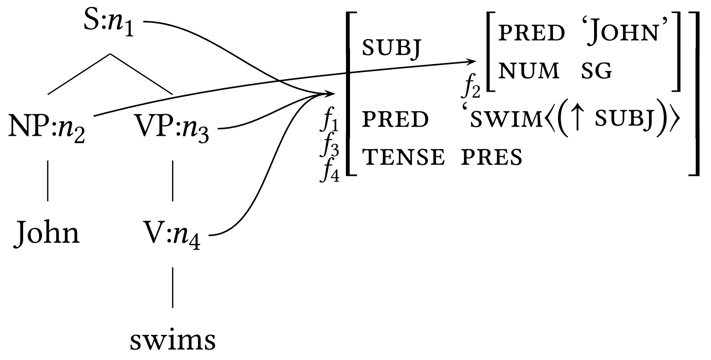
2.2.2 Decomposition in LFG-DOP

Since we are now dealing with $\langle c, f\rangle$ pairs of structure, the *Root* and *Frontier* **decomposition** operations of DOP need to be adapted to stipulate exactly which c-structure nodes are linked to which f-structure fragments, thereby maintaining the fundamentals of c- and f-structure correspondence. As LFG c-structures are little more than annotated PS trees, we can proceed very much on the same lines as in Tree-DOP. *Root* erases all nodes outside of the selected node, and in addition deletes all ϕ-links (informally, parts of the f-structure linked to a c-structure node) leaving the erased nodes, as well as all f-structure units that are not ϕ-accessible from the remaining nodes. Bod & Kaplan (1998) define ϕ-accessibility as follows:

> "An f-structure unit f is ϕ-accessible from a node n iff either n is ϕ-linked to f (that is, $f = \phi(n)$) or f is contained within $\phi(n)$ (that is, there is a chain of attributes that leads from $\phi(n)$ to f)." (Bod & Kaplan 1998: 146)

As an example, consider (1):

(1)



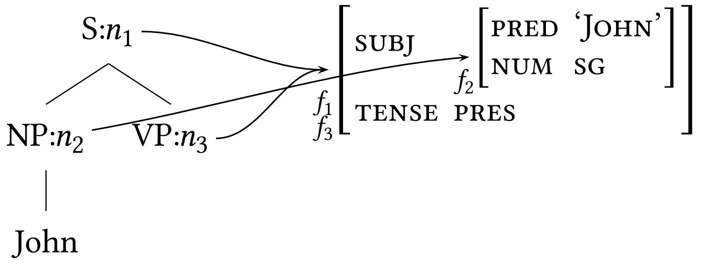
The ϕ-links are shown in (2):

(2) $\phi(n_1) = \mathrm{f}_1$, $\phi(n_2) = \mathrm{f}_2$, $\phi(n_3) = \mathrm{f}_3$, $\phi(n_4) = \mathrm{f}_4$, $\phi(n_1) = \phi(n_3) = \phi(n_4)$

ϕ-accessibility reflects the intuitive notion that nodes in a tree carry information only about the f-structure elements to which the root node of the tree permits access, as in (1). Note that all f-structure units are ϕ-accessible from the S, VP and V nodes, but TENSE and the top-level PRED (the main verb *swim*) cannot be accessed via ϕ from the subject NP node.

Frontier operates as in Tree-DOP, deleting all subtrees of the selected frontier nodes. It also deletes all ϕ-links of these deleted nodes together with any semantic form (e.g. in (1), 'SWIM⟨(↑ SUBJ)⟩') as is the case if the V:swims node is deleted in (3):

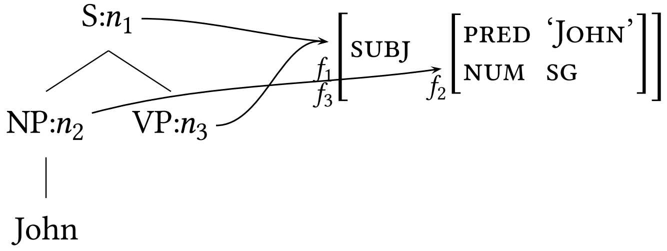
(3)



This illustrates the ability of *Root* nodes to access certain f-structure features even after subnodes have been deleted. Even though the V:swims node is deleted in the c-structure tree, only the semantic form 'swim⟨(↑ SUBJ)⟩' is deleted from the f-structure, and the TENSE feature remains.[4]

It is, however, possible to prune (3) still further, as (4) illustrates:

(4)



This is achieved by applying a third, and new operation, *Discard*, to the TENSE feature in (3).[5] The *Discard* operation adds considerably to LFG's robustness by

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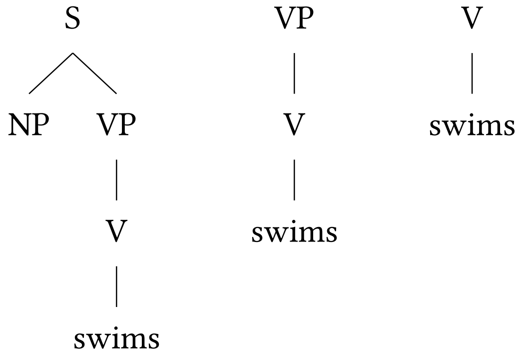
[4] Note that subject-tense agreement *is* seen in some languages e.g. Hindi. Accordingly, there is no universal principle which should rule out fragments such as (3).

[5] This function generates appropriate fragments for English which have no subject-tense dependency; accordingly, we would expect more fragments like (4) in English treebanks, but fewer such fragments for Hindi, say, given the point made in fn. 4.

providing generalized fragments from those derived via *Root* and *Frontier* by freely deleting any combination of attribute-value pairs from an f-structure except those that are ϕ-linked to some remaining c-structure node, or that are governed by the local predicate (i.e. required to be present). Its introduction also necessitates a new definition of the grammaticality of a sentence *with respect to a corpus*, namely any sentence having at least one derivation whose fragments are produced only by *Root* and *Frontier* and not by *Discard*. Way (1999) splits fragments into separate bags of *Discard* and non-*Discard* fragments in order "to facilitate the consideration of grammaticality." Bod (2000) demonstrates that this is helpful for LFG-DOP, too, on experiments with the Verbmobil and Homecentre corpora, which compare favourably with the original model of Bod & Kaplan (1998). In contrast, Hearne & Sima'an (2004) present an improved back-off estimation method where non-*Discard* fragments are naturally preferred.

We omit here the complete LFG-DOP treebank (ignoring the effects of the *Discard* operator) for the sentence *John swims*, but refer the interested reader to Figure 4.1 in Way (2001: 114). Nonetheless, as he does, we point out that each c-structure fragment in an LFG-DOP corpus is not necessarily linked to a unique f-structure fragment. From his Figure 4.1, consider the three fragments in (5):

(5)



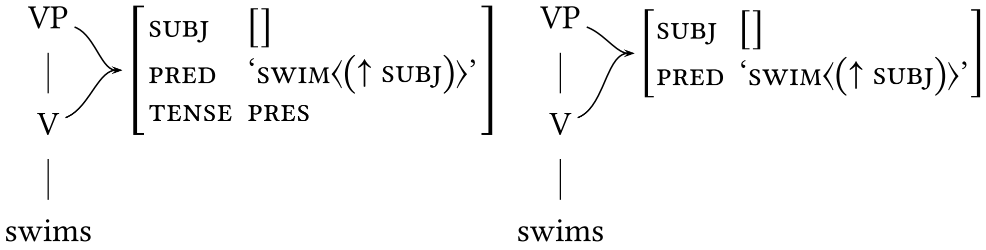
These three c-structure fragments all map to the same f-structure fragment in (6) because of equations such as $\phi(n_1) = \phi(n_3) = \phi(n_4)$ in (2):

(6)
$$\left[\begin{array}{ll} \textsc{subj} & \left[\textsc{num sg}\right] \\ \textsc{pred} & \text{`}\textsc{swim}\langle(\uparrow \textsc{subj})\rangle\text{'} \\ \textsc{tense} & \textsc{pres} \end{array}\right]$$

This f-structure shows that *swims* being singular requires a singular subject. Of course, to be completely accurate, we should add in a subj:pers:3 constraint too, to prevent strings such as *I swims* and *you swims* from being deemed grammatical.

We can illustrate the effect of *Discard* in relaxing the SUBJ:NUM:SG constraint with *swims* in (7):

(7)



Accordingly, if the ill-formed string *The men swims* were input, it could be processed by LFG-DOP because of generalised fragments like these, but would be ruled out as ungrammatical in LFG, given f-structures like (6). Note that *Discard* has been applied to the rightmost f-structure in (7).

2.2.3 Composition in LFG-DOP

Composition in LFG-DOP is also a two-step operation. C-structures are combined by leftmost substitution, as in Tree-DOP, subject to the matching of their nodes. F-structures corresponding to these nodes are then recursively unified, and the resulting f-structures are subjected to the grammaticality checks of LFG.

2.2.4 Probability models for LFG-DOP

$CP(f \mid CS)$ denotes the probability of choosing a fragment f from a competition set CS of competing fragments. In Tree-DOP, we wanted to select a tree t from a treebank, whereas in LFG-DOP we are interested in selecting a $\langle c, f \rangle$ pair from a corpus. The probability of an LFG-DOP derivation is the same as in Tree-DOP; it is just the derivation itself which changes. As in DOP, then, an LFG-DOP derivation $D = \langle f_1, f_2 ... f_n \rangle$ is produced by a stochastic branching process which at each stage in the process randomly samples from a competition set CS of competing samples, as in (8) (cf. example (10) in Bod & Kaplan 1998: 148):

(8)
$$P(\langle f_1, f_2 ... f_n \rangle) = \prod_{i=1}^{n} CP(f_i \mid CS_i)$$

This competition probability $CP(f \mid CS)$ is expressed in terms of fragment probabilities $P(f)$ in (9) (cf. example (11) in Bod & Kaplan 1998: 148):

(9) $$CP(f \mid CS) = \frac{P(f)}{\sum_{f' \in CS} P(f')}$$

Taking (8) and (9) together, the probability of a derivation f is calculated by multiplying together the probabilities of the fragments f_i which are composed together to form that fragment; this is analogous to how derivations are computed in Tree-DOP: there, we just have tree fragments, whereas in LFG-DOP, we have tree fragments together with their associated f-structure fragments.

In Tree-DOP, apart from the *Root* and *Frontier* operations, there are no other well-formedness checks. LFG, however, has a number of grammaticality conditions, some of which – the Completeness check at least – cannot be evaluated during the stochastic process. Accordingly, probabilities for valid representations can only be defined by sampling *post hoc* from the set of representations which are output from the stochastic process. The probability of sampling a valid representation is (10) (cf. example (12) in Bod & Kaplan 1998: 148):

(10) $$P(R \mid R \text{ is valid}) = \frac{P(R)}{\sum_{R' \textit{ is valid}} P(R')}$$

Bod & Kaplan (1998) note that (10) assigns probabilities to valid representations whether or not the stochastic process guarantees validity. The valid representations for a particular utterance *u* are obtained by a further sampling step, with their probabilities given by (11) (cf. example (13) in Bod & Kaplan 1998: 148):

(11) $$P(R \mid R \text{ is valid and yields } u) = \frac{P(R)}{\sum_{R' \textit{ is valid and yields } u} P(R')}$$

Comparing (10–11) with the equivalent formula for calculating the probability of a particular analysis for a Tree-DOP representation, Way (2001) observes that the LFG-DOP formulae contain references to *valid* structures. In Tree-DOP, apart from the root-matching criterion, there are no other validity conditions; in LFG-DOP, depending on the competition set chosen, there may be several.

Omitting the details for reasons of space, Bod & Kaplan (1998) give three different competition sets depending on the stage at which the LFG grammaticality checks are carried out, which affect the the **probability models** for LFG-DOP:

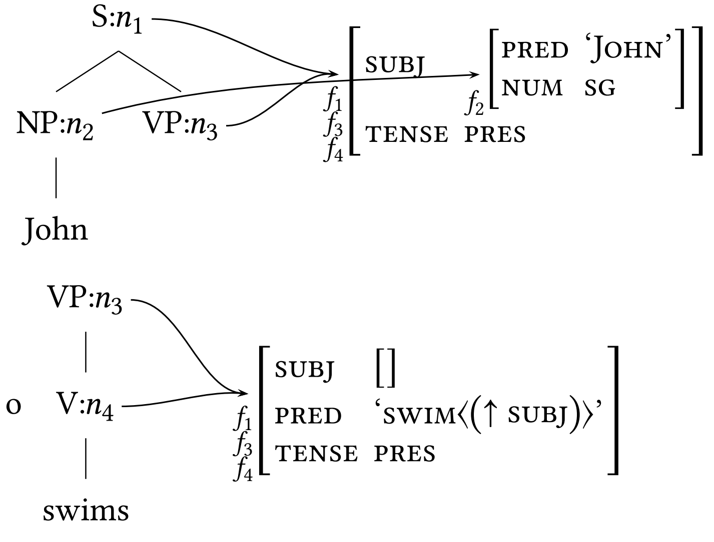
1. A straightforward extension of the Tree-DOP probability model, where the choice of a fragment depends only on its *Root* node (i.e. c-structure matching category) and not on the Uniqueness, Completeness or Coherence conditions of LFG, which are enforced off-line.

2. *Root* nodes must match, and f-structures must be unifiable if two LFG fragments are to be combined. This model takes the LFG Uniqueness condition (namely that each attribute has only one value) as well as the *Root* category into account. As the resultant fragments produced vary depending on the derivation followed, unifiability must be determined at each step in the process.

3. In addition to the previous two steps, the LFG Coherence check is enforced at each step, ensuring that each grammatical function (SUBJ, OBJ etc.) present in the f-structure is governed by a PRED. This means that in this model, we are dealing only with well-formed c-structures which correspond to coherent and consistent f-structures, i.e. structures which satisfy LFG's Uniqueness check, thereby permitting unification only where exactly appropriate. As we have noted already, the LFG Completeness check can only be enforced after all other validity sampling has taken place.

Let us now return to the sentence *John swims*, and show one possible derivation of the $\langle c, f\rangle$ pair in (1). A straightforward way of doing this would be to compose (via the 'o' operator in (12)) the $\langle c, f\rangle$ fragment in (3) with the leftmost fragment in (7), which we include in full in (12):

(12)



This is possible given that the VP node in the upper tree is vacant, so the lower VP tree can be substituted for this node. The respective f-structures are then unified to give the $\langle c, f\rangle$ fragment in (1). Throughout the derivation of this $\langle c, f\rangle$ pair, we have satisfied DOP's *Root* condition (leftmost substitution of 'like' categories only), as well as the Uniqueness, Completeness and Coherence grammaticality conditions of LFG. As a consequence, the resultant structures in (1) are valid. This is equivalent to using the third option given above for possible competition sets.

Of course there will be many other possible derivations which contribute to the overall probability of the sentence *John swims.* Note that if we enforce LFG's grammaticality checks on-line, leftmost substitution of non-*Discard* fragments reduces the size of the competition set for future iterations of the composition process. In (12), for instance, enforcing the Uniqueness condition on-line (models 2 or 3 above) prevents any fragment other than a singular intransitive VP from being substituted into the VP slot. In Tree-DOP, *any* VP could be substituted at this node.

3 LFG-DOT

In this section, we demonstrate that problems with the LFG-MT (Kaplan et al. 1989) and Data-Oriented Translation (DOT: Poutsma (2000)) models of translation can be solved by LFG-DOT.[6] As the LFG-DOT models proposed by Way (1999) and Way (2001) are based on LFG-DOP, they have the same advantages as shown in the previous section, albeit now for translation:

1. Being a probabilistic model, LFG-DOT can overcome problems encountered by LFG-MT which is based solely on LFG's constraints; and
2. By appealing to LFG's f-structure constraints, LFG-DOT can overcome problems encountered by DOT which is based solely on trees.

3.1 LFG-MT

A translation model based on LFG was first presented in Kaplan et al. (1989). This original model introduces the τ-correspondence as a mapping between source

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[6] Hearne (2005) demonstrates that reasonably large-scale models can be built with DOT that considerably outperform SMT. Bod (2007) contains results which demonstrate similar improvements over SMT, but for *really* large-scale models at the time. Given the massive time and space constraints involved in processing DOP models, it is noteworthy that Bod was able to build DOT models trained on more than 750K sentence-pairs of German-English Europarl data (Koehn 2005).

and target f-structures. For *swim*, we would need a transfer lexicon entry such as (13) for translation between English and French:

(13) *swim*:
$(\tau\uparrow \text{PRED}) = \text{nager}$
$(\tau\uparrow \text{SUBJ}) = \tau(\uparrow \text{SUBJ})$

Being a straightforward translation example, this entry demonstrates two things: (i) that the translation of the verb *swim* is *nager*, and (ii) that the translation of the subject of *swim* is the subject of *nager*.

This model is very elegant, and allows for some difficult translation problems to be handled by the LFG-MT formalism. For example, verbs with different semantic forms can be handled relatively straightforwardly. Assume the translation case in (14):

(14) The student answers the question ⟷ L'étudiant répond à la question.

This case can be dealt with as in (15):

(15) *answer*:
$(\tau\uparrow \text{PRED}) = \text{répondre}$
$(\tau\uparrow \text{SUBJ}) = \tau(\uparrow \text{SUBJ})$
$(\tau\uparrow \text{OBL OBJ}) = \tau(\uparrow \text{OBJ})$

This states that *répondre* is the corresponding French predicate of *answer*, that the translation of the SUBJ is straightforward, and that the translation of the OBJ of *answer* is the OBL OBJ of *répondre*.

The LFG-MT model of Kaplan et al. (1989) can also deal correctly with the *like–plaire* relation-changing case, as (16) demonstrates:

(16) *like*:
$(\tau\uparrow \text{PRED}) = \text{plaire}$
$(\tau\uparrow \text{OBL}_{)} = \tau(\uparrow \text{SUBJ})$
$(\tau\uparrow \text{SUBJ}) = \tau(\uparrow \text{OBJ})$

That is, the subject of *like* is translated as the oblique argument of *plaire*, while the object of *like* is translated as the subject of *plaire*.

However, a line of work showed that while the τ-equations of Kaplan et al. (1989) are by and large able to link exactly those source–target elements which are translations of each other, there are a number of cases where this machinery is unable to cope with a set of translation cases, in particular embedded headswitching examples and the correct translation of adjuncts (cf. Arnold et al. 1990, Sadler & Thompson 1991, Way 2001).[7]

It is worth noting that an updated version of LFG-MT was described in Kaplan & Wedekind (1993) which used the concept of *Restriction* to try to overcome some of the problems in mapping between flat syntactic f-structures to hierarchical semantic ones. However, as well as receiving criticism from a monolingual perspective (cf. Butt (1994) and complex predicates in Urdu), Way (2001) demonstrates this new approach failed to ensure that only the correct translations ensued; rather, it was left to a human expert to select the correct translation from a set of alternatives, many of which were incorrect. Despite being an improvement on the original model of Kaplan et al. (1989), it is still open to criticism as a general model of translation.

Another solution proposed around this time involved using linear logic (van Genabith et al. 1998), but this involved adding massive redundancy in the transfer lexicon, cf. Way (2001: 92–96).

Note too that work continued on using LFG as a basis for MT after LFG-DOT was introduced. One such model was that of Riezler & Maxwell (2006). Note that their paper is not a comparison of LFG-MT, but rather with SMT (Koehn et al. 2003). Note that they add a 'fragment grammar' which "allows sentences that are outside the scope of the standard grammar to be parsed as well-formed chunks" (p.251), but they do not compare this with the bag of *Discard*-generated fragment-pairs in LFG-DOT. This work is extended by Graham & van Genabith (2012), who incorporate a deep syntax language model directly into the decoder, as opposed to using it *post hoc* to improve the grammaticality of the target translations. Note that neither approach shows how their models handle any of the traditional 'hard' translation cases. For the approach of Riezler & Maxwell (2006), being based on transfer rules – albeit automatically extracted ones – it will surely fail in similar ways to LFG-MT. As to the model of Graham & van Genabith (2012), and approaches based on SMT in general, it is doubtful whether the system designers can answer the question how such translational phenomena are handled, as SMT does not work in this way. Of course, test sets can be designed which include such 'hard' cases, and the translation output inspected, but SMT systems

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[7] To give the reader some insight into the first-mentioned issue without having to consult the primary literature, LFG-MT can cope with 'straightforward' headswitching examples like *The baby just fell* ⟷ *Le bébé vient de tomber*. However, when such examples appear in embedded clauses, as in *I think that the baby just fell* ⟷ *Je pense que le bébé vient de tomber*, *ad hoc* solutions are required to avoid target f-structures being doubly rooted, i.e. two τ-equations result in inconsistent solutions where one piece of f-structure is required to simultaneously fill two different slots.

by their very nature are far less inspectable than systems which include syntactic constraints, so even if such sentences were translated correctly, it would be hard to know why exactly. Of course, this problem is worse again with today's state-of-the-art neural models; despite the improved quality that can be derived, our knowledge as to what is going on internally inside the systems is less than it's ever been.

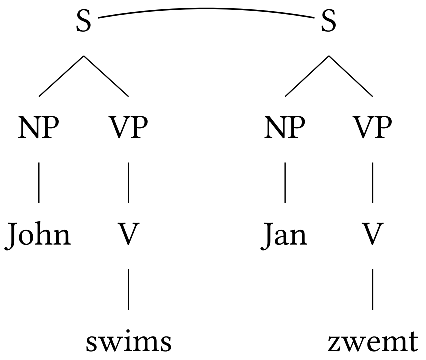
3.2 Data-Oriented Translation

Poutsma (2000) produced two models of tree-based translation, DOT1 and DOT2. These models were formulated along the same lines as DOP and LFG-DOP, with definitions of the representations to be used, how these were to be decomposed, recomposed, and a probability model.

In DOT, the latter determined the likelihood of a target translation given a source string. The representations used were PS trees, decomposition described how to extract well-formed subtree-pairs from these representations,[8] and the composition operator used was leftmost substitution (to ensure unique derivations) of matching *Root* labels.

We illustrate a linked translation pair in DOT in (17) for the the sentence pair ⟨ *John swims*, *Jan zwemt* ⟩:[9]

(17)



If we assume that the sentential fragment in (17) is unseen in our DOT treebank, one derivation of the translation *Jan zwemt* given the source sentence *John swims* might be (18):

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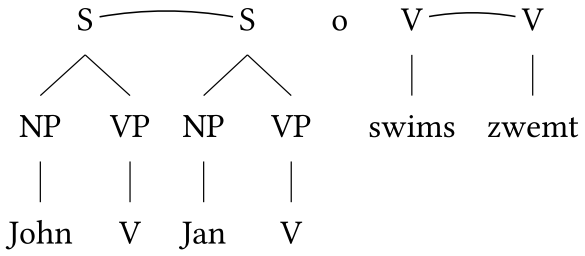
[8] In his thesis, Way 2001 introduces the label γ to refer to the function that links DOT source and target subtree fragments. See Section 3.3.2 for models which use the γ function in LFG-DOT, and Poutsma 2000: Sect. 2.1 for a description of how linked subtrees like the V-labelled fragments in (18) are extracted from tree pairs such as (17).

[9] Here we 'translate' names to indicate that the translation process has been successful, as opposed to merely passing over a source word as untranslated – an out-of-vocabulary item – into the target side.

(18)



Way (1999) showed that the DOT1 model could not always explicitly relate parts of the source-language structure to the corresponding, correct parts in the target structure, so fails to translate correctly where source and target strings differ with respect to word order (e.g. the *like* ⇔ *plaire* relation changing case – which LFG-MT can handle, cf. (16) – plus many more 'hard' translation cases described in Way et al. (1997)).

DOT2 was developed as a consequence of these failings, and improves over DOT1 by not restricting the composition operation to left-most substitution on *both* sides. With that change, DOT2 manages to overcome cases of word-order difference by and large. However, Way (2001) notes that:

> "this is compromised by a lesser amount of compositionality in the translation process. Given the small number of fragments playing a role in the derivation of some translations involving complex phenomena, almost the exact linked sentence pair may need to be present in order for a translation to be possible. Furthermore, any such translations produced have extremely small probabilities with respect to the corpus. Finally, of course, translation systems which are based purely on PS trees will ultimately not be able to handle certain linguistic phenomena." (Way 2001: 190)

To illustrate the 'limited compositionality' problem in DOT2, Way (2001) appeals to the translation pair in (19):[10]

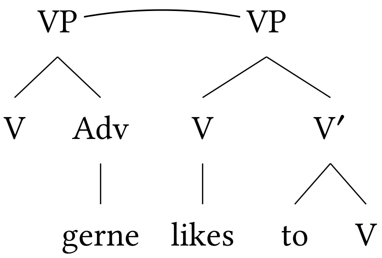
(19) DE: Johannes schwimmt gerne ⇔ EN: John likes to swim.

Essentially, the VPs cannot be broken down further; *schwimmt* and *swim* are not translationally equivalent – one is inflected and the other is in the infinitive form – so in their source–target tree pairs, links cannot be drawn between the fragment-pair in (20), as we might otherwise wish to do, in order to describe the basic translation relations in (19):

---

[10] Given that other similar cases exist, e.g. DE: Josef läuft zufällig ⇔ EN: Joseph happens to run, the redundancy in the DOT2 approach really shows itself to be problematic when such cases are combined, as in strings such as *John likes to happen to swim* (i.e. John likes to swim by chance, rather than planning ahead), and *John happens to like to swim.*

(20)



Accordingly, while it is possible for DOT2 to cope with such examples in contrast to DOT1, which couldn't handle them at all, the exact VPs (*likes to swim*, here) have to exist *a priori* in the treebank. This is because these linked VP pairs are handled non-compositionally in DOT2 between German and English, but the monolingual VPs are treated compositionally in DOP. As can be seen, DOT2 approximates to a translation dictionary for such cases – as *likes to* can be followed by pretty much any verb in English, and *gerne* can modify pretty much any verb in German – which is clearly impractical, and so can be disregarded as a general model of translation.

3.3 Combining DOT and LFG-MT: the best of both worlds

In his thesis, Way (2001) provides four LFG-DOT models which solve all these 'hard' cases:

1. Model 1: Translation via τ
2. Model 2: Translation via τ and γ
3. Model 3: Translation via γ with Monolingual Filtering
4. Translation via γ and 'Extended Transfer'

3.3.1 LFG-DOT1

Way (2001) describes this as a simple linear model, as in (21):

(21)

$$\begin{tikzcd}
c \arrow[r, dash, "\text{LFG-DOP-}\phi"] & f \arrow[d, dash, "\tau"] \\
c' \arrow[r, dash, "\text{LFG-DOP-}\phi'"'] & f'
\end{tikzcd}$$

The different components needed are:

- a source language LFG-DOP model;
- the τ mapping;
- a target language LFG-DOP model.

Way (2001: 193) notes that "LFG-DOT1 contains two monolingual LFG-DOP language models … [so] *Discard* can be run on both source and target sides. This means that LFG-DOT1 can cope with ill-formed or previously uncovered input which LFG-MT would not be able to handle at all". Despite this advantage, LFG-DOT1 unsurprisingly suffers from the same problems as LFG-MT, as its translation function is described by the same operator τ.

3.3.2 LFG-DOT2

Given that τ is an insufficient operator to define all translation problems (cf. fn. 7, for example), Way (2001) describes the translation relation using both the γ and τ functions in his LFG-DOT2 model, summarised in (22):

(22)

$$\begin{tikzcd}
c \arrow[r, dash, "\text{LFG-DOP-}\phi"] \arrow[d, dash, "\gamma"'] & f \arrow[d, dash, "\tau"] \\
c' \arrow[r, dash, "\text{LFG-DOP-}\phi'"'] & f'
\end{tikzcd}$$

This is clearly a more complex model than LFG-DOT1, necessitating:

- a source language LFG-DOP model;
- the γ mapping (i.e. the DOT2 model of translation, cf. fn. 8);
- a target language LFG-DOP model;
- a probabilistic transfer component.

Way (2001) provides a number of ways in which the γ and τ functions might co-operate in his LFG-DOT2 model. He notes that using LFG-DOP as the source and target language models overcomes the shortcomings of both Tree-DOP and LFG, and that including τ allows certain 'hard' cases (like relation-changing) to be handled correctly, unlike the DOT1 model.

Furthermore, Way (2001) notes that LFG-DOT2 is more robust than LFG-MT, in that *Discard* can produce generalized fragments which may be able to deal with input for which LFG-MT cannot offer any translation.

Ultimately, as the τ mapping cannot always produce the desired translation, Way jettisons this function in his LFG-DOT3 and LFG-DOT4 models, to which we turn next.

3.3.3 LFG-DOT3

LFG-DOT3 relies solely on γ to express the translation relation. The architecture of LFG-DOT3 is shown in (23):

(23)

$$\begin{tikzcd}
c \arrow[r, dash, "\text{LFG-DOP-}\phi"] \arrow[d, dash, "\gamma"'] & f \\
c' \arrow[r, dash, "\text{LFG-DOP-}\phi'"'] & f'
\end{tikzcd}$$

Way (2001) demonstrates that contrary to other models described here, embedded headswitching cases in LFG-DOT3 are handled in the same manner as non-embedded headswitching cases, exactly as required (cf. fn. 7). He also shows that LFG-DOT3 can cope with certain cases of combinations of exceptional phenomena which prove problematic for other formalisms. However, like DOT2 (cf. Section 3.2), LFG-DOT3 also suffers from the problem of limited compositionality.

3.3.4 LFG-DOT4

To overcome this problem, Way (2001) uses a restricted form of *Discard* in an 'extended transfer' phase in LFG-DOT4 to generalize the translation relation appropriately. Essentially, in LFG-DOP (and consequently LFG-DOT), fragments generated by *Discard* occupy an unjustifiably large proportion of the probability space. Accordingly, Way (1999) proposes to split fragments into two bags: those generated by *Root* and *Frontier*, and those generated by *Discard*. In LFG-DOT4, Way (2001) allocates a small amount of the probability space to lemmatized translation pairs produced by a second application of *Discard*.[11] To revisit

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[11] Another way of mitigating this problem is suggested by Way (2001: 112), namely to adopt the approach of Zaenen & Kaplan (1995), which cuts down on the possible number of LFG-DOP fragments compared to the description of LFG in Kaplan & Bresnan (1982). In Zaenen & Kaplan (1995), lexical heads are ϕ-linked only to semantic forms and not to their enclosing f-structures, while other primitive feature values remain unlinked.

the problematic example in (19), if *Discard* is used to relax the TENSE constraint, then the V nodes in (20) can be linked; they couldn't before as the V in German was a finite verb, while the V in English was an infinitive. Accordingly, Way (2001: 190) suggests that "this model describes the translation relation exactly as required, and furthermore overcomes the problems of LFG-MT … and DOT models of translation". See Table 1 for a summary of the comparative advantages and disadvantages of each of the models covered in this chapter.[12]

Table 1: A comparison of the advantages and disadvantages of the MT models described in this work

Model	Ill-formed input	Word order	Embedded headswitching	All 'hard' cases	Avoids limited compositionality
LFG-MT	N	Y	N	N	N
DOT1	Y	N	N	N	N
DOT2	Y	Y	Y	N	N
LFG-DOT1	Y	Y	N	N	N
LFG-DOT2	Y	Y	Y	N	N
LFG-DOT3	Y	Y	Y	Y	N
LFG-DOT4	Y	Y	Y	Y	Y

4 Automatic derivation of f-structures from treebanks

In this section we consider how the resources needed for large-scale LFG-DOP and LFG-DOT models can be generated. We also explain the two different ways in which f-structures can be derived from a tree.

4.1 Towards large-scale resources for LFG-DOP and LFG-DOT

LFG-DOP needs large collections of monolingual annotated data (treebanks) in order to parse monolingual input, and LFG-DOT needs large collections of bilingual annotated data. At the time LFG-DOP and LFG-DOT were being developed, no such large f-structure annotated data existed. Constituency treebanks had

---

[12] See Way (2003) for more details on these models, and Hearne (2005) for an alternative LFG-DOT model based on LFG-DOT3 but which incorporates a different probability model and fragmentation procedure.

been available for several years, and large-scale hand-crafted LFG grammars were available only for a few languages. However, neither could provide the input needed to support the training of LFG-DOP or LFG-DOT models. Constituency treebanks alone could not provide the linguistic detail needed, and hand-crafted grammars were unable to select the most likely parse from a (sometimes) large number of possible solutions.

To address these shortcomings, van Genabith, Way, et al. (1999b) and van Genabith, Sadler, et al. (1999) proposed initial methods to automatically derive the LFG-treebank resources required to support training LFG-DOP and LFG-DOT models, although this was not the main driving force behind this work.

Initially, the work conducted produced grammars and lexicons for English, which seeded high-performing probabilistic parsers (see Section 5). Later, related methods were used to extract similar resources for a range of other languages (cf. Section 6). Once the general approach had been validated for different languages and treebanks, it is possible to sketch a research project which could generate the resources needed for large-scale LFG-DOP and LFG-DOT experimentation.

Taking a large-scale parallel corpus such as Europarl (Koehn 2005), we would need to:

1. Parse source and target sides to generate c-structure trees for the two languages;
2. Run the f-structure annotation algorithm(s) over each side;
3. Apply the *Root* and *Frontier* operations to extract the separate bags of fragments.

After step 2, we have $\langle c, f\rangle$ pairs of structure for all sentences on both sides of the corpus, so we can build LFG-DOP models for the individual source and target sides by running *Root* and *Frontier* operations on each side, and start producing $\langle c, f\rangle$ pairs for new monolingual input. To generate resources for the better of the four models, LFG-DOT4, we need to align each source tree generated in step 1 with each target tree generated in the same step. Fortunately, Europarl contains information regarding which sentences in one language map to which sentences in another, so we can now apply *Root* and *Frontier* operations on both sides to extract the separate bags of fragments that are needed, and start translating new input strings. This experiment remains for future work.

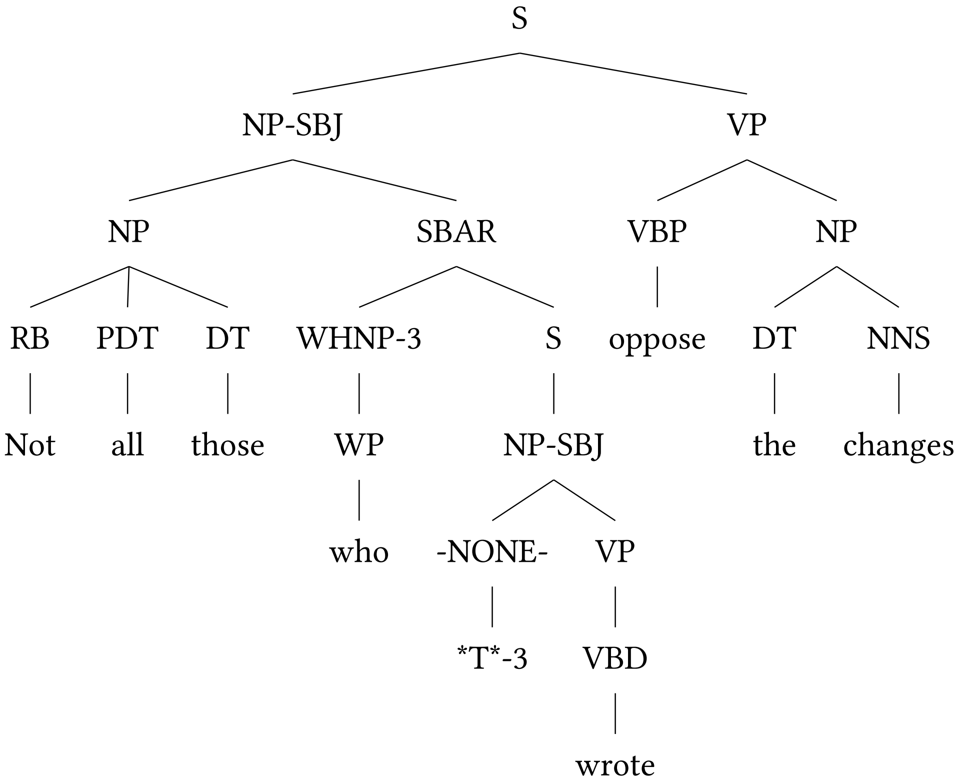
4.2 Direct transformation vs. indirect annotation

The initial approaches of van Genabith, Way, et al. (1999b) and van Genabith, Sadler, et al. (1999) focused on deriving f-structure annotations from PS trees. The intuition was that there were already reasonably reliable tools for automatically producing a tree from an input sentence, and so it would be easier to scale a tree-annotation plus f-structure derivation approach, compared to automatically deriving c- and f-structure simultaneously from raw input.

There are two ways to derive an f-structure from a tree: **direct** transformation or **indirect** annotation. The direct method recursively and destructively transforms a treebank tree into an f-structure. The indirect method only ever adds information: it annotates the treebank tree with f-structure annotations (equations). These annotations are then collected and passed to a constraint solver which resolves the equations and, if the equations are consistent, outputs an f-structure.

Examples (24)–(26) illustrate the indirect method: all nodes in the tree in (24) are annotated with equations in (25), which are collected and resolved into an f-structure in (26).

(24)



(25)

```
(S
    (NP-SBJ[up-subj=down]
        (NP[up=down]
            (RB[down-elem=up:adjunct] Not[up-pred='not'])
            (PDT[up-spec:det=down] all[up-pred='all'])
            (DT[up=down] those[up-pred='those'])
        )
        (SBAR[up-relmod=down]
            (WHNP-3[up-topicrel=down,up-topicrel:index=3]
                (WP[up=down] who[up-pred=pro,up-pron_form='who'])
            )
            (S[up=down]
                (NP-SBJ[up-subj=down,up-subj=up:topicrel]
                    (-NONE- *T*-3)
                )
                (VP[up=down]
                    (VBD[up=down] wrote[up-pred='write',up-tense=past])
                )
            )
        )
    )
    (VP[up=down]
        (VBP[up=down] oppose[up-pred='oppose',up-tense=pres])
        (NP[up-obj=down]
            (DT[up-spec:det=down] the[up-pred='the'])
            (NNS[up=down] changes[up-pred='change', up-num=pl,up-pers=3])
        )
    )
    (. .)
)
```

(26)

```
subj : adjunct : 1 : pred : not
      spec : det : pred : all
      pred : those
      relmod : topicrel : index : 3
                          pred : pro
                          pron_form : who
                subj : index : 3
                       pred : pro
                       pron_form : who
                pred : write
                tense : past
pred : oppose
tense : pres
obj : spec : det : pred : the
      pred : change
      num : pl
      pers : 3
```

The earliest approach to automatically identifying functional grammatical categories such as subj, obj, etc in PS trees is probably that of Lappin et al. (1989). Nodes in trees are linked to their corresponding grammatical functions. Their motivation was to generate a set of grammatical function-based transfer rules as part of an MT project.

A regular expression-based, indirect automatic annotation method is described in Sadler et al. (2000). This involves extracting a context-free PS grammar (CFG) from a treebank fragment. F-structure annotation principles are stated in terms of regular expressions matching CFG rules. By applying regular expression-based annotation principles to the rules that are extracted, and using these annotated rules to re-match the original trees, f-structures can be generated for these trees. The number of annotation principles is appreciably smaller than the number of extracted CFG rule types since the regular expression-based annotation principles capture linguistic generalisations.

The flat, set-based tree description rewriting method of automatically annotating trees with f-structure descriptions developed by Frank (2000) can be seen as a generalisation of the regular expression-based technique of Sadler et al. (2000). Here the idea is that each tree is translated into a flat description using terms from a tree description language (e.g. *lex, arc, phi* etc.). Annotation principles are then defined in terms of rules employing a rewriting system originally developed for transfer-based MT architectures (Kay et al. 1994). In certain circumstances, the principles can be applied order-independently, or in a particular cascading order. One of the advantages of this method is that tree fragments of arbitrary depth can be considered, whereas in the regular expression-based method, tree depth is limited to 1 (i.e. CFG rules).

The earlier approaches were limited in scale to corpora in the order of hundreds of trees. In Cahill et al. (2002a), a first version of a large-scale indirect annotation algorithm was described. This algorithm was scaled to a corpus containing tens of thousands of trees. The algorithm recursively traverses a PS tree and annotates f-structure information on each node. McCarthy (2003) and Burke (2006) continued to expand this algorithm in terms of linguistic coverage. The algorithm itself is modular and separates the linguistic data from the traversal algorithm. There are two stages to the algorithm: (i) “proto”-f-structures are generated which contain unresolved long-distance dependencies (LDDs); and (ii) trace information encoded in the treebank is used to correctly link moved constituents to where they should be interpreted semantically. Given a PS tree with f-structure-annotated nodes, a constraint solver based on the one described in Gazdar & Mellish (1989) was used to produce the final f-structure representation for the tree. This body of work yielded the first large-scale algorithm for converting a treebank into a corpus of f-structures. This was a prerequisite for the parsing work that built on this corpus as described in Section 5.

Similar efforts to automatically acquire wide-coverage grammars for TAG (Xia 1999), HPSG (Miyao et al. 2003), and CCG (Hockenmaier & Steedman 2002) appeared around the same time as the work on LFG.

5 Probabilistic parsing & lexicon induction using LFG

With the availability of large-scale f-structure-annotated treebanks, it was now possible to train probabilistic LFG parsers.

The initial parsing experiments of Cahill et al. (2002b) were conducted on the Penn Treebank (Marcus et al. 1994). Two main approaches were compared:

1. Parse with a standard CFG parser and then automatically annotate the resulting tree (*pipeline* architecture)

2. Automatically annotate the nodes in the trees of a large corpus with f-structure information and train a probabilistic parser on it (*integrated* architecture)

Both approaches yielded c-structures whose node labels included f-structure annotations. These f-structure annotations were then collected and resolved to generate a final f-structure. Initial parsers generated what were called "proto"-f-structures which did not include any LDD resolution. It should be noted that since these techniques were probabilistic, a set of n-best trees (and therefore f-structures) could also straightforwardly be produced. This was not possible with hand-crafted grammars which output all possible f-structure solutions for a given sentence without any way to sort them. Riezler et al. (2002) showed that it was possible to *post hoc* rank the output of such a parser, however.

In Cahill (2004) and Cahill et al. (2004), additional functionality was added to the original algorithm to allow for LDD resolution. This yielded more complete f-structures. There were two main components to the algorithm: (i) a set of possible functional uncertainty paths, and (ii) a subcategorisation lexicon.

In order to obtain the set of possible functional uncertainty paths, all observed paths between co-indexed material were extracted from the f-structures automatically derived from the Penn Treebank. These paths were associated with probabilities. O'Donovan et al. (2004) and O'Donovan (2006) describe an approach for automatically acquiring a large-scale subcategorisation lexicon from the Penn

Treebank. This relies on the intuition that if the original conversion of the treebank into f-structures is of high enough quality, then the lexical entries for all predicates can be reverse-engineered (van Genabith, Way, et al. 1999a). Frames are not predefined, yet the frames that are automatically acquired fully reflect LDDs in the source data-structures, discriminate between active and passive frames, and conditional probabilities are associated with each frame.

Given a set of semantic forms s with probabilities $P(s|l)$ (where l is a lemma), a set of paths p with $P(p|t)$ (where t is either TOPIC, TOPICREL or FOCUS) and an f-structure f, the core of the algorithm to resolve LDDs recursively traverses f to identify the most likely location of co-indexed material.

Evaluation of the f-structures produced by both parsing approaches was carried out against several corpora over time: the DCU-105 corpus (Cahill et al. 2002a), the automatically converted Section 23 of the Penn Treebank, the PARC 700 corpus (King et al. 2003) and the CBS 500 (Carroll et al. 1998). F-structures were converted into dependency triple format and compared to the gold-standard triples to give results in terms of precision, recall and f-score. Results demonstrated state-of-the-art results compared to other 'deep' parsers available at the time. Cahill, Burke, O'Donovan, et al. (2008) summarize a large set of parser comparisons, and show that the f-structures produced by the automatic processes described above were able to outperform two hand-crafted parsers: RASP (Carroll & Briscoe 2004) and the the English ParGram LFG run on XLE (Riezler et al. 2002). Rimell et al. (2009) conduct a comparison of several "deep" parsers on a specialized corpus of sentences containing only LDDs. They find that the HPSG and CCG parsers perform better than the DCU LFG parser on this set of difficult sentences.

6 Multilingual probabilistic LFG induction

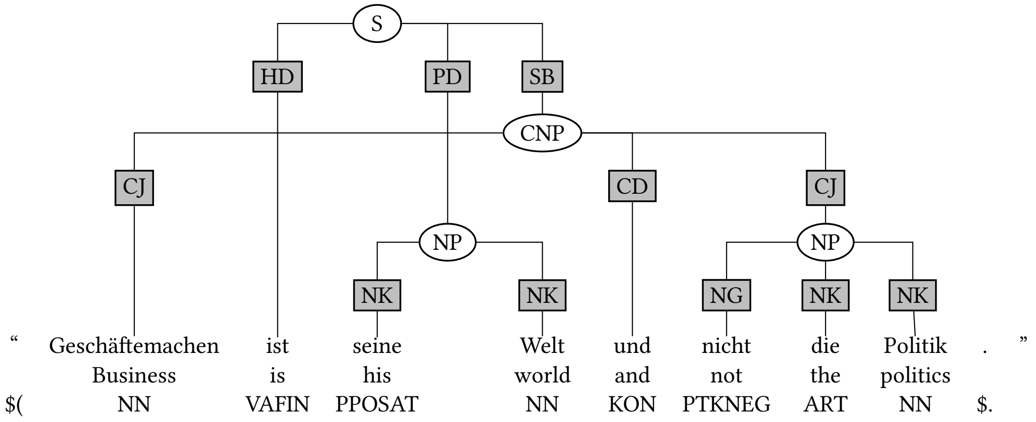
The approach developed for English was language-independent. Given a large enough and detailed treebank, one could theoretically follow the same framework to generate parsers and lexicons for other languages. Indeed, given that comparable treebank existed for some languages other than English, a large body of work ensued in this direction.

Cahill et al. (2003) first attempted this for German using the TiGer Treebank (Brants et al. 2002). This treebank differs from the Penn Treebank in that it encodes parses in terms of labeled graphs that allow crossing edges. In Cahill et al. (2003), the graphs are first converted to trees similar to those found in the Penn Treebank with trace information added to account for moved constituents.

A set of rules was then developed that automatically assigned f-structure equations to the nodes in the trees, and the same techniques described in Cahill et al. (2002b) were used to automatically acquire the first large-scale probabilistic LFG for German.

We provide an example graph from the TiGer treebank in (27) for the German sentence “Geschäftemachen ist seine Welt und nicht die Politik” (“Business is his world, not politics”).

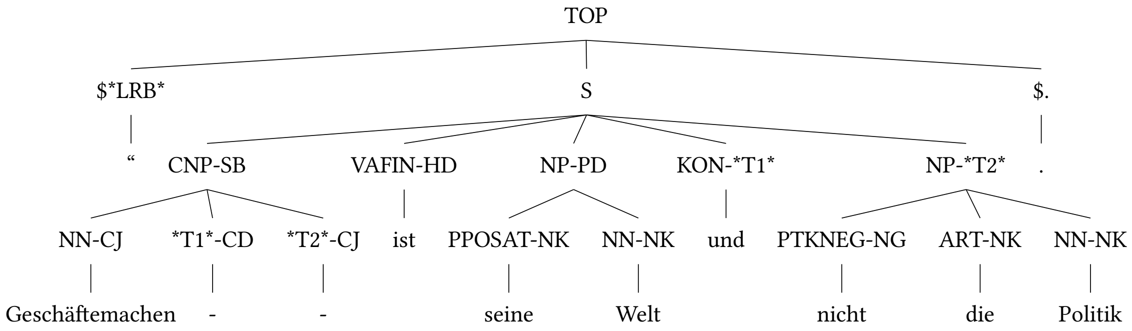
(27)



‘Business is his world, not politics.’

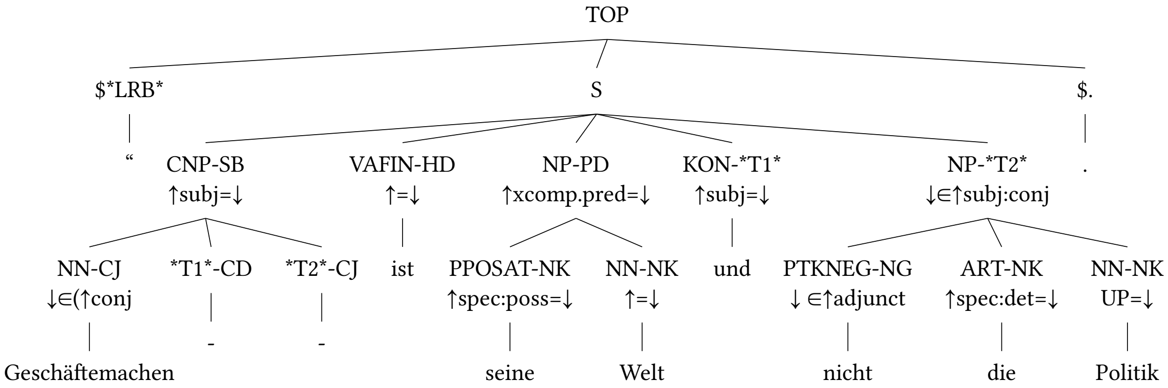
In (28), the graph in (27) is first automatically converted into a PS tree with traces and coindexation to indicate linked elements, analogous to how this kind of information is encoded in the English Penn-II treebank.

(28)



In (29), the tree in (28) is then annotated with f-structure equations. The annotation algorithm relies heavily on the functional component of the tree node labels (e.g. that SB indicates a SUBJECT).

(29)



Finally, the equations in (25) are collected and passed through a constraint solver to generate the f-structure in (30), using the same procedure as for English.

(30)
$$\left[\begin{array}{ll} \textsc{xcomp.pred} & \left[\begin{array}{ll} \textsc{spec} & \left[\textsc{poss}\ \left[\textsc{pred}\ \textsc{pro}\right]\right] \\ \textsc{pred} & \textsc{Welt} \end{array}\right] \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{conj} & \left\{\begin{array}{l} \left[\textsc{pred}\ \textsc{Geschäftemachen}\right] \\ \left[\begin{array}{ll} \textsc{pred} & \textsc{Politik} \\ \textsc{spec} & \left[\textsc{det}\ \left[\textsc{pred}\ \textsc{die}\right]\right] \\ \textsc{adjunct} & \left\{\left[\textsc{pred}\ \textsc{nicht}\right]\right\} \end{array}\right] \end{array}\right\} \\ \textsc{coord-form} & \textsc{und} \end{array}\right] \\ \textsc{pred} & \textsc{ist} \end{array}\right]$$

Rehbein & van Genabith (2009) continued this work and explored the effect of the design of the treebank on the success of the technique. They compared extracting a probabilistic LFG from both TiGer and TüBa-D/Z (Telljohann et al. 2006) and found (1) that automatically inducing linguistic resources from (semi-) free word order languages such as German is much harder than for more configurational languages like English, and (2) that the the treebank encoding can have a significant effect on the success of the automatic f-structure annotation approach. Rehbein & van Genabith (2009) found that the encoding of linguistic structures in the TiGer treebank was better suited for automatic induction of LFG resources, because it was more difficult to automatically learn the grammatical function relations as they were encoded in the TüBa-D/Z.

For Chinese, Burke, Lam, et al. (2004) first applied the approach to the Penn Chinese Treebank (Xue et al. 2002). We provide in (31) an example tree from this treebank.

(31)
```
(IP-HLN
      (NP-PN-SBJ
            (NR 江泽民)
            (NR 李鹏))
      (VP
            (VV 电唁)
            (NP-OBJ
                  (NP-PN
                        (NR 尼克松))
                  (NP
                        (NN 逝世)))))
```
“江泽民李鹏电唁尼克松逝世”
‘Jiang Zemin and Li Peng condoled the bereavement of Nixon by a telegram.’

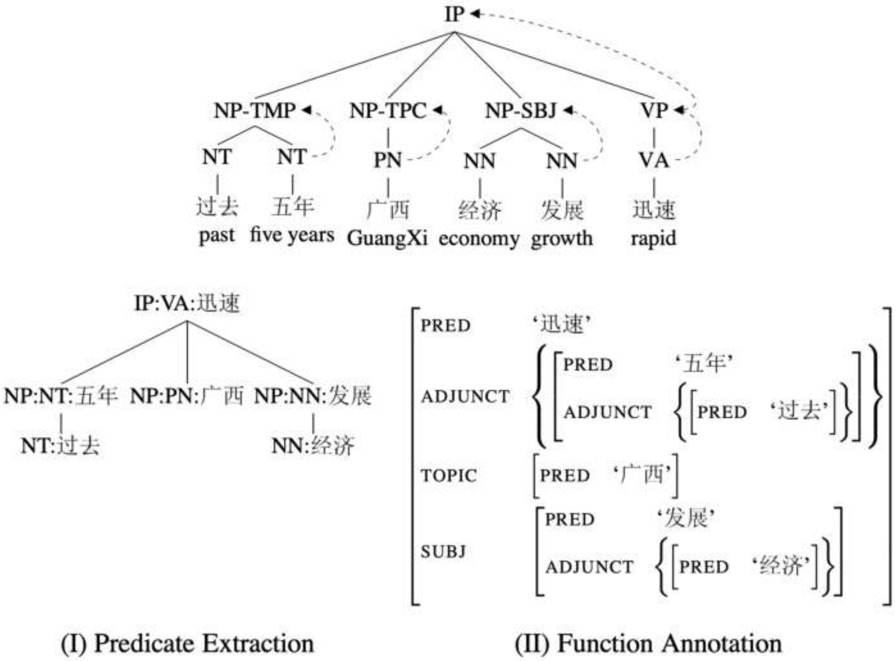
Each node in the tree in (31) is then annotated with f-structure equations, and the f-structure in (32) is derived.

(32)
```
subj :   coord_form : null
         coord :    1 :   pred : '江泽民'
                          pers : 3
                          noun_type : proper
                          gloss : ‘Jiang_Zemin’
                    2 :   pred : '李鹏'
                          pers : 3
                          noun_type : proper
                          gloss : ‘Li_Peng’
pred : '电唁'
gloss : condole_by_a_telegram
obj :    adjunct :  3 :   pred : '尼克松'
                          pers : 3
                          noun_type : proper
                          gloss : ‘Nixon’
         pred : '逝世'
         pers : 3
         noun_type : common
         gloss : ‘bereavement’
```
“江泽民李鹏电唁尼克松逝世”
“Jiang Zemin and Li Peng condoled the bereavement of Nixon by a telegram.”

Guo et al. (2007) and Guo (2009) extended this work in terms of coverage, robustness, quality and fine-grainedness of the resulting LFG resources. They propose a more general two-stage annotation architecture, avoiding some of the limitations of the PS annotation-based method. They argue that this approach may be more suitable for less configurational languages. This algorithm works by transducing the tree into an f-structure by means of an intermediate dependency structure.

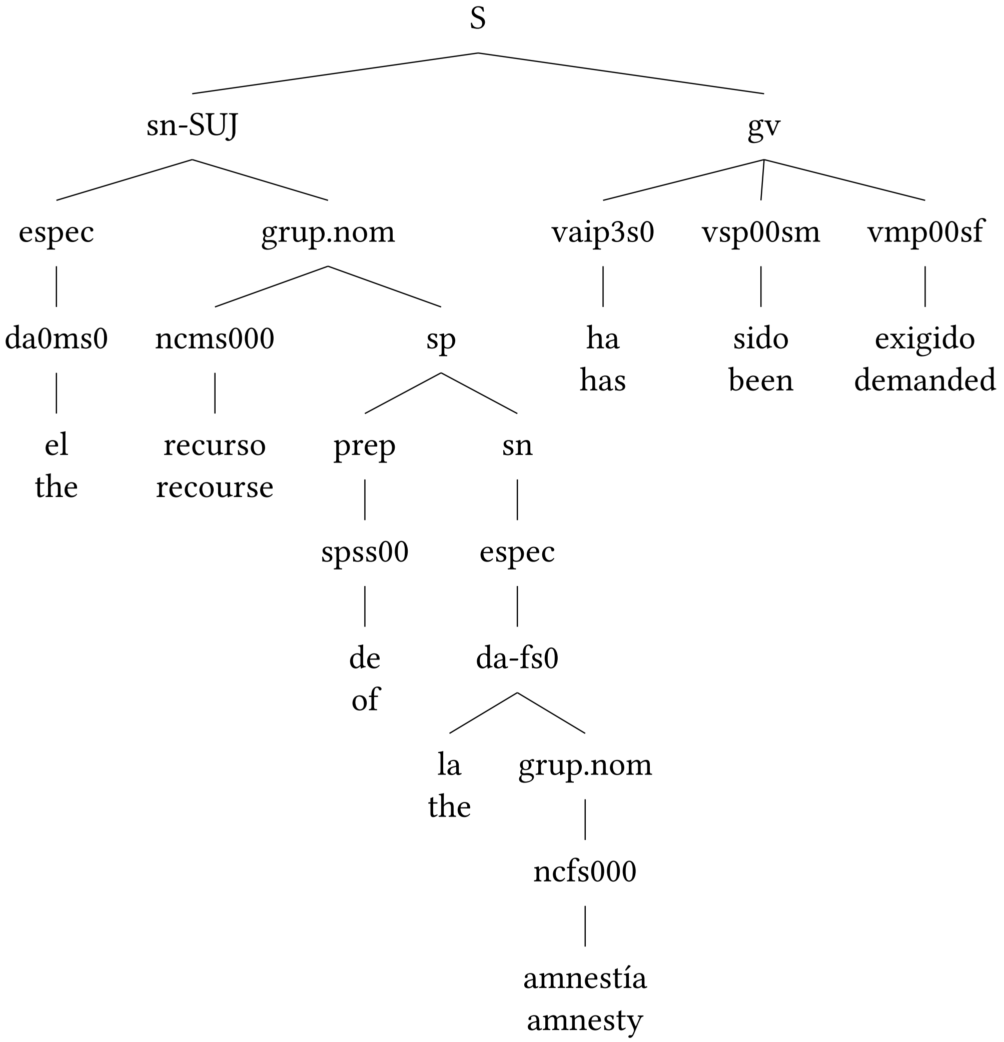
In (33), we show an example where predicate information is first extracted from the tree, and then a simpler set of function-based annotations converts the intermediate structure into an f-structure. The advantages of this approach are that it guarantees a single connected f-structure, as well as simplifying the process of taking LDDs into account.

(33)



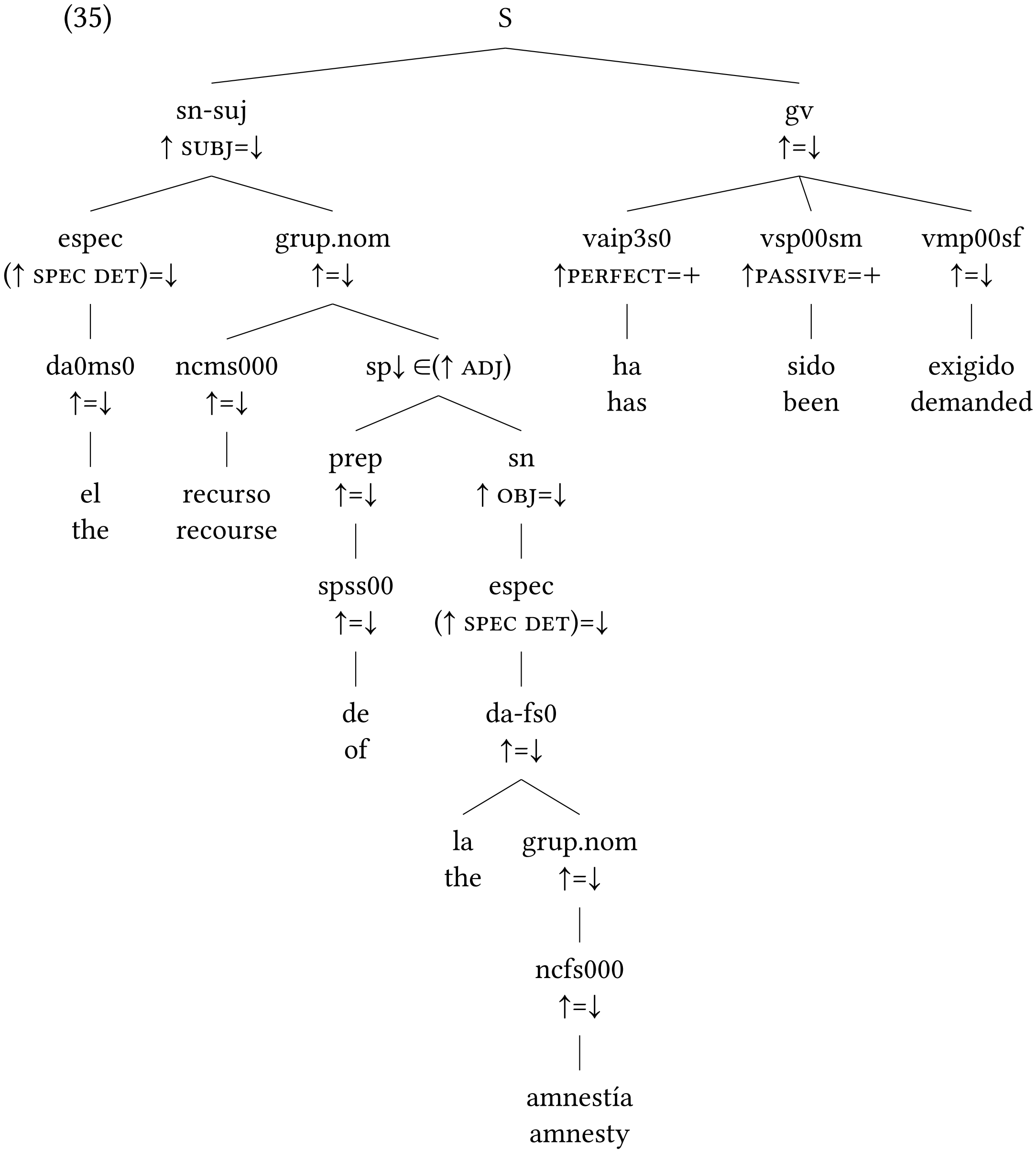
O'Donovan et al. (2005) proposed an adaptation of the original approach for Spanish using the CAST3LB treebank (Civit 2003). In (34), we provide an example from the CAST3LB treebank.

(34)



The tree in (34) is then annotated with equations, as illustrated in (35). The equations are then resolved into the f-structure in (36).

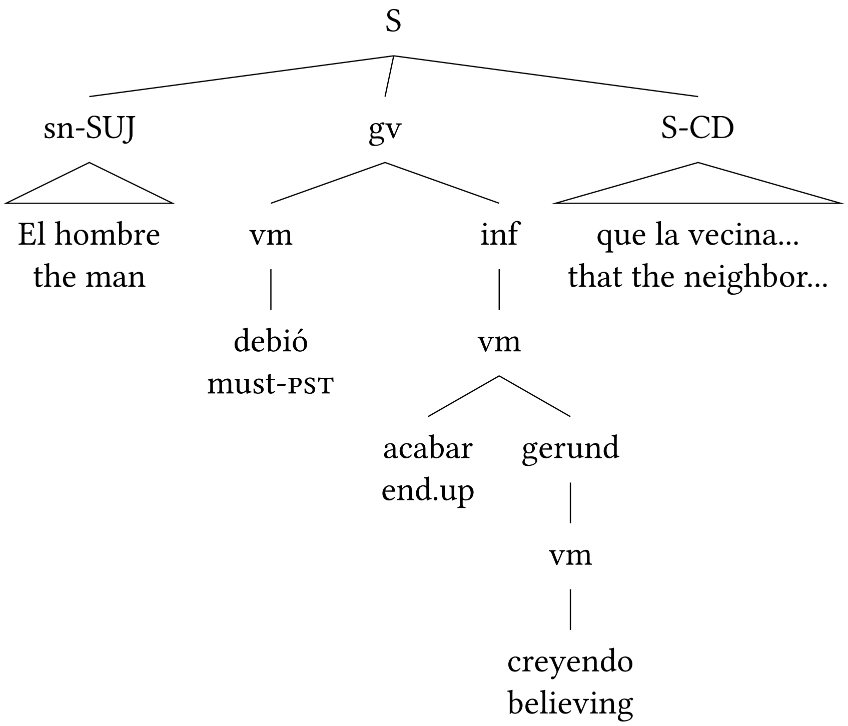
(35)


S
sn-suj
↑ SUBJ=↓
gv
↑=↓
espec
(↑ SPEC DET)=↓
grup.nom
↑=↓
vaip3s0
↑PERFECT=+
vsp00sm
↑PASSIVE=+
vmp00sf
↑=↓
da0ms0
↑=↓
ncms000
↑=↓
sp↓ ∈(↑ ADJ)
ha
has
sido
been
exigido
demanded
el
the
recurso
recourse
prep
↑=↓
sn
↑ OBJ=↓
spss00
↑=↓
espec
(↑ SPEC DET)=↓
de
of
da-fs0
↑=↓
la
the
grup.nom
↑=↓
ncfs000
↑=↓
amnestía
amnesty

(36)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{exigir}\text{'} \\ \textsc{perfect} & + \\ \textsc{passive} & + \\ \textsc{tense} & \textsc{present} \\ \textsc{subj} & \begin{bmatrix} \textsc{spec} & \begin{bmatrix} \textsc{det} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{el}\text{'} \\ \textsc{num} & \textsc{sing} \\ \textsc{gend} & \textsc{masc} \end{bmatrix} \end{bmatrix} \\ \textsc{pred} & \text{`}\textsc{recurso}\text{'} \\ \textsc{num} & \textsc{sing} \\ \textsc{gend} & \textsc{masc} \\ \textsc{adj} & \left\{ \begin{bmatrix} \textsc{pred} & \text{`}\textsc{de}\text{'} \\ \textsc{obj} & \begin{bmatrix} \textsc{spec} & \begin{bmatrix} \textsc{det} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{el}\text{'} \\ \textsc{num} & \textsc{sing} \\ \textsc{gend} & \textsc{fem} \end{bmatrix} \end{bmatrix} \\ \textsc{pred} & \text{`}\textsc{amnest\'{i}a}\text{'} \\ \textsc{num} & \textsc{sing} \\ \textsc{gend} & \textsc{fem} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix} \end{bmatrix}$$

This was extended in Chrupała & van Genabith (2006) where three main issues were addressed: (i) new constructions that had standard LFG analyses (e.g clitic doubling and null subjects); (ii) new constructions where no LFG analysis was available (e.g. periphrastic constructions in Spanish, see Figure 1); and (iii) limitations of the previous approach due to treebank- and language-specific assumptions which did not hold for Spanish and the CAST3LB treebank. Similar to what Guo et al. (2007) and Rehbein & van Genabith (2009) had found in their adaptations, the original approach assumed that the functional information could easily be derived from the tree configuration, but this proved not to be the case for many languages. Therefore, the functional tags in the parser output were critical for the success of these annotation algorithms. As a result, Chrupała & van Genabith (2006) outlined an improved method for tagging functions in parse trees, not only for Spanish, but for English, too. This was an important step in the development of a probablistic Spanish LFG parser based on the CAST3LB treebank.

In the case of French, no suitable treebank was immediately available. Therefore, Schluter & van Genabith (2007) first modified the Paris 7 Treebank (Abeillé et al. 2004), as this was the closest in format to what would be needed. A subset of the original treebank was transformed to yield a leaner, more coherent, treebank with several transformed structures, and new linguistic analyses. In Schluter & van Genabith (2008), it was shown that a probabilistic parser trained on the cleaner, modified treebank performed better than a parser trained on the



$$\left[\begin{array}{ll}
\textsc{subj} & \boxed{1}\left[\text{“}\textsc{el hombre}\text{”}\right] \\
\textsc{pred} & \text{‘}\textsc{deber}\text{’} \\
\textsc{tense} & \textsc{past} \\
\textsc{light} & + \\
\textsc{xcomp} & \left[\begin{array}{ll}
\textsc{subj} & \boxed{1} \\
\textsc{pred} & \text{‘}\textsc{acabar}\text{’} \\
\textsc{light} & + \\
\textsc{xcomp} & \left[\begin{array}{ll}
\textsc{subj} & \boxed{1} \\
\textsc{pred} & \text{‘}\textsc{creer}\text{’} \\
\textsc{light} & - \\
\textsc{comp} & \left[\text{“}\textsc{que la vecina...}\text{”}\right]
\end{array}\right]
\end{array}\right]
\end{array}\right]$$

Figure 1: Treatment of periphrastic constructions outlined in Chrupała & van Genabith (2006)

much larger, but noisier, original treebank. In addition, Schluter & van Genabith (2008) and Schluter (2011) showed that the techniques for automatically acquiring LFG resources from treebanks could successfully be adapted to the French case. Thanks to a rich morphological and functional annotation in the treebank, the automatic annotation algorithm can rely on node labels rather than inferring functional labels via tree configurations. This leads to fewer incomplete f-structures, and fewer cases where LDDs have not been resolved.

Oya & van Genabith (2007) showed that the approach can also be adapted for Japanese using the Kyoto Text Corpus (Kurohashi & Nagao 1997). The Japanese corpus encodes syntactic units in addition to rich morphological information. The automatic annotation algorithm adds f-structure equations at the level of syntactic unit. Figure 2 shows how the f-structure equations are added to each syntactic unit of the sentence "Taro went to Seoul". In the case of Japanese LFG parsing, the key to successful parsing results was in zero pronoun identification.

Finally, Tounsi et al. (2009a) and Tounsi et al. (2009b) demonstrated that the approach was also possible for Arabic using the Penn Arabic Treebank (Maamouri & Bies 2004). The annotation algorithm was able to take advantage of rich morphological tags in the treebank to support the fact that Arabic is a morphologically rich language.

In most cases we observe that the original reliance on tree configurations to identify functional properties worked best for English. For the other languages, relying on functional information already in the original treebank, and then ensuring that the CFG parser also contains that information, yielded the most accurate f-structure parsers. Evaluation of LFG parsing for the other languages followed roughly the same procedure as for English, using a small manually annotated corpus of sentences from the treebank used to derive the algorithm and parser.

7 Related approaches to grammar induction

A natural evaluation of this approach to creating large-scale probabilistic LFG parsers is to compare large-scale grammars created manually using the XLE platform.

The method proposed in Riezler et al. (2002) provides a mechanism for ranking all possible solutions generated by the hand-crafted grammar, relying on the same kinds of treebank resources as the methods described above. Kaplan et al. (2004) show that the accuracy of the hand-crafted grammar is more accurate than the Collins (1999) parser (f-score of 77.6 vs 74.6), while only slightly slower

```
#S-ID:950101001-001
* 0 2D
太郎  たろう              * 名詞 人名 * *     (Taro Noun Person**)
が  が                   * 助詞 格助詞 * *    (ga particle Case **)
F0:pred ='Taro',
F0:case='ga',
F2:subj=F0,
* 1 2D
ソウル  そうる            * 名詞 地名 * *     (souru "Seoul" * Noun Place**)
に                       * 助詞 格助詞 * *    (ni particle Case**)
F1:pred='Seoul',
F1:case='ni',
F2:obl=F1,
* 2 -1D
行った  いった  行く  動詞 * 子音動詞 過去形 (itta 'went' iku Verb * ConsonantStem pst)
F2:pred='iku',
F2:tns='pst',
F2:stmt='decl',
F2:style='plain'.
EOS
```

(a) The automatically annotated sentence

$$\begin{bmatrix} \text{subj} & \begin{bmatrix} \text{pred} & \text{`Taro'} \\ \text{case} & \text{ga} \end{bmatrix} \\ \text{obl} & \begin{bmatrix} \text{pred} & \text{`Seoul'} \\ \text{case} & \text{ni} \end{bmatrix} \\ \text{pred} & \text{`iku}\langle\text{subj, obl}\rangle\text{'} \\ \text{stmt} & \text{'decl'} \\ \text{style} & \text{'plain'} \\ \text{tense} & \text{pst} \end{bmatrix}$$

(b) The resulting f-structure

Figure 2: An example from the Kyoto Text Corpus: from syntactically annotated sentence to f-structure

(total 299 CPU seconds vs 200 CPU seconds to parse 560 sentences). The two approaches have the same goal: to provide a ranked list of LFG parses for a given input. The difference is in how this ranked list is derived, and how much manual effort is required. Furthermore, in Cahill, Maxwell, et al. (2008) it was shown that a simple pruning mechanism on the c-structure forests generated by the XLE parser could significantly reduce parsing time, while maintaining comparable accuracy.

8 Conclusion

This chapter has described methods based on LFG that permit accurate, robust, scalable, probabilistic LFG parsers and MT systems to be built from large collections of automatically annotated data. While this is commonplace nowadays, it was much less so 20–25 years ago.

LFG-DOP extends LFG by generalizing well-formed analyses to allow ill-formed and previously uncovered strings to be handled. LFG-DOT, a robust, hybrid model of translation based on LFG-DOP, was demonstrated to be able to solve 'hard' cases of translation that proved difficult for DOT and LFG-MT.

The range of work on automatic annotation of LFG grammars summarised here was an important step in ensuring scalability and robustness that is commonplace nowadays. Once large-scale treebanks could be generated via these techniques, competitive probabilistic parsers were built, and large-scale lexical resources were induced. However, most experiments carried out using LFG-DOP (and LFG-DOT) were relatively small-scale, but we sketch here a method for large-scale experimentation using the resources created via the techniques described in this paper.

As well as the important extension of the core LFG framework to account for probabilistic parsing, this seminal work also provided the foundations for the now commonplace task of large-scale deep linguistic LFG annotation. In sum, the work described in this chapter laid the foundations for multilingual annotation of treebanks, which in turn allowed competitive scalable parsing and MT models to be developed that are accepted as best practice today.

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Chapter 25

LFG treebanks

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Treebanks are syntactically annotated corpora. LFG treebanks are collections of LFG analyses, usually created by parsing a corpus with an LFG grammar. This chapter provides an overview of existing LFG treebanks and explains how they are created, how they may be searched, and what their potential use may be to the LFG and other communities.

1 Introduction

Annotated corpora are important resources for many branches of linguistics, language studies and natural language processing. A common form of corpus annotation consists of labeling words with their parts of speech, lemmas and morphosyntactic features, such as number, person, tense, etc. Using only annotation at the word level limits the potential to search for important grammatical information, such as syntactic constructions, grammatical functions and predicate–argument relations. The usefulness of corpora is therefore greatly enhanced if they also include syntactic annotation, such as phrase structure and functional relations. Syntactically annotated corpora are usually called treebanks; if they are created by parsing, they may also be called parsed corpora or parsebanks.

LFG treebanks are treebanks annotated according to the LFG formalism. They are usually created as parsebanks, by parsing a corpus with an LFG grammar and disambiguating the parse results. An LFG parsebank is thus essentially a collection of analyses according to a grammar. LFG parsebanks encode a wealth of morphological, syntactic and semantic information in their c- and f-structure representations, and tend to be more detailed than treebanks adhering to other

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formalisms. The term treebank is well established even if the treebank may contain f-structures, which are directed graphs rather than trees.

This chapter is aimed at two audiences. The first target group consists of linguists who may wish to learn to use LFG treebanks in order to find data for their research. The second target group is linguists who may wish to build LFG treebanks as part of a grammar development project.

A major platform for LFG treebanking is INESS (Infrastructure for the Exploration of Syntax and Semantics) at the CLARINO Bergen Center (University of Bergen, Norway).[1] This infrastructure will be further introduced below and will be used throughout the chapter to illustrate the various possibilities of LFG treebanking.

Section 2 describes how LFG treebanks can be created through parsing with the Xerox Linguistic Environment and further processed with the LFG Parsebanker. In Section 3 the LFG treebanks in the INESS treebanking infrastructure are presented. Section 4 demonstrates how LFG treebanks may be queried with INESS Search. Finally, Section 5 describes approaches to conversion between LFG treebanks and treebanks adhering to other formalisms.

2 Building LFG treebanks

2.1 Basic requirements

A parser, an implemented grammar and lexicon, and efficient disambiguation tools are prerequisites for creating a parsebank. A useful set of tools in this respect is the Xerox Linguistic Environment (XLE), developed at the Palo Alto Research Center and the Xerox Research Centre Europe in Grenoble. XLE includes both a parser and a generator for LFG grammars, and it is suitable for grammar implementation on a small or large scale (Crouch et al. 2011, Maxwell & Kaplan 1993). For detailed information on XLE, see Forst & King 2023 [this volume].

A grammar and lexicon with wide coverage are essential for building a large treebank of authentic texts, as well as for other applications. Grammar development is however a process which typically starts with a small set of rules which is successively expanded. In this development, the grammar must constantly be tested to see whether all the old rules still work in addition to the new rules. In this incremental process, a corpus, even a small one initially, may be useful as a

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[1] https://clarino.uib.no/iness. INESS was built in the eponymous project (2010-2017) with funding from the Research Council of Norway and the University of Bergen (Rosén et al. 2012, Meurer et al. 2013).

test suite for parsing. As the grammar grows, it can be tested on a larger corpus and further improved. Larger grammars and lexicons do however increase the ambiguity in the analyses, so that efficient disambiguation is important.

XLE-Web[2] is a web-based implementation of XLE that was first developed in the LOGON and TREPIL projects (Rosén et al. 2005, 2006). XLE-Web uses the same parsing technology and software as XLE, but differs from the original platform in several ways. The original XLE is a standalone, integrated platform for grammar writing and debugging, whereas XLE-Web can be used through any modern browser. XLE-Web does not have tools for grammar writing, but it offers excellent tools for disambiguation.

As mentioned above, ambiguity becomes a considerable problem as the grammar grows. Therefore, XLE-Web offers *discriminant disambiguation* to efficiently select the intended analysis among possibly many alternative analyses. Discriminant analysis is a technique for identifying minimal differences between analyses and letting disambiguation proceed by resolving these differences rather than by inspecting whole structures (Rosén et al. 2007). An example of the XLE-Web display with discriminants is provided in Figure 1 for the ambiguous sentence *He saw the girl with binoculars*,[3] parsed with the English ParGram grammar.[4]

This sentence has two possible analyses due to a PP attachment ambiguity: *with binoculars* may be either an ADJUNCT of the clause or an ADJUNCT in the OBJ. Whereas XLE offers packed f-structures, XLE-Web offers packed representations for both c- and f-structures. A packed representation presents all analyses in one graph, with indices at choice points. In the middle of Figure 1 is a packed c-structure with one choice point which splits into the subtrees labeled *a1* and *a2*. A corresponding choice can be seen in the packed f-structure shown on the right in the figure. Although the disambiguated f-structure will have an ADJUNCT either on the outer level or inside the OBJ, both functions occur in the packed f-structure, labeled with *a1* and *a2* respectively.

On the left in the figure is a table with discriminants computed on the basis of these choice points. They present the user with each individual distinction between the analyses. There are two f-structure discriminants and ten c-structure discriminants.[5] F-structure discriminants describe paths through the f-structure

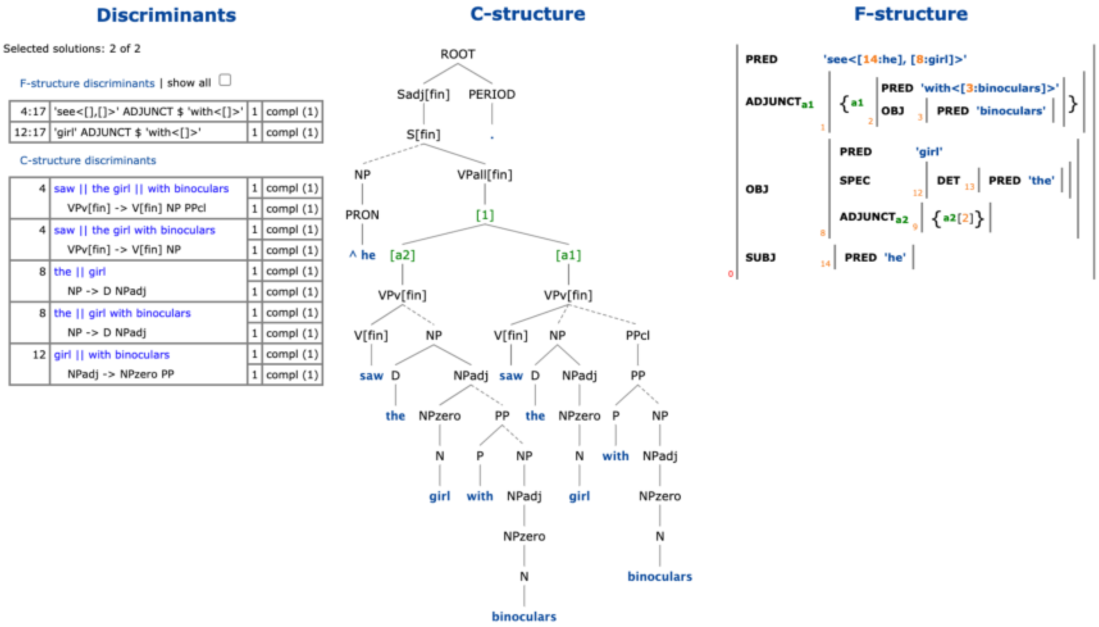
---

[2] https://clarino.uib.no/iness/xle-web

[3] In this and many subsequent f-structures, the *PREDS only* mode of display has been chosen. PREDS only mode displays only PRED values and the attribute paths which lead to them. This mode is often preferred when a full f-structure is too large to be easily legible.

[4] This grammar was developed in the Parallel Grammar (ParGram) project, see Section 3.6.2.

[5] In some cases there may also be lexical and morphological discriminants, but not for this sentence, which does not display any lexical ambiguities.



Discriminants

Selected solutions: 2 of 2

F-structure discriminants | show all ☐

4:17	'see<[],[]>' ADJUNCT $ 'with<[]>'	1	compl (1)
12:17	'girl' ADJUNCT $ 'with<[]>'	1	compl (1)

C-structure discriminants

4	saw || the girl || with binoculars	1	compl (1)
	VPv[fin] -> V[fin] NP PPcl	1	compl (1)
4	saw || the girl with binoculars	1	compl (1)
	VPv[fin] -> V[fin] NP	1	compl (1)
8	the || girl	1	compl (1)
	NP -> D NPadj	1	compl (1)
8	the || girl with binoculars	1	compl (1)
	NP -> D NPadj	1	compl (1)
12	girl || with binoculars	1	compl (1)
	NPadj -> NPzero PP	1	compl (1)

Figure 1: Analysis with discriminants and packed c- and f-structures for *He saw the girl with binoculars.*

from a PRED value to another PRED value or an atomic value. The two f-structure discriminants shown here indicate that the phrase *with binoculars* is an ADJUNCT either of the verb *see* or of the noun *girl*. The ten c-structure discriminants present the various minimal subtrees (a minimal subtree being a mother node and its daughter nodes) that make up the subtrees indexed with *a1* and *a2*. C-structure discriminants are either constituent discriminants, which show the bracketing of a substring, or rule discriminants, which show the labeled bracketing of a substring, expressed as a phrase structure rule. Rule discriminants are always displayed directly under the corresponding constituent discriminant, thus showing clearly which string of words the rule represents a bracketing of.

A discriminant may be chosen by clicking on it, or rejected by clicking on *compl* (for *complement*).[6] After a discriminant or its complement has been clicked on, it is displayed in boldface; the choice may be reversed by clicking on the boldfaced discriminant, thus resetting it. Since there are only two analyses for the

---

[6] The numbers to the left of the discriminants are anchors, which are necessary in case the same word or phrase occurs more than once in the sentence. In c-structure discriminants the anchor identifies the position of the first character in the substring. In f-structure discriminants the anchors identify the position of the first character of the words that project the PRED values in the discriminant. The number to the right of a discriminant (or its complement) indicates the number of solutions that will remain after the discriminant (or its complement) is chosen.

sentence in Figure 1, the intended one may be selected by choosing or rejecting any one discriminant. Figure 2 shows the effect of choosing the analysis in which *with binoculars* is an adjunct of the verb *see* by clicking on the first f-structure discriminant, resulting in full disambiguation. Discriminants that have not been chosen and that are no longer relevant for disambiguation, because they do not distinguish between any remaining analyses, are not displayed. This is important for efficiency, since the disambiguator then has fewer discriminants to take into consideration.

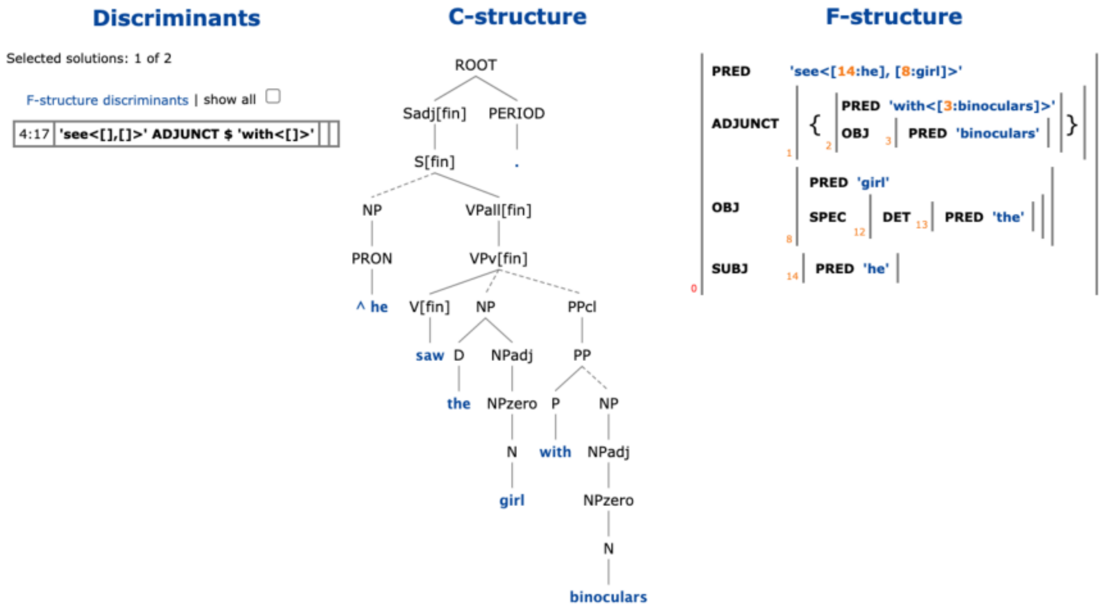


Figure 2: Fully disambiguated analysis for *He saw the girl with binoculars.*

This process may seem like overkill for this simple example which has only two readings. It becomes rewarding, however, when there are multiple ambiguities in the sentence. Even when the combination of ambiguities may give rise to a very large number of analyses, the number of discriminants does not necessarily increase as much, so that discriminant analysis remains comparatively efficient. A more detailed presentation of disambiguation with discriminants in LFG may be found in Rosén et al. (2007).

At the time of writing, the XLE-Web instance at INESS offers online parsing with the ParGram grammars of the following languages: English, French, Georgian, German, Indonesian, Italian, Malagasy, Norwegian, Polish, Tamil, Tigrinya, Turkish, Urdu and Wolof. Some of these have broad coverage, while others are more limited in scope.

2.2 The LFG Parsebanker

The LFG Parsebanker, available in INESS, is an integrated set of tools for creating and searching LFG treebanks (Rosén et al. 2009). It allows texts to be batch parsed with the XLE parser, and it stores the analyses in a database. The resulting parsebank may be disambiguated by using discriminants in the same way as described above. The LFG Parsebanker stores both the analyses and all discriminant choices that were made. This means that the grammar and lexicon may be further developed, and the treebank subsequently reparsed and at least partially redisambiguated with the stored discriminant choices. This method makes it possible to develop the grammar and the treebank in tandem, thus incrementally improving the quality of the analyses. The stored discriminants may also be used for stochastic parseranking. In this way larger parsebanks can be automatically disambiguated.

A possible drawback of constructing a treebank by parsing with an LFG (or other) broad-coverage unification grammar is that the grammar cannot hope to have full coverage for all authentically occurring sentences in a large corpus. Nevertheless, some traditional treebanks that are (at least partially) manually annotated are meant to assign an analysis to every sentence, and a variety of methods are utilized to achieve this. When a sentence is not covered by the grammar, an annotator can, for instance, manually construct an analysis to "fix" the problem. Although this provides an analysis for the treebank, it does not provide an analysis that is consistent with a grammar, and sentences that are not actually grammatical may receive analyses as if they were. In contrast, a pure parsebank does not resort to such ad hoc fixes, since it is often primarily meant to test the coverage and precision of a grammar, so that it is desirable to keep the treebank in sync with the grammar. The LFG Parsebanker therefore does not permit disambiguators to edit the automatically derived analyses, but allows them to make notes for grammar and lexicon development to solve coverage problems.

3 LFG treebanks in INESS

INESS is a treebanking infrastructure for building, hosting and exploring treebanks. It includes the above-mentioned XLE-Web and the LFG Parsebanker. It also has an elaborate infrastructure for browsing, search and visualization, as will be explained below.

INESS accommodates not only LFG treebanks, but also treebanks based on other frameworks, such as HPSG (Pollard & Sag 1994), constituency, and dependency treebanks. The infrastructure makes treebanks available online in an internet browser, eliminating the need to download treebanks and software for viewing and searching them, thus considerably facilitating access to them. Since INESS hosts many treebanks, there is an interface for treebank selection, as described in Section 3.1.

While some treebanks have completely open access, others require user authentication and authorization. Treebank owners decide under what licensing terms their treebanks are to be made available; some treebanks have restrictive licenses due to copyright of the input texts. The most open license that copyright will allow is recommended (Rosén & De Smedt 2022). INESS participates in the CLARIN Service Provider Federation (SPF), which allows researchers to authenticate themselves by logging in with their own university credentials, thus gaining access to many more treebanks than are freely available. The CLARIN SPF has participant institutions in many countries, both in Europe and beyond. Users not belonging to one of these institutions can apply for a user name and password at CLARIN.[7]

INESS hosts LFG treebanks of varying sizes. The larger treebanks TIGER, the LFG Structure Bank for Polish, and NorGramBank are presented in Section 3.2, Section 3.3 and Section 3.4, respectively. The smaller treebanks are presented in Section 3.5. INESS also hosts several parallel treebanks with LFG annotations, presented in Section 3.6. The INESS interface is described in more detail by Meurer et al. (2020).

3.1 Selecting treebanks in INESS

The first step in exploring treebanks involves selecting one or more treebanks. At the time of writing, INESS hosts 433[8] treebanks for 115[9] languages. The *Treebank Selection* page in INESS, shown in Figure 3, groups treebanks according to language, collection and type.

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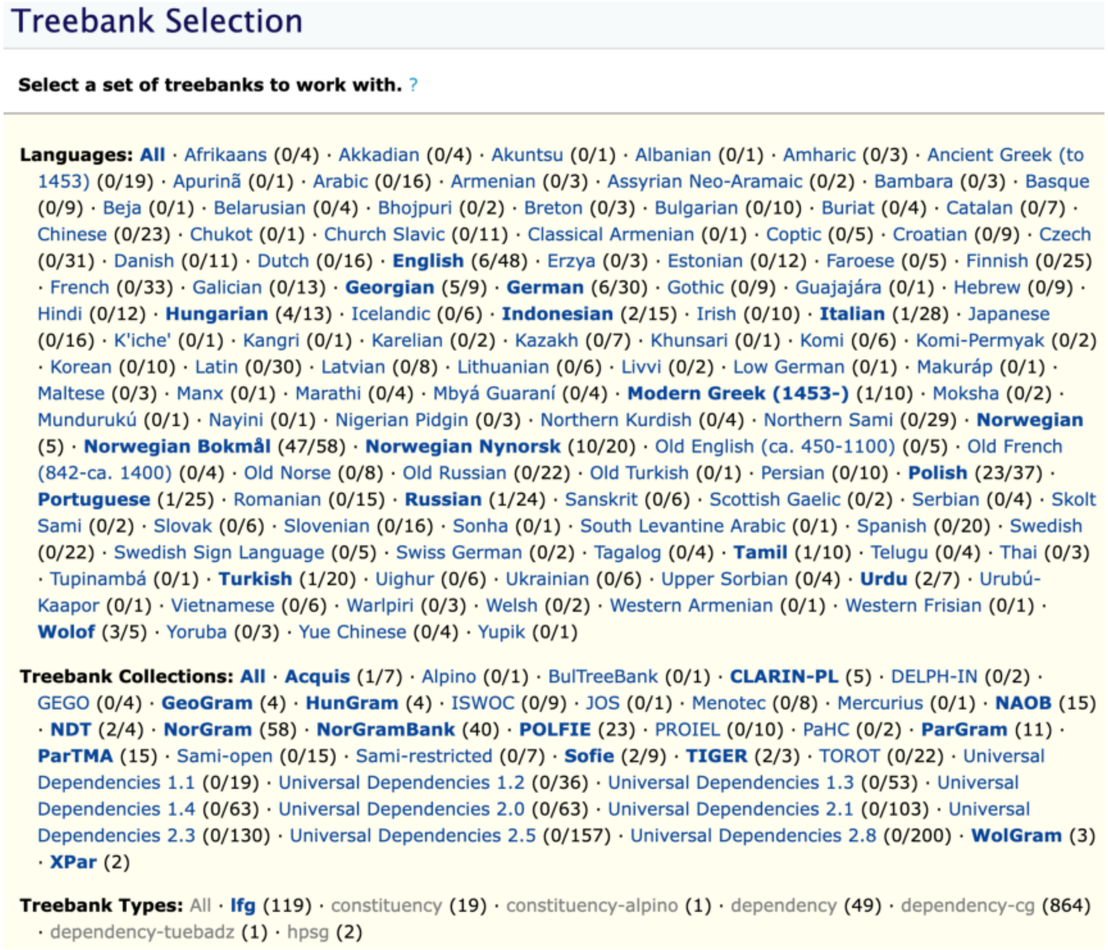
[7] CLARIN is a digital infrastructure offering data, tools and services to support research based on language resources (http://clarin.eu).

[8] According to Figure 3, there are 1057 treebanks in total, but this number includes all of the versions of the UD treebanks. If we only count the number of treebanks in Universal Dependencies 2.5 (200), the total number of treebanks is 433.

[9] There are 117 language names, but three of these are Norwegian, Norwegian Bokmål, and Norwegian Nynorsk, and these have been counted as one language: Norwegian. Norwegian Bokmål and Norwegian Nynorsk are the two written standards for the Norwegian language, with a good deal of lexical variation and many differences in spelling and morphology. Most treebank texts are written consistently in one variety or the other, so that users can choose which written variety to explore. Some texts, however, contain both varieties, for instance the proceedings of the Norwegian parliament 'Stortinget'; the latter are categorized simply as Norwegian.



Treebank Selection

Select a set of treebanks to work with. ?

Languages: **All** · Afrikaans (0/4) · Akkadian (0/4) · Akuntsu (0/1) · Albanian (0/1) · Amharic (0/3) · Ancient Greek (to 1453) (0/19) · Apurinã (0/1) · Arabic (0/16) · Armenian (0/3) · Assyrian Neo-Aramaic (0/2) · Bambara (0/3) · Basque (0/9) · Beja (0/1) · Belarusian (0/4) · Bhojpuri (0/2) · Breton (0/3) · Bulgarian (0/10) · Buriat (0/4) · Catalan (0/7) · Chinese (0/23) · Chukot (0/1) · Church Slavic (0/11) · Classical Armenian (0/1) · Coptic (0/5) · Croatian (0/9) · Czech (0/31) · Danish (0/11) · Dutch (0/16) · **English** (6/48) · Erzya (0/3) · Estonian (0/12) · Faroese (0/5) · Finnish (0/25) · French (0/33) · Galician (0/13) · **Georgian** (5/9) · **German** (6/30) · Gothic (0/9) · Guajajára (0/1) · Hebrew (0/9) · Hindi (0/12) · **Hungarian** (4/13) · Icelandic (0/6) · **Indonesian** (2/15) · Irish (0/10) · **Italian** (1/28) · Japanese (0/16) · K'iche' (0/1) · Kangri (0/1) · Karelian (0/2) · Kazakh (0/7) · Khunsari (0/1) · Komi (0/6) · Komi-Permyak (0/2) · Korean (0/10) · Latin (0/30) · Latvian (0/8) · Lithuanian (0/6) · Livvi (0/2) · Low German (0/1) · Makuráp (0/1) · Maltese (0/3) · Manx (0/1) · Marathi (0/4) · Mbyá Guaraní (0/4) · **Modern Greek (1453-)** (1/10) · Moksha (0/2) · Mundurukú (0/1) · Nayini (0/1) · Nigerian Pidgin (0/3) · Northern Kurdish (0/4) · Northern Sami (0/29) · **Norwegian** (5) · **Norwegian Bokmål** (47/58) · **Norwegian Nynorsk** (10/20) · Old English (ca. 450-1100) (0/5) · Old French (842-ca. 1400) (0/4) · Old Norse (0/8) · Old Russian (0/22) · Old Turkish (0/1) · Persian (0/10) · **Polish** (23/37) · **Portuguese** (1/25) · Romanian (0/15) · **Russian** (1/24) · Sanskrit (0/6) · Scottish Gaelic (0/2) · Serbian (0/4) · Skolt Sami (0/2) · Slovak (0/6) · Slovenian (0/16) · Sonha (0/1) · South Levantine Arabic (0/1) · Spanish (0/20) · Swedish (0/22) · Swedish Sign Language (0/5) · Swiss German (0/2) · Tagalog (0/4) · **Tamil** (1/10) · Telugu (0/4) · Thai (0/3) · Tupinambá (0/1) · **Turkish** (1/20) · Uighur (0/6) · Ukrainian (0/6) · Upper Sorbian (0/4) · **Urdu** (2/7) · Urubú-Kaapor (0/1) · Vietnamese (0/6) · Warlpiri (0/3) · Welsh (0/2) · Western Armenian (0/1) · Western Frisian (0/1) · **Wolof** (3/5) · Yoruba (0/3) · Yue Chinese (0/4) · Yupik (0/1)

Treebank Collections: **All** · **Acquis** (1/7) · Alpino (0/1) · BulTreeBank (0/1) · **CLARIN-PL** (5) · DELPH-IN (0/2) · GEGO (0/4) · **GeoGram** (4) · **HunGram** (4) · ISWOC (0/9) · JOS (0/1) · Menotec (0/8) · Mercurius (0/1) · **NAOB** (15) · **NDT** (2/4) · **NorGram** (58) · **NorGramBank** (40) · **POLFIE** (23) · PROIEL (0/10) · PaHC (0/2) · **ParGram** (11) · **ParTMA** (15) · Sami-open (0/15) · Sami-restricted (0/7) · **Sofie** (2/9) · **TIGER** (2/3) · TOROT (0/22) · Universal Dependencies 1.1 (0/19) · Universal Dependencies 1.2 (0/36) · Universal Dependencies 1.3 (0/53) · Universal Dependencies 1.4 (0/63) · Universal Dependencies 2.0 (0/63) · Universal Dependencies 2.1 (0/103) · Universal Dependencies 2.3 (0/130) · Universal Dependencies 2.5 (0/157) · Universal Dependencies 2.8 (0/200) · **WolGram** (3) · **XPar** (2)

Treebank Types: All · **lfg** (119) · constituency (19) · constituency-alpino (1) · dependency (49) · dependency-cg (864) · dependency-tuebadz (1) · hpsg (2)

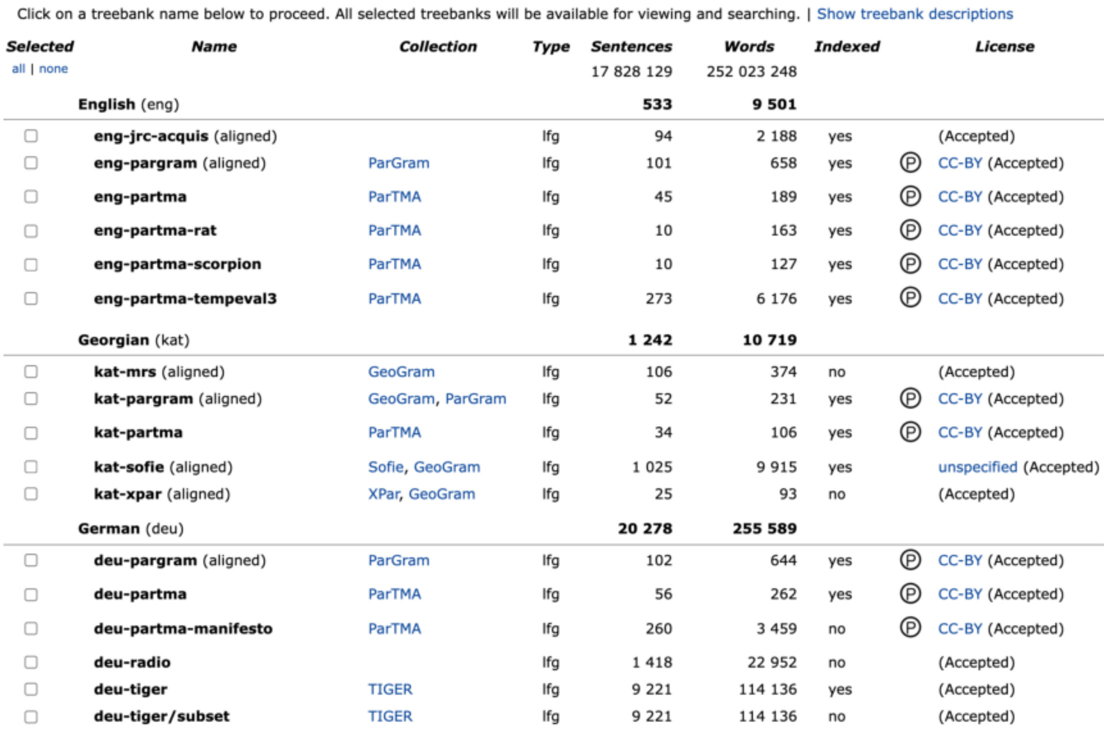
Figure 3: The INESS user interface for treebank selection, with treebank type *lfg* chosen

A collection contains several treebanks with something in common, for instance that they were developed as part of a specific project, or that they consist of translations of the same text into different languages (including the source language text). A single treebank may belong to more than one collection. Type refers to the annotation type, such as LFG, HPSG, constituency, and dependency, and includes subtypes of these. The user may click on any language, collection or type to make a first choice about which treebanks should be displayed.

In Figure 3 we see the effect of clicking on the type *lfg*; after this choice, only the languages and treebank collections that have LFG treebanks are displayed in boldface. Counting the boldfaced languages in Figure 3 shows that there are 16 languages that have LFG treebanks. After each language name, the numbers in parentheses indicate how many of the treebanks are LFG treebanks; for English, (6/48) means that six of 48 treebanks are LFG treebanks. In a similar manner, under Treebank Collections, TIGER (2/3) means that two of the three treebanks in the collection called TIGER are LFG treebanks.

Once a first choice has been made by a user, a list of all treebanks matching that choice is displayed. When LFG is chosen, a total of 119 treebanks are listed. The top of this list is shown in Figure 4.[10] For each treebank, this overview shows its name, which collections it belongs to, its annotation type, its size (in sentences and words), whether it has been indexed for search, and the type of license (if any). The user may choose one or more treebanks by ticking off the boxes to the left of the treebank name; clicking on the name of one of the chosen treebanks brings the user to that treebank. When exploring a treebank for the first time, the user is asked to accept the license conditions.

Clicking on a treebank name brings the user to the *Sentence Overview* page for that treebank; the sentences are listed one per line together with information about their disambiguation status. Clicking on a sentence displays the *Sentence* page, where the analysis for that sentence is shown including the textual context the sentence occurs in (the previous and following three sentences).



Click on a treebank name below to proceed. All selected treebanks will be available for viewing and searching. | Show treebank descriptions

Selected all | none	***Name***	***Collection***	***Type***	***Sentences*** 17 828 129	***Words*** 252 023 248	***Indexed***	***License***
	English (eng)			**533**	**9 501**		
☐	**eng-jrc-acquis** (aligned)		lfg	94	2 188	yes	(Accepted)
☐	**eng-pargram** (aligned)	ParGram	lfg	101	658	yes	Ⓟ CC-BY (Accepted)
☐	**eng-partma**	ParTMA	lfg	45	189	yes	Ⓟ CC-BY (Accepted)
☐	**eng-partma-rat**	ParTMA	lfg	10	163	yes	Ⓟ CC-BY (Accepted)
☐	**eng-partma-scorpion**	ParTMA	lfg	10	127	yes	Ⓟ CC-BY (Accepted)
☐	**eng-partma-tempeval3**	ParTMA	lfg	273	6 176	yes	Ⓟ CC-BY (Accepted)
	Georgian (kat)			**1 242**	**10 719**		
☐	**kat-mrs** (aligned)	GeoGram	lfg	106	374	no	(Accepted)
☐	**kat-pargram** (aligned)	GeoGram, ParGram	lfg	52	231	yes	Ⓟ CC-BY (Accepted)
☐	**kat-partma**	ParTMA	lfg	34	106	yes	Ⓟ CC-BY (Accepted)
☐	**kat-sofie** (aligned)	Sofie, GeoGram	lfg	1 025	9 915	yes	unspecified (Accepted)
☐	**kat-xpar** (aligned)	XPar, GeoGram	lfg	25	93	no	(Accepted)
	German (deu)			**20 278**	**255 589**		
☐	**deu-pargram** (aligned)	ParGram	lfg	102	644	yes	Ⓟ CC-BY (Accepted)
☐	**deu-partma**	ParTMA	lfg	56	262	yes	Ⓟ CC-BY (Accepted)
☐	**deu-partma-manifesto**	ParTMA	lfg	260	3 459	no	Ⓟ CC-BY (Accepted)
☐	**deu-radio**		lfg	1 418	22 952	no	(Accepted)
☐	**deu-tiger**	TIGER	lfg	9 221	114 136	yes	(Accepted)
☐	**deu-tiger/subset**	TIGER	lfg	9 221	114 136	no	(Accepted)

Figure 4: Top of the list of treebanks after the type *lfg* has been chosen

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[10] Treebank names in INESS begin with the three-letter ISO 639-3 code for the relevant language.

3.2 The TIGER treebank

The original TIGER treebank of German newspaper text (Brants et al. 2002, 2004) uses a hybrid annotation combining constituency and dependency information; part of it is also annotated with LFG structures. The constituency/dependency part of the treebank was constructed by two different methods. In one method a cascaded probabilistic parser was used in combination with manual annotation with the ANNOTATE tool (Brants & Plaehn 2000). The other method involved parsing with the German LFG grammar, followed by manual disambiguation; the XLE transfer system was employed to change the representations into the TIGER format (Zinsmeister et al. 2002). The LFG analyses were thus originally utilized in an experimental way to construct a more traditional treebank, but they now also constitute a useful resource as a standalone LFG treebank.

Figures 5 and 6 display the constituency/dependency and LFG analyses, respectively, for the sentence in (1). The URLs in parentheses in the captions are PIDs (persistent identifiers). They provide links to the analyses in the treebanks. Such links are persistent as long as the treebank they refer to remains available. For treebanks with certain licensing conditions, the PIDs may only work if the user is logged in and has accepted the license. For LFG treebanks, which are dynamic (they can be reparsed after changes are made to the grammar and/or lexicon), the PIDs are persistent in the sense that they provide a link to the *current* analysis of the sentence in the treebank.

(1) German
Das Angebot ist bereits groß.
the offer is already large
'The offer is already large.'

The tree in Figure 5 contains information about both phrase structure and syntactic functions. The nodes in yellow boxes are phrasal categories, while the nodes in the blue boxes under the S node are syntactic functions: sb for subject, hd for head, mo for modifier and pd for predicate complement.

The c-structure in Figure 6 displays extensive unary branching – many nodes have only single daughters – and many complex category labels, i.e., c-structure nodes subscripted with features enclosed in square brackets. The latter device moves some of the feature complexity of the LFG grammar from the f-structure space into the context-free c-structure space, which improves parsing efficiency while maintaining the simplicity of the c-structure rules. In the f-structure we see that the subj is also analyzed as the topic, the predicate complement is analyzed as an xcomp-pred, and the modifier is analyzed as an adjunct.

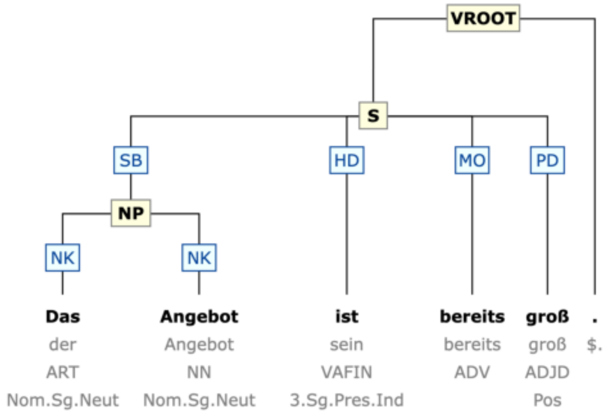

Figure 5: TIGER constituency/dependency analysis of (1) (http://hdl.handle.net/11495/D8B8-3970-851A-3@dep138682)

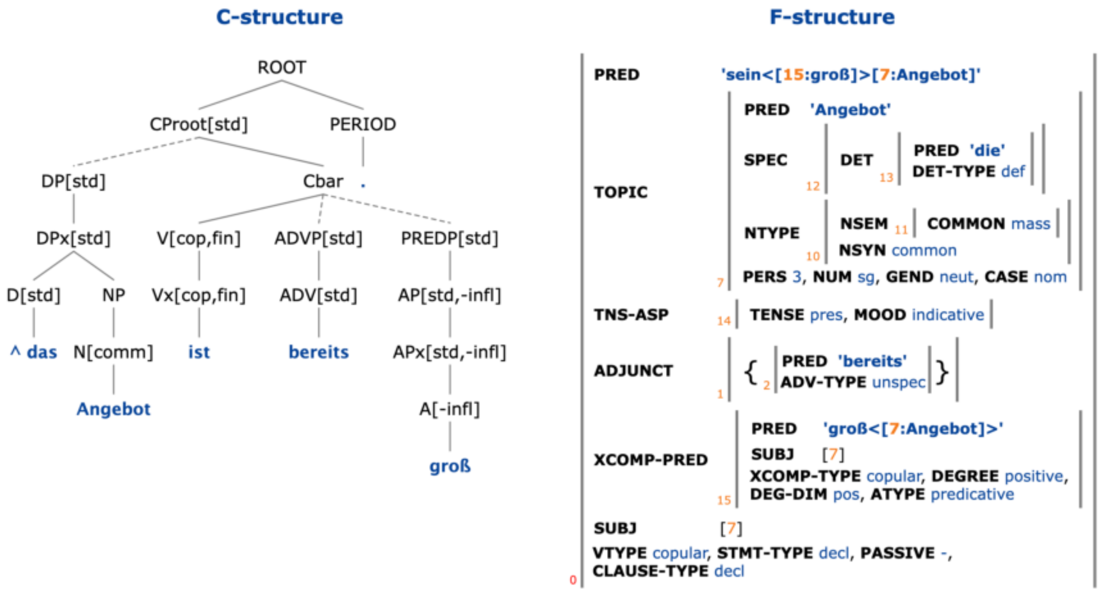

Figure 6: TIGER LFG analysis of (1) (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg41730)

3.3 The LFG Structure Bank for Polish

The LFG Structure Bank for Polish was built by parsing a corpus with the POLFIE grammar (Patejuk & Przepiórkowski 2012, 2014). This grammar was created by reusing context-free grammar rules written for another parser for Polish, Świgra, and adding annotations for building the f-structures. The corpus for the treebank is the one-million word subcorpus of the National Corpus of Polish[11] which has been manually annotated, the same subcorpus that was used for the previously annotated Składnica treebank.[12]

In INESS, the treebanks created by the POLFIE grammar are all in one large collection, also called POLFIE. This collection includes the LFG Structure Bank for Polish as well as other treebanks. The size of the POLFIE collection is 179,994 sentences and 2,022,026 words. Some of the subtreebanks in POLFIE are also in other collections: CLARIN-PL, ParGram and ParTMA.

Sample c- and f-structures from the POLFIE treebank for the sentence in (2) are given in Figure 7.

(2) Polish
Drzewo zostało ścięte wczoraj.
tree.NOM.SG.N get.3SG.N cut.NOM.SG.N yesterday
'The tree was cut down yesterday.'

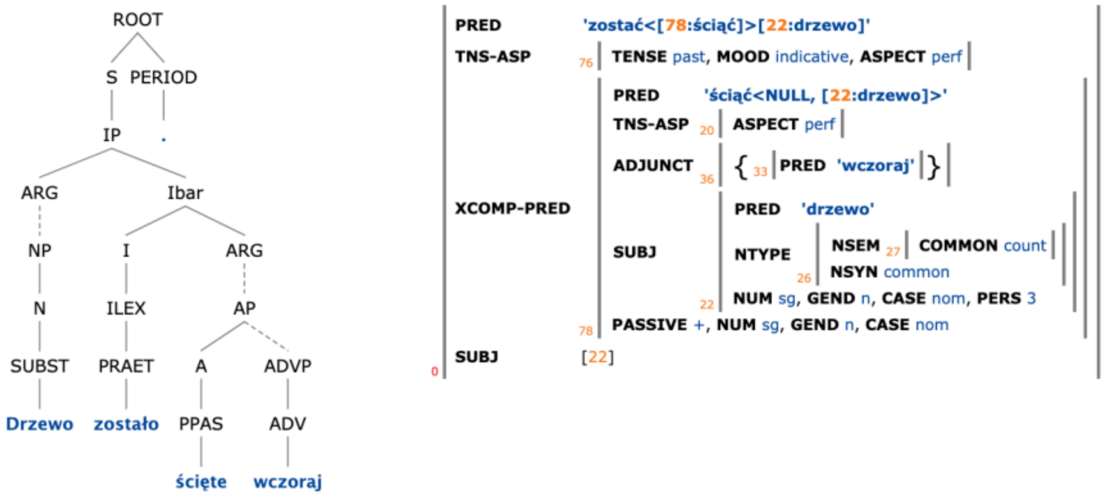

Figure 7: C- and f-structures for the Polish sentence in (2) (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg1411740)

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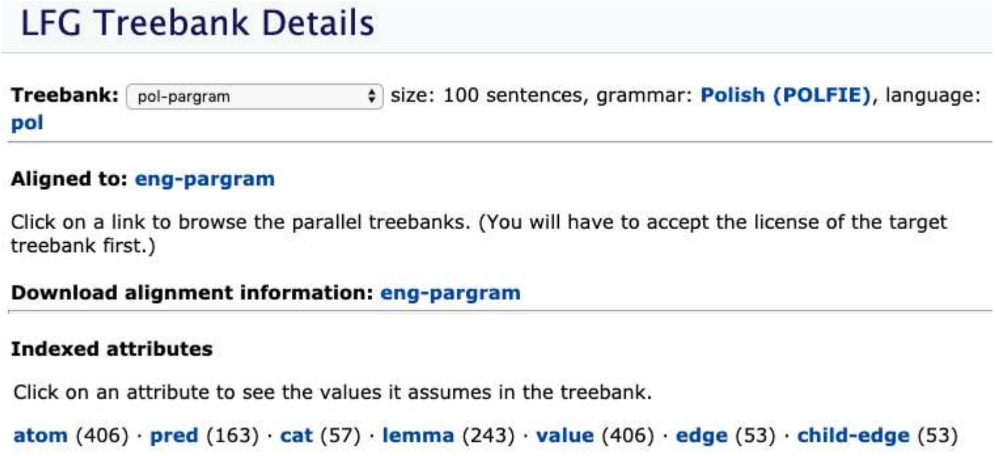
[11] http://nkjp.pl/index.php?page=0&lang=1

[12] http://zil.ipipan.waw.pl/Składnica

In the c-structure we see some familiar categories such as A, ADV, ADVP, NP, N, I, Ibar, etc., but there are also categories which we might not immediately be able to identify, such as ILEX, PRAET and PPAS. Some terms in the f-structure may also be unfamiliar, such as NTYPE, NSEM and NSYN.[13] Treebank documentation should ideally be made available by treebank creators to assist users in exploring the treebank; unfortunately INESS lacks documentation for many treebanks.

An overview of all *indexed attributes* for each treebank may be found on the *Treebank Details* page. The indexed attributes are all labels used in the treebank annotation that can be searched for. For LFG treebanks, these attributes include *cat* (category) and *edge* (feature or attribute, in more standard LFG terminology). A screenshot of the top of this page is shown in Figure 8.



LFG Treebank Details

Treebank: pol-pargram size: 100 sentences, grammar: **Polish (POLFIE),** language: **pol**

Aligned to: eng-pargram

Click on a link to browse the parallel treebanks. (You will have to accept the license of the target treebank first.)

Download alignment information: eng-pargram

Indexed attributes

Click on an attribute to see the values it assumes in the treebank.

atom (406) · **pred** (163) · **cat** (57) · **lemma** (243) · **value** (406) · **edge** (53) · **child-edge** (53)

Figure 8: Treebank details for POLFIE

Clicking on *cat* and *edge* under *Indexed attributes* produces the lists in Figure 9. These lists are shown sorted according to frequency; we see that, for instance, the category NP occurs 236 times in this subcorpus (pol-pargram) consisting of 100 sentences.

3.4 NorGramBank: A Norwegian LFG parsebank

The INESS project had the twofold goal of building a treebanking infrastructure and of building the first large treebank for Norwegian. The result of the latter effort is the treebank collection NorGram, consisting of 15 million sentences (215

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[13] These f-structure attributes also occur in Figure 6, and they illustrate the parallelism on the f-structure level achieved by the ParGram grammars; see Section 3.6.2.

cat, distinct values: 57

This table shows all values of the attribute, together with their corpus counts.

Sorted ● by frequency ○ alphabetically

236	NP
201	N
199	SUBST
156	IP
115	ARG
103	S
98	--
86	ROOT
83	PERIOD
63	I
63	ILEX
58	Ibar
56	AP
56	PRAET
54	A
47	ADJ
40	AP-SURROUND-OR-NONE
39	FIN
37	COMMA
28	NEG
24	PP
23	P
23	PREP
15	CP
15	CPbare
10	COMP
7	PRON-TYPE
7	PSUBST
7	IMPT
7	XPsem
6	INF
5	MOD
5	PPAS
5	ADVP
5	RM
4	QUB
4	XPextr
4	A-TYPE
4	PADJ
4	NUMP
4	NUMbare
4	NUM
3	INT-MARK
3	ADV
3	PRON
3	PPRON3
2	SIEBIE
2	PACT
2	MODPART
2	PADV
2	XP_FOCUS
2	FM
2	CNEG
2	CONJ
1	IMPS
1	PCON

edge, distinct values: 53

This table shows all values of the attribute, together with their corpus counts.

Sorted ● by frequency ○ alphabetically

587	-
422	PRED
326	CHECK
326	_CAT
287	CASE
285	NUM
279	GEND
226	PERS
206	NTYPE
206	NSYN
206	NSEM
206	COMMON
132	SUBJ
117	TNS-ASP
117	ASPECT
103	TENSE
103	MOOD
98	_TOP
75	$
72	OBJ
55	ADJUNCT
54	DEGREE
51	ATYPE
36	PASSIVE
28	NEG
23	PTYPE
20	POSS
19	XCOMP-PRED
14	_VOC
13	CLAUSE-TYPE
12	TYPE
11	COMP
10	_PREDICATIVE
10	COMP-FORM
8	PFORM
8	OBL-STR
7	OBJ-TH
6	OBL
5	REFLEXIVE
5	_RQR
5	XCOMP
4	OBL-LOCAT
4	ACM
2	OBL-COMPAR
2	UDF
2	NEG-CONST
2	COORD-FORM
1	OBL-AG
1	XADJUNCT
1	OBL-PERL
1	OBL-MOD
1	OBL-ADL

Figure 9: Values for the *cat* and *edge* attributes in POLFIE

million words) and by far the largest LFG treebank available in INESS. It was parsed with the eponymous grammar NorGram, a wide-coverage LFG grammar developed in the LOGON, TREPIL and INESS projects. Several versions of this grammar were constructed and used for parsebanking, including versions with c-structure pruning (Cahill et al. 2008). Some material was disambiguated manually with discriminants, but the bulk of the parsebank was disambiguated automatically through stochastic parseranking, based on the stored discriminants.

The collection NorGramBank (Dyvik et al. 2016) consists of a subset of the texts parsed in the NorGram collection. NorGramBank has more than 160 million words and consists of a variety of text types; while some newspaper texts were included, edited fiction and nonfiction texts were preferred because these have a higher language quality and fewer errors. Any error in a sentence, whether typographical, orthographical or grammatical, will result in a failure to find the intended analysis on parsing. Some NorGram texts were excluded from NorGramBank because the source texts had many OCR errors.

The text selection for the corpus was partially dependent on available resources. While published texts are valued sources for treebanks and other corpora, copyright restrictions must be taken into account. It is therefore paramount to clear permissions with rights holders before starting to work on texts. In the case of NorGram, several texts were obtained through the National Library of Norway. For some of these, copyright had expired. For newer texts, exceptional permission to use these with some restrictions was obtained from the government. Every corpus must be provided with metadata, including such information as provenance and conditions for use.

The Norwegian treebanks parsed with NorGram have proved useful for lexicography (see Section 4.4). Some NorGram treebanks have been specifically added for NAOB, a dictionary project by the Norwegian Academy for Language and Literature aimed at building a large dictionary for Norwegian Bokmål. In INESS, the collection called NAOB consists of 15 treebanks with a total of over 11 million sentences (161 million words).

The Norwegian example analyses shown in Figures 10, 11, 14, 15 and 18 are all from the NorGram treebanks.

3.5 Small treebanks for grammar development

Most of the small LFG treebanks in INESS are test suites used in various projects. GeoGram, HunGram and WolGram are collections of test suites used for the development of XLE grammars for Georgian (Meurer 2009), Hungarian (Laczkó et al. 2013, Laczkó 2014) and Wolof (Dione 2014, 2019), respectively. Some of these test suites are parts of parallel treebanks (see Section 3.6). Other treebanks in these collections may only be available to their creators since they are work in progress and not at a stage where they may be useful to other researchers. Treebank developers decide whether they want to make their treebanks publicly available.

3.6 Parallel treebanks with LFG annotations

A parallel treebank is a collection of monolingual treebanks that are aligned with each other on the sentence level, and sometimes also on phrase and/or word levels. The most common type of parallel treebank involves one or more translations of a text that are aligned with the source text, but a parallel treebank can also have different annotations of the same text, for example a constituency annotation and a dependency annotation.

The user can select aligned parallel treebanks by choosing *Show only Parallel Treebanks* on the *Treebank Selection* page and selecting a collection from those that are then displayed in boldface. One of the treebanks to be examined is then chosen in the usual manner by clicking in the box next to the treebank name and subsequently clicking on the treebank name. From the *Sentence Overview* page, clicking on *Treebank Details* provides an overview of which other treebanks are aligned. Selecting one of those treebanks will start the display of parallel analyses for the two chosen languages.

The following subsections will present the XPAR Project (Section 3.6.1), the treebanks developed in the Parallel Grammar Project (Section 3.6.2), and other parallel treebanks containing LFG analyses (Section 3.6.3).

3.6.1 The XPAR Project

Language Diversity and Parallel Grammars (XPAR) was a pilot project which aimed to determine to what extent the development of parallel deep grammars for typologically diverse languages may support the automatic derivation of high-quality parallel treebanks for those languages (Dyvik et al. 2009). Principles for phrase alignment and methodology for the automatic alignment of c-structures from manually aligned f-structures were developed in the project.

A small parallel test suite of translationally equivalent Georgian and Norwegian sentences was used in developing the alignment tool. An example of aligned sentences is provided in (3), and their sentence-aligned analyses are shown in Figure 10.

(3) a. Georgian
gia-s uqvars eka.
Gia-DAT loves Eka.NOM
‘Gia loves Eka.’

b. Norwegian
Jon elsker Maria.
Jon loves Maria
‘Jon loves Maria.’

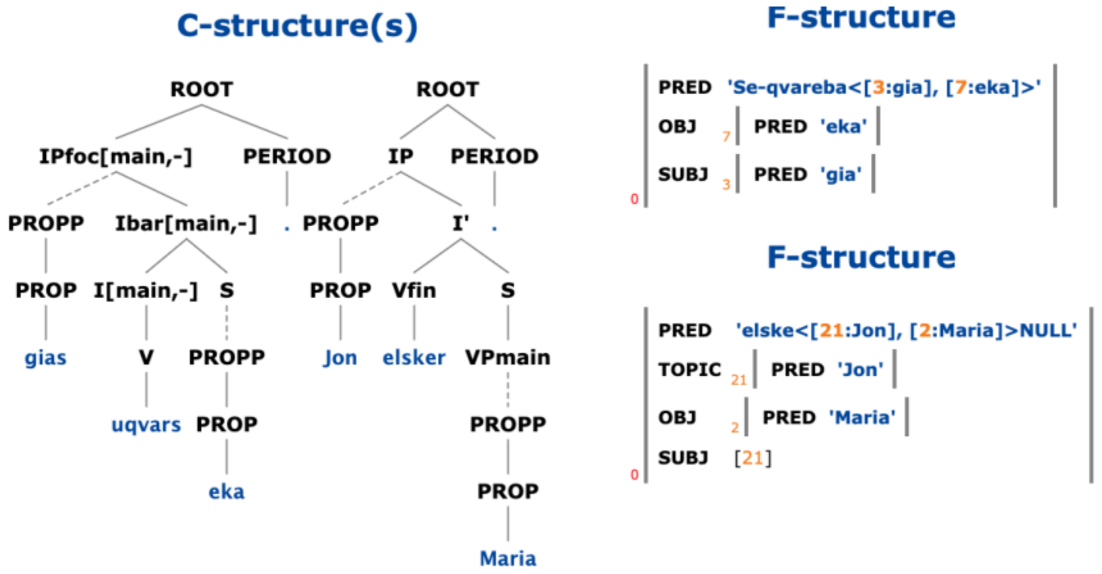

Figure 10: Sentence aligned c- and f-structures for the Georgian (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg51519) and Norwegian (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg60949) sentences in (3)

F-structures are manually aligned on the basis of translational correspondences at the level of predicate–argument structure. Subsidiary f-structures correspond if their predicates are in a translational relationship to one another. The alignment is done by dragging the index of one f-structure onto the corresponding index of the other f-structure. For instance, in Figure 10, the OBJ index 7 in the Georgian f-structure may be dragged onto the OBJ index 2 in the Norwegian one. This results in indices of the form $\boxed{n \rightarrow m}$, where n is the original index of that f-structure and m is the original index of the f-structure it is aligned with. Figure 11 shows the result of this manual alignment of f-structures, where the indices for the OBJ, SUBJ and main PRED have been aligned. Once the f-structures are aligned, the LFG Parsebanker automatically aligns the corresponding nodes

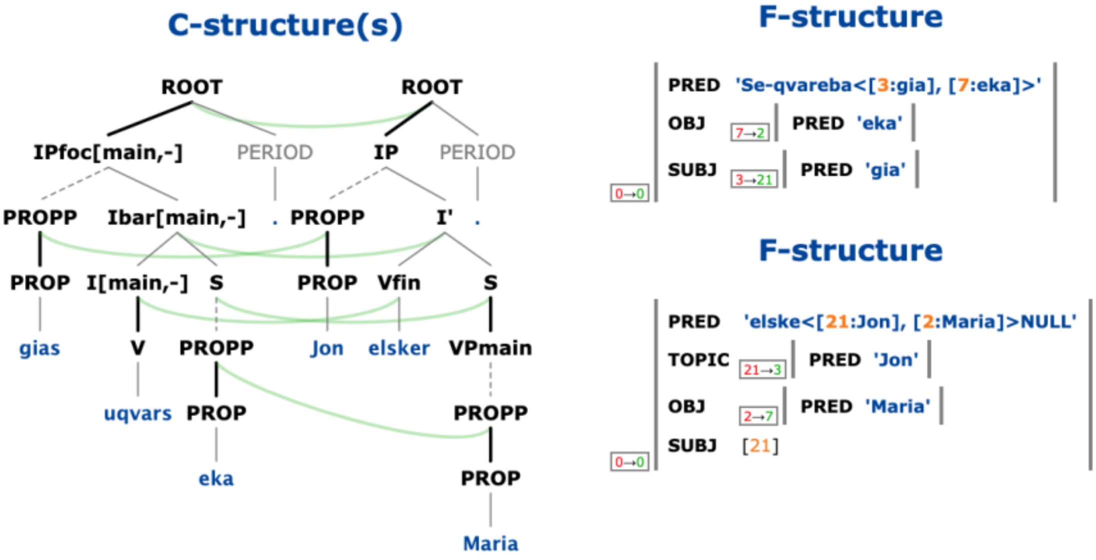

Figure 11: Word and phrase aligned c- and f-structures for the Georgian and Norwegian sentences in (3)

in the c-structures, shown by the curved green lines. We see, for example, that the OBJ alignment in the f-structures results in the alignment of the PROPP nodes dominating *Eka* and *Maria* in the c-structures.

3.6.2 The Parallel Grammar Project treebanks

The Parallel Grammar Project (ParGram) is an international cooperative effort to develop parallel LFG grammars implemented in XLE (Butt et al. 1999, 2002). Originally three languages were involved in the project: English, French and German; later, other languages joined, including Georgian, Hungarian, Indonesian, Japanese, Norwegian, Polish, Tamil, Turkish, Urdu and Wolof, among others. The main focus of the ParGram project was to develop and maintain linguistically motivated parallelism at the level of f-structure. Some of the ParGram participants have also been involved in the ParSem project, an effort to develop semantic structures based on the ParGram syntactic structures, with most of the ParSem systems using XLE's transfer system.

ParGram has created two parallel treebanks to support the aim of developing parallel LFG grammars. These treebanks consist of test suites encompassing various syntactic constructions. The English sentences were first agreed upon, and then translated into the other languages in the project. The first set of 50 sentences included such constructions as declaratives, interrogatives, imperatives, transitivity, passive, unaccusative, and subcategorized declaratives (Sulger et al.

2013). These sentences are included in the ParGram collection in INESS. Another set of sentences, concerned with tense, mode and aspect, constitutes the ParTMA collection. Figure 12 shows word and phrase aligned c- and f-structures for the English and German sentences in (4).

(4) a. What did the farmer see?

b. German
Was sah der Bauer?
what saw the farmer
'What did the farmer see?'

The f-structures for these sentences are practically identical, whereas the c-structures are quite different. This is both because the languages are different (English has *do*-support and German does not) and because the grammars for these languages have used quite different principles and techniques in writing the phrase structure rules. Still we see that most c-structure nodes are aligned. Since the XPAR principles align only translationally corresponding f-structures with PRED values, not all c-structure nodes can be aligned. The word *did* and the question marks only contribute features to the f-structure, not PRED values; these features are not shown here since the f-structures are displayed in PREDs only mode.

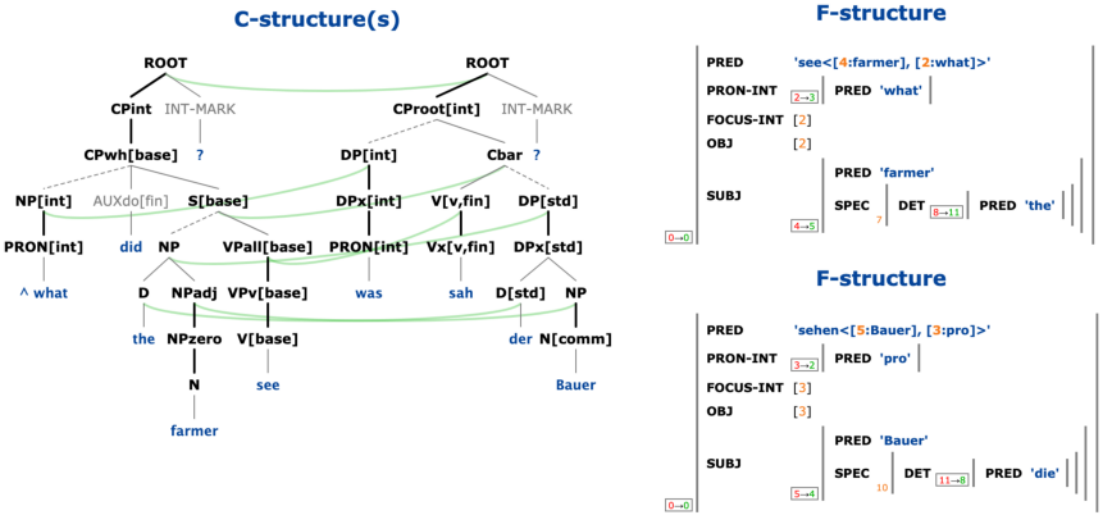

Figure 12: Word and phrase aligned c- and f-structures for the English (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg423651) and German (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg444239) sentences in (4)

3.6.3 Other parallel treebanks including LFG

Several projects have built parallel treebanks that include both LFG treebanks and treebanks of other types. Three such parallel treebanks are presented here.

The Sofie Parallel Treebank is a parallel corpus containing the first chapters of Jostein Gaarder's novel *Sofies verden* "Sophie's World". This text was chosen for treebanking because it is a well-written text that has been translated into a great number of languages. The Nordic Treebank Network developed treebanks based on these texts for Danish, Estonian, German, Icelandic and Swedish in the period 2001–2005. The META-NORD project,[14] which ran from 2011 to 2013, had as one of its goals to promote the accessibility of treebanks, including some that had not been maintained and were no longer accessible (Losnegaard et al. 2013). An English treebank, originally developed in the SMULTRON project,[15] and a Georgian treebank, developed at Uni Computing in Bergen, Norway, were added to the Sofie collection. Two treebanks for Norwegian were also developed, one an LFG treebank and the other a constituency treebank with syntactic and functional categories. Only the Georgian and one of the Norwegian treebanks have LFG annotation; the rest of the treebanks have various types of constituency annotation. In the initial version of the LFG Sofie treebank for Norwegian, 73% of sentences received analyses. An in-depth study of the sentences that received full parses that were not entirely correct showed that 29% lacked the correct analysis because of grammar problems, while lexical problems accounted for 71%, with missing multiword expressions in the lexicon being the most important of these. Subsequent grammar and lexicon updates resulted in correct analyses for more than 90% of these sentences (Losnegaard et al. 2012).

The META-NORD Acquis Parallel Treebank is a small parallel corpus of translations of a European Union directive.[16] The EU languages Danish, Estonian, Finnish, Latvian and Swedish, as well as the non-EU languages Norwegian and Icelandic, have treebanks in the collection. All language pairs are aligned at sentence level. The Norwegian treebank contains LFG analyses, while the other languages have consistency or dependency annotations.

The Norwegian Dependency Treebank was developed by the National Library of Norway (Solberg et al. 2014); it is made available in INESS as the treebanks named nob-ndt-dep (for Norwegian Bokmål) and nno-ndt-dep (for Norwegian

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[14] http://www.meta-net.eu/projects/meta-nord/

[15] https://www.ling.su.se/english/nlp/corpora-and-resources/smultron/stockholm-multilingual-treebank-smultron-1.14047

[16] Directive 2002/74/EC, from the Acquis Communautaire (AC), the total body of European Union law applicable in the member states.

Nynorsk). The treebank has also been converted to the Universal Dependencies (UD) annotation scheme (Øvrelid & Hohle 2016), creating the treebanks nob-ud-2.5-dep and nno-ud-2.5-dep. The same texts were parsed with NorGram to obtain LFG analyses, resulting in the treebanks nob-ndt-lfg and nno-ndt-lfg. The original dependency annotations were created automatically, but the analyses were then manually checked and corrected, resulting in a gold standard treebank. The dependency treebanks contain analyses for all sentences, while the LFG treebank has coverage for about 90% of the sentences. The analyses for the sentences that are covered in the LFG treebank are, however, much more detailed than those in the dependency treebanks. See Section 4.5 for more on UD treebanks, including a comparison with LFG analyses.

4 Exploring and exploiting LFG treebanks

4.1 INESS Search

Prior to the INESS project, there was no search tool that could perform search in LFG f-structures. INESS Search (Meurer 2012, 2020, Rosén et al. 2017) is a search tool that was developed in order to fill this need. It is a reimplementation and extension of TIGERSearch (Lezius 2002), a search system designed for the TIGER treebank (Zinsmeister et al. 2002, Brants et al. 2004). INESS Search retains the full functionality of TIGERSearch for querying constituency and dependency treebanks while extending its functionality in order to query fully general directed graphs like LFG f-structures; in addition, it can be used for search in HPSG treebanks. INESS Search supports almost full first-order predicate logic, including negation and existential and universal quantification, with the exception of universal quantification over disjunctions.

INESS Search is fully integrated in the INESS infrastructure and is used via its Web interface. There is extensive documentation for INESS Search online, both a walkthrough that describes how to get started searching in INESS treebanks,[17] and thorough documentation of the query language itself.[18]

In addition to extending TIGERSearch, INESS Search has implemented simplifications to the syntax of search expressions for more clarity. Suppose you want to find examples of NPs with AP modifiers that have embedded PPs, such as the German NP in (5). In TIGERSearch you could write the search expression in (6), whereas (7) is an equivalent abbreviated expression in INESS Search.

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[17] https://clarino.uib.no/iness/page?page-id=INESS_Search_Walkthrough

[18] https://clarino.uib.no/iness/page?page-id=INESS_Search

(5) German
die von Slumbewohnern unerlaubt gebauten Lehmhütten
the by slum.dwellers illegally built mud.huts
'the mud huts illegally built by slum dwellers'

(6) `[cat="NP"] > #x:[cat="AP"] & #x > [cat="PP"]`

(7) `NP > AP > PP`

The TIGERSearch expression in (6) may be read as follows: "There is a node with the category NP that dominates a node #*x* with the category AP; this same AP node #*x* dominates a node with the category PP." Each node has a variable, but it does not always need to be expressed; in (6), it is necessary to specify through the use of an explicit variable that it is the same AP that is dominated by the NP and that dominates the PP, otherwise the search results would return all sentences where there is at least one NP dominating an AP and at least one AP dominating a PP. In the abbreviated INESS Search expression (7), this chaining is inferred, so that an explicit mention of the variable is not necessary in this case. Furthermore, as also shown in Table 1, node labels may be used directly in the search expression, lexical and terminal nodes need only be enclosed in double quotes, and atomic f-structure values only in single quotes. One of the search results for the search expression in (7) from the TIGER treebank, the NP in (5), is shown in Figure 13; the node labels mentioned in the search expression are highlighted in red in the graph.

Table 1: Some examples of abbreviated syntax in INESS Search

Expression	Abbreviation	Explanation
`[cat="NP"]`	`NP`	node labels
`[word="book"]`	`"book"`	lexical nodes in dependency treebanks; terminal nodes in LFG and phrase-structure treebanks
`[atom="sg"]`	`'sg'`	atomic f-structure values in LFG treebanks
`[PP > #x:NP & #x > PP]`	`PP > NP > PP`	chaining of relations

4.2 Querying with INESS Search

Formulating well-targeted search expressions presupposes knowledge about the analyses in the treebank. One way of quickly gaining such knowledge is to use

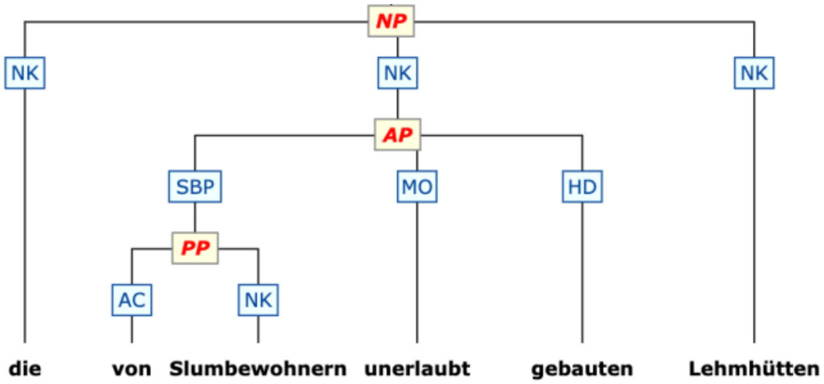

Figure 13: TIGER tree for (5) (http://hdl.handle.net/11495/D8B8-3970-851A-3@dep101299)

XLE-Web to parse sentences with the kind of grammatical phenomenon one is interested in and to study the analyses. Suppose that we want to search for passive sentences. The Norwegian passive sentence in (8) gets the analysis in Figure 14 when parsed in XLE-Web.

(8) Norwegian
Verden ble skapt av Gud.
world.DEF.SG was created by God
'The world was created by God.'

Examining the f-structure shows that the verb *skape* 'create' is the head of the XCOMP. It is a two-place predicate, with the PRED of the OBL-AG, *Gud* 'God', as its first argument, the agent. The XCOMP also has an attribute-value pair 'PASSIVE +'. A simple search expression for passives with agent phrases can thus be formulated using these f-structure characteristics, as shown in (9).

(9) `#x >PASSIVE #y:'+' & #x >OBL-AG`

This expression may be read: "There is an f-structure #*x* which has an attribute PASSIVE with the value '+' (bound to #*y*), and this same f-structure #*x* also has an attribute OBL-AG."

The negation operator in INESS Search allows users to restrict searches with respect to properties that sentences should *not* have. The search expression in (10), where the exclamation point is the negation operator, searches for passives *without* agent phrases. The sentence in (11) is one of those found by this expression; its c- and f-structures are shown in Figure 15. The f-structure nodes that are named with explicit variables in the search expression are marked in red in the

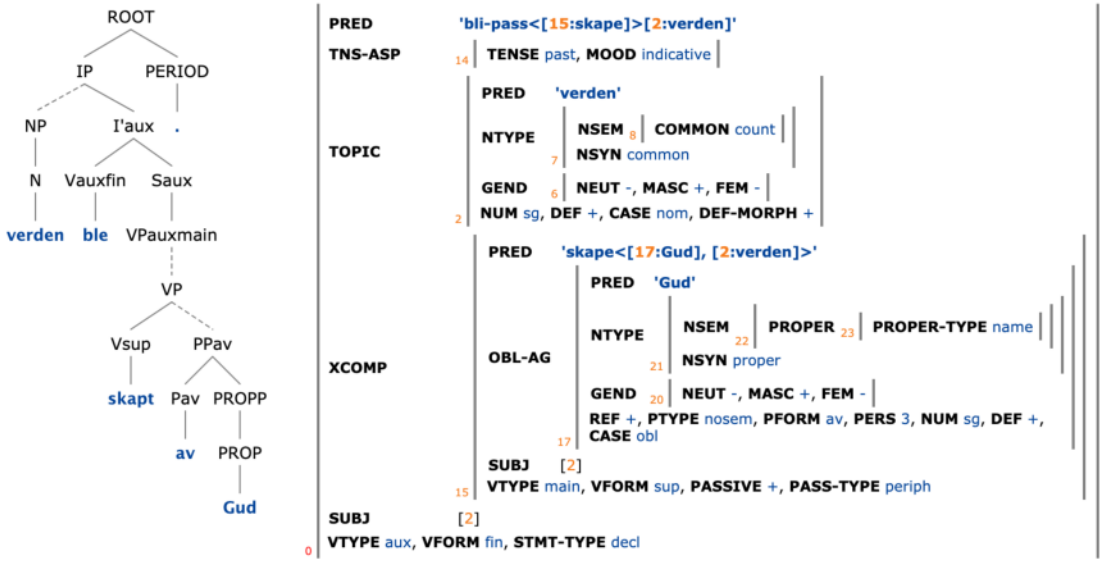

Figure 14: C- and f-structures from XLE-Web for the passive sentence in (8)

search result. In the f-structure we note that the XCOMP does not have an OBL-AG, and that the first argument of the main PRED is 'NULL'.

(10) `#x >PASSIVE #y:'+' & #x !>OBL-AG`

(11) Norwegian
Hvordan er verden skapt?
how is world.DEF.SG created
'How was the world created?'

4.3 An example-based introduction

For some researchers, INESS Search can be difficult to use, even with the simplifications that have been introduced. To assist users of NorGramBank in formulating search expressions, an example-based introduction to the search system has been written.[19] It is based on the Norwegian reference grammar *Norsk referansegrammatikk* (Faarlund et al. 1997) and the chapters and examples therein. Most researchers in Norwegian syntax will be familiar with the rather theory-neutral analyses in this book, and the goal is to provide them with LFG analyses of the

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[19] This introduction, in Norwegian, is part of the INESS documentation: https://clarino.uib.no/iness/page?page-id=norgram-soek#innledning.

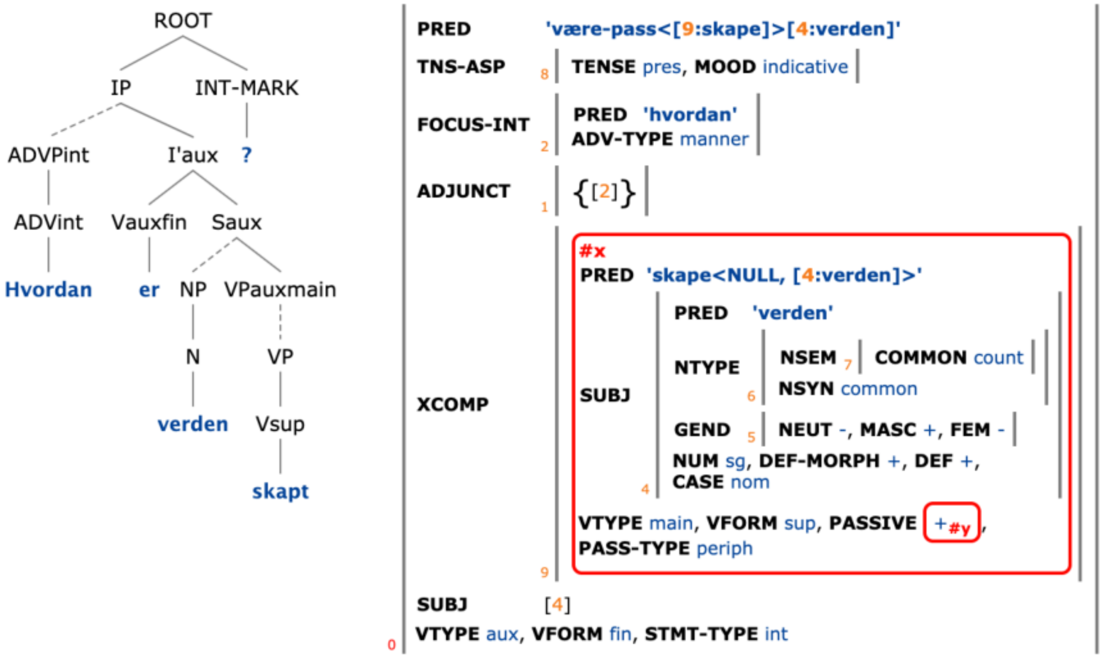

Figure 15: C- and f-structures for the passive sentence in (11) (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg6174124)

constructions that are of interest, including the page numbers in the book where the constructions are treated. For each construction, the example-based documentation provides an LFG analysis of one sentence together with a commentary explaining the analysis. A search expression that will find the construction is provided, along with both a paraphrase and a lengthier prose explanation of the expression. Finally a list of a few matching sentences is presented.

A construction type that is difficult to search for without a treebank is relative clauses without complementizers. It would not be straightforward to find these in corpora which are not syntactically annotated, so this is a good illustration of the added value of treebanks. The search expression for relatives without complementizers is given in (12).

(12)
```
#x >(ADJUNCT $) #f >TOPIC-REL #g
& #f >OBJ #g & #f >CLAUSE-TYPE 'rel'
& !(#f >COMP-FORM)
& !(#x >PRON-TYPE 'free')
```

This search expression may be read: “An f-structure #*x* has an attribute ADJUNCT with a value that includes an f-structure #*f*; furthermore, #*f* has an attribute TOPIC-REL with the value #*g*, and an attribute OBJ with the same value #*g*;

#f also has an attribute CLAUSE-TYPE with the value ‘rel’ and does not have an attribute COMP-FORM; the f-structure #x does not have an attribute PRON-TYPE with the value ‘free’ (the last specification ensures that free relatives will not be found).” An example sentence found by this expression in NorGramBank is given in (13), where the boldfaced relative clause *jeg så* lacks a complementizer.

(13) Norwegian
Alt **jeg så** var frontlykt-ene.
all I saw was headlight-DEF.PL
‘All I saw was the headlights.’

4.4 Search with templates

A further simplification in INESS Search is the implementation of search templates, which abbreviate complete parameterized search expressions. For the Norwegian treebank NorGramBank, a number of such templates have been provided, primarily for the benefit of lexicographers.[20] Templates obviate the need for understanding an often complicated search expression, since users can choose one on the basis of a description of its intention, but they can examine the whole expression if desired. Templates are parameterized in the sense that the user can fill in values for one or more parameters, such as word or lemma forms, predicates, or grammatical features.

Suppose you want to find out how common nominal complement clauses with and without complementizers are after certain verbs. The template shown in Figure 16, named *AT-verbwithandwithout(@verb)*, may be used for this purpose. The user fills in the verb, in this case *fortelle* ‘tell, relate’, and clicks on *Run query*. The results of the search are presented in a table, sorted according to whether they include the complementizer or not. We see that the vast majority of occurrences of complement clauses with this verb, 21,465 (97.5%), do have complementizers.

This can be compared with the results for the verb *tro* ‘think, be of the opinion’, shown in Figure 17. For this verb the proportion of uses with the complementizer is only 33.8%. In this screenshot the user has clicked on the first row in the table, showing the number of occurrences for the verb without the complementizer (66,258). This brings up a list over all the sentences with this pattern. Here the user has clicked twice on *Next* in order to come to page 3; there are so many hits that the list consists of 3,313 pages. When the user mouses over a sentence, a simplified f-structure is displayed to the right of the list. Clicking on a sentence

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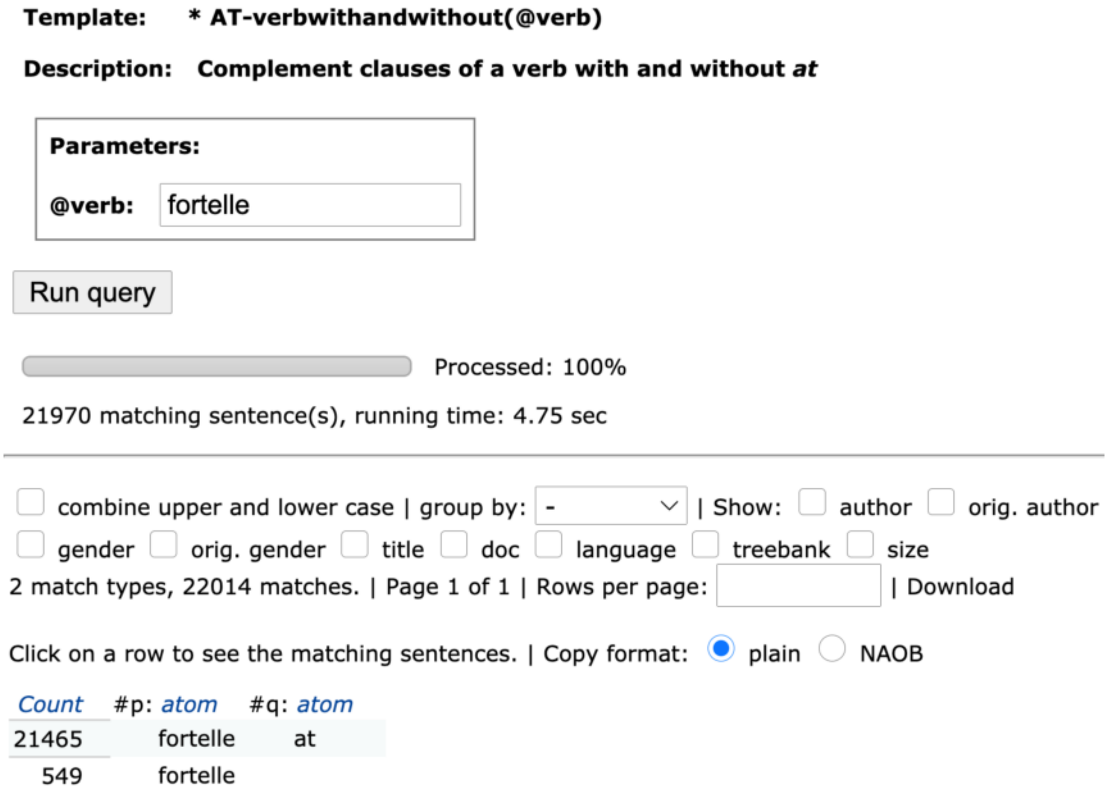
[20] Documentation in Norwegian: https://clarino.uib.no/iness/documentation/INESS-Sketch-veiledning-2020.pdf



Template: *** AT-verbwithandwithout(@verb)**

Description: **Complement clauses of a verb with and without *at***

Parameters:

@verb: fortelle

Processed: 100%

21970 matching sentence(s), running time: 4.75 sec

☐ combine upper and lower case | group by: - | Show: ☐ author ☐ orig. author ☐ gender ☐ orig. gender ☐ title ☐ doc ☐ language ☐ treebank ☐ size

2 match types, 22014 matches. | Page 1 of 1 | Rows per page: | Download

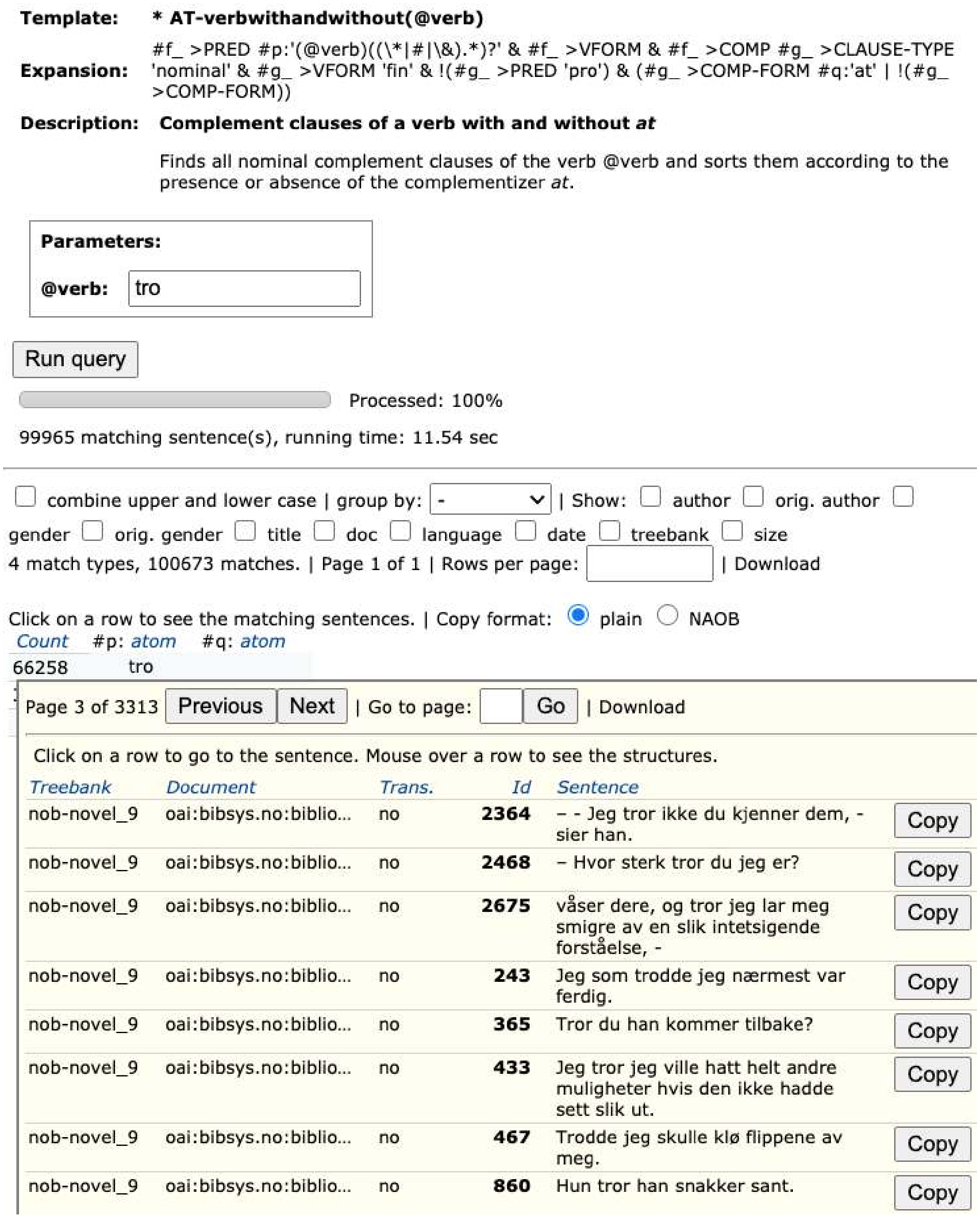
Click on a row to see the matching sentences. | Copy format: ● plain ○ NAOB

Count	#p: *atom*	#q: *atom*
21465	fortelle	at
549	fortelle	

Figure 16: Template for nominal clause search with and without complementizer for the verb *fortelle* ‘tell, relate’

brings the user to the *Sentence* page where the c-structure and the full f-structure are displayed. By default the quite complicated search expression which is used in this template is hidden, as in Figure 16. In Figure 17, the user has clicked on the template name, bringing up the expansion with the search expression. In this figure a more detailed prose description is also displayed, obtained by clicking on the boldfaced, more compact, part of the description.

Rauset et al. (2021) provide concrete examples of the use of template search in NorGramBank for various dictionary projects in Norway. The lexicographers use templates to examine both the usage and frequency of words. The most common valency frames for verbs, as well as the most common prepositions and/or particles that they occur with, are examined by using the template *V-argframes(@V)*; this template also provides evidence about whether the verbs occur reflexively. The templates *ADJ-attrib-or-nominal(@ADJ)* and *V-attr-or-pred-ptc(@V)* provide evidence of the nominal and adjectival use of participles, which is sometimes the basis for the creation of separate entries for derived adjectives.



Template: * **AT-verbwithandwithout(@verb)**

Expansion: `#f_ >PRED #p:'(@verb)((\*|#|\&).*)?' & #f_ >VFORM & #f_ >COMP #g_ >CLAUSE-TYPE 'nominal' & #g_ >VFORM 'fin' & !(#g_ >PRED 'pro') & (#g_ >COMP-FORM #q:'at' | !(#g_ >COMP-FORM))`

Description: **Complement clauses of a verb with and without *at***

Finds all nominal complement clauses of the verb @verb and sorts them according to the presence or absence of the complementizer *at*.

Parameters:

@verb: tro

Processed: 100%

99965 matching sentence(s), running time: 11.54 sec

☐ combine upper and lower case | group by: - | Show: ☐ author ☐ orig. author ☐ gender ☐ orig. gender ☐ title ☐ doc ☐ language ☐ date ☐ treebank ☐ size

4 match types, 100673 matches. | Page 1 of 1 | Rows per page: | Download

Click on a row to see the matching sentences. | Copy format: ● plain ○ NAOB

Count	#p: atom	#q: atom
66258	tro	

Page 3 of 3313 | Go to page: | Download

Click on a row to go to the sentence. Mouse over a row to see the structures.

Treebank	Document	Trans.	Id	Sentence	
nob-novel_9	oai:bibsys.no:biblio...	no	**2364**	– - Jeg tror ikke du kjenner dem, - sier han.	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**2468**	– Hvor sterk tror du jeg er?	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**2675**	våser dere, og tror jeg lar meg smigre av en slik intetsigende forståelse, -	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**243**	Jeg som trodde jeg nærmest var ferdig.	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**365**	Tror du han kommer tilbake?	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**433**	Jeg tror jeg ville hatt helt andre muligheter hvis den ikke hadde sett slik ut.	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**467**	Trodde jeg skulle klø flippene av meg.	Copy
nob-novel_9	oai:bibsys.no:biblio...	no	**860**	Hun tror han snakker sant.	Copy

Figure 17: Template for nominal clause search with and without complementizer for the verb *tro* 'think, be of the opinion'

Targeted queries that provide evidence for colligations are useful when treating high-frequency words with many senses. The template *N-argofverbs(@N)* provides a list sorted by frequency of the verbs that occur with a certain noun as their first or second argument. Such results help lexicographers determine whether the sense distinctions made in older versions of the dictionaries are still reasonable, or whether there should be changes made by adding or removing distinctions, or for instance by promoting a sense that is now more common than previously.

An example of a word which was missing a sense is the reflexive verb *utmerke seg* 'distinguish oneself', which was defined as having only a positive connotation. The lexicographers, however, did not believe this to be accurate. The template *V-prepobj(@V,@P)* was used to examine which words occur as objects of the prepositions *med* 'with' and *ved* 'by'. The search results showed several occurrences of the noun *mangel* 'lack' as the object of *ved*; one of these examples is given in (14). This and similar searches provided empirical support for the establishment of a new subsense of the verb with a negative connotation.

(14) Norwegian (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg14979442)
Han vil ... utmerke seg med mangel på konsistens i sine
he will distinguish REFL with lack of consistency in his
handlingsvalg ...
action.choice
'He will ... distinguish himself with lack of consistency in his choice of actions ... '

4.5 Comparison of search in LFG and dependency treebanks

Dependency treebanks are the most widely used type of treebanks, notably via the Universal Dependencies (UD) initiative.[21] The UD treebanks are grounded in dependency grammar, which assigns dependency relations between words, and does not analyze phrases and constituency relations (Tesnière 1959). An important early dependency treebank was the Prague Dependency Treebank (Hajič et al. 2001). Among the treebanks provided by INESS, dependency treebanks are the most numerous (250), with the UD treebanks accounting for most of these (200). The latest version in INESS at the time of writing is 2.8. INESS also keeps earlier versions, making it possible to track progress between versions.

The LFG and UD analyses of the sentence in (15) are shown in Figures 18 and 19. For both treebanks, information about lemma, part of speech and morphological

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[21] https://universaldependencies.org

features may be displayed (by clicking on the word for the dependency treebank, or by clicking on the preterminal node for the LFG treebank). The c-structure in Figure 18 shows the hierarchical phrase structure of the sentence, labeled with a rich inventory of syntactic categories. The corresponding f-structure encodes syntactic functions, grammatical features, and predicate–argument relations, as represented in the semantic forms of the verbs. The dependency structure in Figure 19 is shallower and less detailed than the LFG structure. Dependencies between words are shown by labeled arrows that go from a word to its dependents.

(15) Norwegian
Han hadde aldri vært lykkeligere.
he had never been happier
'He had never been happier.'

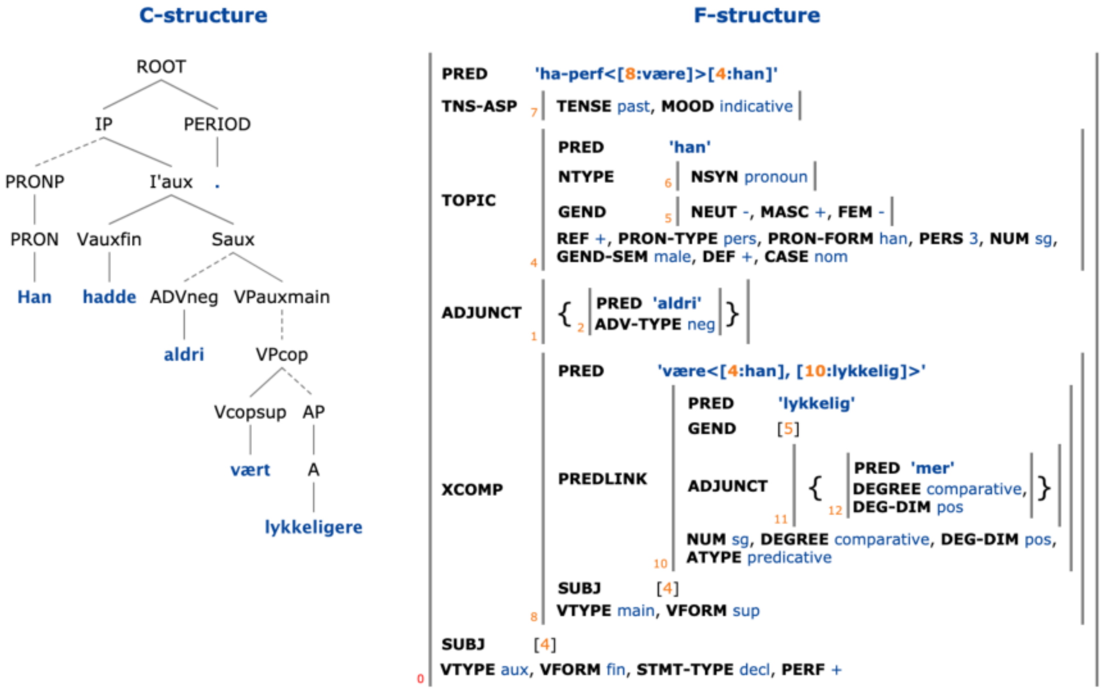

Figure 18: LFG analysis of the sentence in (15) (http://hdl.handle.net/11495/D8B8-3970-851A-3@lfg4292653)

The deeper analysis in an LFG treebank improves the search possibilities as compared with a dependency treebank. Rosén et al. (2020) compares search in the UD version of the Norwegian Dependency Treebank with the same texts in NorGramBank. The example given there is searching for the first argument of verbs. This may be done straightforwardly in an LFG treebank, but it is much

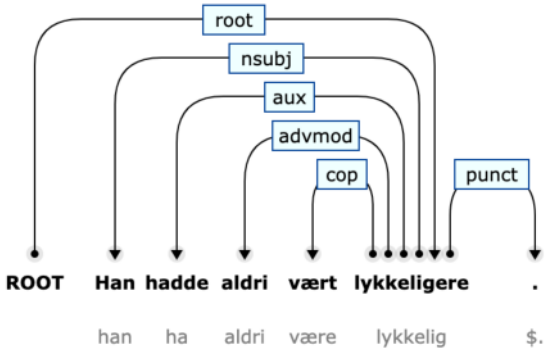

Figure 19: UD analysis of the sentence in (15) (http://hdl.handle.net/11495/D8B8-3970-851A-3@dep8965528)

more difficult in a dependency treebank since predicate–argument structure is not encoded there. The first argument of a verb can be the subject of an active verb or of a predicative present participle, the agent phrase of a passive verb, or the head of an attributive present participle. And since the UD guidelines allow for several ways of annotating some of these possibilities, creating a search expression to capture them is extremely complicated. For more detail on this comparison, see Rosén et al. (2020).

5 Conversion between LFG treebanks and other treebanks

Besides pure parsebanking with a grammar, other approaches have been used to construct treebanks by converting between formalisms or by enriching treebanks with additional information. The Universal Dependencies initiative is in some ways similar to ParGram in that both approaches aim at assigning common annotations to comparable items and structures across languages.

Since dependency relations may be labeled as grammatical functions such as subject and object, dependency structures have a resemblance to f-structures in LFG. The PARC 700 Dependency Bank is a treebank in dependency format based on the English LFG grammar developed at PARC (King et al. 2003). The corpus was created only to make a dependency bank. LFG analyses were transformed to dependency graphs, but no LFG treebank per se was created.

The TIGER corpus, mentioned in Section 3.2, utilized the large-scale German LFG grammar of the ParGram project for the semiautomatic creation of TIGER treebank annotations. The grammar was used for full parsing, followed by semiautomatic disambiguation and automatic transfer into the treebank format (Zinsmeister et al. 2002). The hybrid representation structure of TIGER, combining constituent analysis and functional dependencies, benefited from information in the c-structures and f-structures provided by the LFG grammar.

Conversely, an LFG treebank may be created by enriching phrase-structure oriented treebank resources with functional structures, as suggested by Frank et al. (2003) and Cahill (2004). For more on grammar induction, see Cahill & Way 2023 [this volume].

Forst (2003) describes a method for converting the TIGER treebank to a testsuite for the German LFG ParGram grammar. The conversion utilizes the machine translation transfer system in XLE.

Recently, detailed algorithms for the conversion from LFG analyses to dependency structures were proposed by Meurer (2017) and Przepiórkowski & Patejuk (2020). While the latter follow the more standard assumption that f-structures provide a good basis for developing dependency trees, the former takes c-structures as the starting point, but combines this with information from f-structures.

6 Conclusion

This chapter has provided an introduction to LFG treebanks, illustrated throughout with the tools and visualizations of the INESS treebanking infrastructure. The process of developing an LFG grammar in tandem with a treebank through incremental parsebanking has been described. Both large and small LFG parsebanks for a number of languages have been presented. Several different methods for searching LFG treebanks with INESS Search have been explained: users can write search expressions themselves with the aid of XLE-Web and the INESS Search documentation; they can find search expressions for the phenomena they are interested in by consulting the example-based search documentation; and they can use search templates that only require filling in one or more search items. LFG treebanks have been compared with other treebanks, and it has been shown that the more detailed and sophisticated annotation in LFG treebanks provides richer opportunities for research than simpler annotations.

While INESS has already been developed over more than a decade, the system, and especially its interface, will continue to evolve. Consequently, future interactions may be slightly different from the interactions and screen displays shown in this chapter.

Although LFG treebanks are certainly valuable resources for research and development, building an LFG treebank is a time-consuming and expensive undertaking, especially for a language for which no large-coverage LFG grammar and lexicon yet exist. However, the task is made somewhat easier with the help of the LFG Parsebanker as described above, and INESS is open to making more treebanks accessible for research and development.

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Part VI

Language families and regions

Chapter 26

LFG and African languages

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Lexical Functional Grammar (LFG) as a formal, constraint-based grammatical theory has been used to analyze various languages around the world since the 1970s. These analyses comprise grammatical descriptions, grammatical formalizations, and computational implementations of the grammars developed using LFG. Africa is home to over 2000 languages and while not even half of these have established writing systems let alone descriptive grammars in any linguistic framework, quite a substantial number of these languages, especially many Bantu languages, have been analyzed using LFG. The list includes languages such as Swahili, Chicheŵa, Chishona, Kichaga, Dagaare, Akan, Tigrinya, Wolof, Soso, Wan, Setswana, Yąg Dii, Malagasy, and Ndebele. In this chapter we first outline the major, salient linguistic features of African languages and then indicate how LFG has been used to analyze these salient features, covering topics such as the lexical integrity principle, applicative constructions, object asymmetries, agreement, reciprocal marking, locative inversion, serial verb construction, and focus marking phenomena. In the process of doing all this, the analyses in the chapter point to the major contributions of African languages to the development of LFG and, in turn, to the major contributions of LFG to the understanding of African language phenomena.

1 Introduction

Since the second half of the 20th century, African language data have been applied to the development of many descriptive and formal frameworks within modern linguistics – from phonology through morphosyntax to semantics and

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pragmatics. Descriptive frameworks such as Greenbergian universals, Hallidayan systemic functional grammar, Chomskyan generative grammar, and Goldsmithian autosegmental phonology, among others, have been used to analyse African languages. One of these major frameworks is the Lexical Functional Grammar (LFG) framework as developed by Bresnan & Kaplan (1982).

In this chapter we focus on the symbiotic relationship between African languages and LFG, showing how African languages have provided useful data for developing and testing LFG and how LFG has been used to analyze some intricate grammatical structures and processes in African languages like Swahili, Chichewâ, Dagaare, Akan, Tigrinya, Wolof, and Setswana.

The chapter is organized as follows. This introductory part provides a brief outline of the language situation in Africa, showing that Africa is a highly multilingual society and its people are very polyglottic. We also provide a snapshot of the major features of African languages. Section 2 is the main and longest part of the chapter. We provide concise illustrations of how LFG has been used to analyze various grammatical structures and phenomena including the lexical integrity principle, applicative constructions, object symmetries and asymmetries, agreement, reciprocal marking, locative inversion, serial verb constructions, and discourse function analyses. In Section 3, we briefly summarize the contribution of LFG to the analyses of African language phenomena, and conclude the chapter in Section 4 by tying together the various strands in all the sections of the chapter.

1.1 The language situation in Africa

Africa is not only a mineral resource rich continent, it is also a linguistic resource rich continent. Not only are there many languages on the African continent, Africans also exhibit a rich polyglottic repertoire in multilingual societies with many individual Africans, particularly in urban centres, speaking an average of four to five languages per person. Indeed, Africa has the second largest number of languages among the continents. According to Eberhard et al. (2020), there are at least 7,102 living languages in the world and 2,138 of them are in Africa.[1] African languages belong to a diverse set of language families, mainly including the Niger–Congo language family (divided into Niger–Congo A and Niger–

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[1] We use the term *African languages* (or the *Languages of Africa*) broadly to refer to languages indigenous to the African continent. This term is to be distinguished from the term *Languages in Africa* which would comprise the indigenous languages and non-indigenous languages including former colonial languages like English, French, and Portuguese, which continue to be used as "official" languages in many African countries.

Congo B, which comprises the Bantu languages), the Afro-Asiatic language family, and the Nilo-Saharan language family, as well as members of the disputed Khoisan language family (Güldemann 2014); see Figure 1.[2]

The great amount of language diversity on the African continent and elsewhere is of interest to linguists and other scholars who believe in the need for

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[2] As suggested by one reviewer, Austronesian languages, especially on the islands to the East of Africa, like Madagascar, ought to also be included in Figure 1; see Arka & Yeh 2023 [this volume] for more on Austronesian languages. In addition, we should also acknowledge that not many people believe in the genetic unity of "Khoisan" language family anymore.

Figure 1: Language families of Africa

Map adapted by Sebastian Nordhoff from https://commons.wikimedia.org/wiki/File:African_language_families_en.svg (c) Mark Dingemanse (original PNG version); https://fr.wikipedia.org/wiki/Utilisateur:Pmx (SVG version), CC BY-SA 3.0

linguistic and cultural diversity, and therefore the need to document and preserve these languages and their associated cultures. This diversity itself is a double-edged sword (Bodomo 2017). On the one hand, each of these 2,138 languages in Africa is the basis of a rich culture as languages are the main media through which we express and convey our cultural values. On the other hand, the fact that we have many languages within each of the 55 polities in Africa means that we face serious challenges and problems for language policy formulation and language planning. With this brief mention of the language situation, we now sketch some salient features of African languages in Section 1.2.

1.2 Salient linguistic features of African languages

African languages have contributed a lot in informing descriptive and theoretical frameworks for analyzing the world's languages:

> In brief, whether the search for universals is pursued along the lines of cross-linguistic generalizations, as recommended by Comrie, building on the work of Greenberg and others, or it is conceived of in terms of the biologically specified abstract principles that determine the form of human grammars and characterize the content of the language responsible cognitive structures, it is clear that African languages will definitely continue to make valuable contributions to progress in generative grammar. (Mchombo 1997: 202)

Thirty years ago, in her plenary address *African Languages and Syntactic Theories* on the occasion of the 20th Annual Conference on African Linguistics, Joan Bresnan recognized the impact of African languages on syntactic theories in these aspects: logophoricity, topic/subjecthood, agreement, argument asymmetries, and the syntax of verbs. But the impact was thought to be fairly mild compared to advances in phonology (Bresnan 1990). As time went by, Henderson (2011: 15) asserts that the significant development in this area "has been the exponential increase in syntax researchers who are interested in African languages, along with the sheer volume of work they have produced".

The complex morphology of many African languages has been of great interest among linguists, lending support to the study of morphosyntax largely dominated by Bantu languages (Bresnan & Mchombo 1995, Mchombo 1980, 1997, 2002, 2003, 2004, Moshi 1995, Morimoto 2002, Matambirofa & Mabugu 2014). The syntactic derivation of the verb stem in Bantu languages typifies the highly agglutinative nature of these languages, including various suffixes (sometimes called extensions) and prefixes associated with negation, tense/aspect, modality, markers of agreement with the subject and the object, as shown in (1).

(1) Swahili (Petzell 2004: 152–153)

a. si-ku-mw-on-a
NEG.SM-NEG.T-OM-see-FV
'I didn't see him/her.'

b. Erik a-li-pig-i-w-a simu na mwalimu.
Eric SM-PST-ring-APPL-PASS-FV phone by teacher
'Eric was rung by the teacher.'

Example (1a) involves the phenomenon of negation spread in which *si* is both a negative marker and a subject marker. In this case, the morpheme *si* can be called a *portmanteau morph*, i.e., a single morpheme expressing two meanings. Portmanteau morphs and feature spreading such as the negation spread are said to be frequent phenomena in Bantu and other non-Bantu languages such as Mande. In (1b), it is demonstrated that these affixes follow a strict order and certain combinatorial restrictions. For example, the applicative comes before the passive in Swahili.

In general, Creissels & Good (2018) provide a good context to the discussion of African languages with a list of generalizations regarding the state of the art of the morphosyntactic typology of the languages of the continent. These features are listed in (2) below (Creissels & Good 2018: 709–710):

(2)
a. The ergative type of core syntactic role coding is exceptional among African languages.
b. Case-marked subjects or objects are less common among African languages than at world level.
c. The so-called "marked-nominative" type of case contrast between subjects and objects is exceptional in other parts of the world but very common among African languages that have a case contrast between subjects and objects.
d. Obligatory agreement of transitive verbs with their object does not seem to be attested among African languages.
e. Second-position clitics are relatively common in the languages of the world, but exceptional among African languages.
f. In a relatively high proportion of African languages, the construction of verbs with an argument frame of the type giver–given–recipient tends to assimilate the recipient (rather than the thing given) to the patient of prototypical transitive verbs, and double object constructions are particularly frequent.

g. Focus strategies implying morphosyntactic alternations, and in particular focus marking by means of verbal inflection, are particularly common in Africa.
h. The use of special verb forms in sequential constructions is particularly widespread among African languages.
i. Applicatives are particularly common in Africa, and a relatively high proportion of African languages make a wide use of obligatory applicatives and of various types of non-canonical applicatives.
j. Classifier systems are exceptional among African languages.
k. Relatively few African languages are devoid of a morphological plural or have a morphological plural restricted to a subset of nouns occupying a high position in the animacy hierarchy.
l. African languages that do not use the same morpheme as a noun phrase coordinator and as a comitative adposition are relatively rare.
m. The proportion of languages with a syntactically flexible constituent order is much lower among African languages than at world level.
n. The constituent order SOVX, relatively rare at world level, is relatively frequent among African languages.
o. Clause-final negative particles occur among African languages much more frequently than in other parts of the world.
p. Changes in the constituent order triggered by negation are particularly common among African languages.
q. True relative pronouns are particularly rare in African languages, and the use of dependent verb forms in postnominal relatives, relatively rare in the languages of the world, is common among African languages.
r. Logophoricity is particularly widespread among African languages.
s. Systems of coding of spatial relations in which the distinction location at/movement towards/movement from manifests itself exclusively on verbs are more frequent in Africa than in most other parts of the world.

Admittedly, when it comes to the analyses of African languages in LFG, it is hard not to be “Bantu-centric”, given the pioneering work done by Sam Mchombo and Joan Bresnan. In more recent times, however, much more work is being produced in non-Bantu languages, and we have tried to include the analyses on these non-Bantu languages as much as possible. These mainly include Wolof, Tigrinya, Soso, Wan, Yąg Dii, Malagasy, Dagaare, and Akan. In Section 2, we illustrate the analyses of many of these features.

2 Major African language grammatical phenomena analysed in LFG

In this section, the longest in the chapter, we do a concise analysis of major constructions and grammatical phenomena in African languages from an LFG perspective. We begin with the lexical integrity principle, showing how data from African languages have been used to illustrate one of the best known principles in the LFG theoretical framework. We then move on to discuss argument structure and morphology, agreement, reciprocal marking, locative inversion, serial verbs, and discourse functions.

2.1 Lexical integrity principle

This subsection begins with a constraint on the architecture of grammar inspired by African language structure. When we encounter a sequence of morphemes in African languages, a natural question to ask is: what is indeed a word? In the framework of Lexical Functional Grammar, the lexical integrity principle has been of great importance with respect to c(ategorial)-structure and f(unctional)-structure in clarifyng that the morphemic structure of words differs from the c-structure of phrases both in constituents and principles of combination. In their seminal paper, Bresnan & Mchombo (1995) elicit a great deal of evidence from Bantu noun class markers in support of the lexical integrity principle. They argued that "the Bantu noun class markers are a particularly fruitful domain for investigations of lexical integrity because they straddle the borderlines between syntax and morphology and between inflection and derivation" (Bresnan & Mchombo 1995: 183).

Bantu noun class markers have a mixed inflectional and derivational nature when they mark nominals for number and gender, specifying the agreement forms of determiners, modifiers and predicates. The number classes, on one hand, trigger the syntactic agreement as an inflectional process, and on the other hand, the gender classes change the semantic class of the stem since they are associated with semantic properties such as animacy, configuration, location, size, plurality or quality and the process is seen as derivational. The standard morphological analysis was strongly advocated by Doke (1929, 1935), in which the class markers are analyzed as morphologically bound morphemes. However, this position has been challenged alternatively by the syntactic analyses (e.g. Myers 1987) or the head-movement theories of word derivation (e.g. Kinyalolo 1991, Carstens 1991). Throwing themselves into this debate, Bresnan & Mchombo (1995) draw the evidence that supports the lexical integrity principle from the morphology and syntax of Bantu noun class prefixes by applying a couple of effective tests of lexical integrity to the class markers of nouns in Chicheŵa and other Bantu languages. Four main tests go to build up the argument.

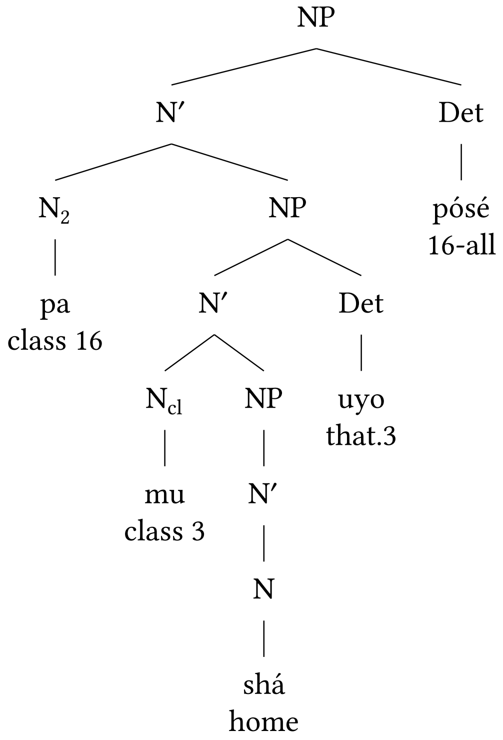
2.1.1 Test 1: phrasal recursivity

The central idea of phrasal recursivity is that the arbitrarily deep embedding of syntactic phrasal modifiers is not allowed in word-internal constituents. For Bresnan and Mchombo, there are mixed results on this front due to the so-called alternative concord when modifiers simultaneously show concord with any of several class markers on the same noun (Bresnan & Mchombo 1995: 195), as shown in example (3).

(3) Chishona (Myers 1987: 104)
pa-mu-shá uyo p-ósé pa-káchéna
16-3-home that.3 16-all 16-white
'at that whole white house'

The noun 'home' is preceded by two noun class markers from classes 16 and 3. Interestingly, the first following modifier agrees with the inner class 3 marker and the final two agree with the outer class 16 marker. Myers (1987) provides the following syntactic representation:

(4)



This representational analysis also correctly accounts for the fact that the inner concord modifiers must precede the outer ones as indicated by the ungrammaticality in (5).

(5) Chishona
*pa-mu-shá apo w-ósé pa-káchéna
16-3-home that.16 3-all 16-white

The same holds true for Chicheŵa, shown below in (6a)–(6d).

(6) Chicheŵa

a. pa mu-dzi p-áthú p-ônse
16 3-village 16-our 16-all
'at all of our village'

b. pa mu-dzi w-áthú p-ônse
16 3-village 3-our 16-all
'at all of our village'

c. pa mu-dzi w-áthú w-ônse
16 3-village 3-our 3-all
'at all of our village'

d. *pa mu-dzi p-áthú w-ônse
16 3-village 16-our 3-all

But the syntactic analysis of Myers (1987) does not necessarily apply to all class markers. As a matter of fact, it turns out that the class marker 16 in these examples belongs to the locative classes comprising of 16, 17 and 18, and an alternative concord is only possible with these locative classes. As for the nonlocative class markers, they are prefixed to the nouns and noun stems without the recursive structure of syntactic NPs, where alternative concord is impossible, as shown in (7).

(7) Chicheŵa

a. ka-mu-ndá k-ánga
12-3-field 12-my
'my small field'

b. *ka-mu-ndá w-ánga
12-3-field 3-my

2.1.2 Test 2: inbound anaphoric islands

The inbound anaphoric islands test can also tell a true syntactic phrase from a derived word. According to this test, anaphoric and deictic uses of pronouns should occur within the phrasal NP complement to a class marker. Again it is true with the locative class markers but not with the other class markers as shown in (8) and (9).

(8) Chichewâ

a. mu iyi
18 9.this
'in this (e.g. house)'

b. pa icho
16 7.that
'on that (e.g. hat)'

c. ku ǐwo
17 6.them
'to them (e.g. pumpkins)'

(9) Chichewâ

a. *chi iyi
7 9.this

b. *ka icho
12 7.it

c. *ti ǐwo
13 6.them

Since morphological words are inbound anaphoric islands, the ungrammaticality of the examples in (9) can only be explained by the morphological analysis of these prefixes instead of the syntactic analysis shown in (8).

2.1.3 Test 3: conjoinability

As expected, the locative classes pass the conjoinability test. Following the syntactic analysis, two NP complements should be conjoinable under a single class marker, shown below in (10). However, the other class markers fail the test as shown in (11).

(10) Chicheŵa

a. Mu-ku-pít-á ku [m-sika kapéná m-zinda]?
II.pl/hon.sbj-prog-go-ind 17 3-market or 3-city
'Are you going to the market or the city?'

b. A-na-gw-ér-á m [chi-tsîme kapéná chĭ-gwa]?
1sbj-rec.pst-fall-appl-ind 18 7-well or 7-valley
'Did he fall into the well or the valley?'

c. Mu-na-ík-á pa [m-pando kapéná m-tŏndo]?
II.pl/hon.sbj-rec.pst-put-ind 16 3-chair or 3-mortar
'Did you put (it) on the chair or the mortar?'

(11) Chicheŵa

a. *Mu-na-chéz-á ndí m- [phunzitsi kapéná sangalatsi]?
II.pl/hon.sbj-rec.pst-converse-ind with 1- teacher or entertainer
'Did you converse with the teacher or entertainer?'

b. *A-na-b-á ka- [m-pando kapéná m-tŏndo]?
1sbj-rec.pst-steal-ind 12 3-chair or 3-mortar
'Did he steal a little chair or a little mortar?'

2.1.4 Test 4: gapping

Under this test, it is possible to gap the noun following the locative class marker. In contrast, none of the other class markers allow this gapping, as shown in (12).

(12) Chicheŵa

a. A-nyamăta a-na-vín-á njerero pa bwaló lá mfúmú Kapanga ndí pá (bwaló) lá mfúmú Kapatuka.
2-boy 2sbj-rec.pst-dance-ind 9.name.of.dance 16 5.courtyard 5asc 9chief K. and 16 5.courtyard 5asc 9chief K.
'The boys danced the njerero dance on Chief Kapanga's courtyard and on Chief Kapatuka's (courtyard).'

b. *Kodí áná awa a-ku-fún-á m-pira w-á mphira kapéná m-*(pira) w-á nsanza?
Q 2.child 2this 2sbj-prog-want-ind 3-ball 3-asc 9.rubber or 3-(ball) 3-asc 10.rag
'Do these children want a rubber ball or a rag ball?'

All these tests show that the locative class markers are syntactically independent and all the others are morphological prefixes. Bresnan & Mchombo (1995) provided an explanation with regard to the split between the syntactic and morphological class markers. As hypothesized by Greenberg (1977, 1978), the class markers in Niger-Congo have evolved historically from syntactic elements of NPs into being morphologically bound as prefixes or suffixes. Along this line, it is possible that this process of historical change has been completed for most of the class markers of proto-Bantu that became prefixes, but a few like locatives retained their syntactic behavior as nominal constituents.

According to Bresnan & Mchombo (1995), the fact that agreement is marked both syntactically and morphologically does not violate the lexical integrity principle:

> By factoring apart the syntactic levels of f-structure and c-structure, we can distinguish naturally between structure-dependent syntactic principles (e.g., constituent order), which respect lexical integrity, and function-dependent syntactic principles (e.g., agreement), which do not. (Bresnan & Mchombo 1995: 213)

In the LFG framework, the correspondence between structural form and syntactic function is in general imperfect. Take Bantu noun class markers, for example. Here changes in form can occur partly independent of changes in function. As a result, this lends strong support to the lexical integrity principle. With this illustration of the lexical integrity principle, we now go on to discuss argument structure in Section 2.2.

2.2 Argument structure and morphosyntax

In this subsection we discuss two main constructions, applicatives and objective asymmetries mainly in Bantu languages, before outlining some recent works in mainly non-Bantu languages.

2.2.1 Applicative constructions

The discussion of grammatical functions came to the fore in the 1980s and early 1990s (Marantz 1984, Baker 1988a, Alsina 1992, Alsina & Mchombo 1990, 1993, Bresnan & Moshi 1990). Valency-changing operations like the passive, applicative, causative and similar alternations had raised the question whether grammatical functions (GF) should be seen to be primitives or derivatives. Bantu languages contributed a lot to this discussion since these languages are characterized by applicative, causative and passive morphemes (see (1b) for example).

This section centers on a critique made by Alsina & Mchombo (1990) on Baker (1988b) over applicatives in Chicheŵa. Baker (1988b) proposes an asymmetry in the assignment of the beneficiary and instrumental theta-roles. For Baker, instrumentals are assigned their theta-roles as NP sisters of the verb, while beneficiaries are theta-marked in a PP complement to the verb. In other words, beneficiaries get their theta-role indirectly from the verb through the PP but instrumentals are theta-marked directly by the verb. According to Alsina and Mchombo, Baker's theory is particularly successful in two aspects (Alsina & Mchombo 1990: 495):

(13) a. Word order: while the beneficiary NP must precede a theme/patient NP in the verb phrase, the instrumental NP may either precede or follow it.

b. Object markers: while only the applied object in a beneficiary applicative may be expressed by means of an object marker, either the applied or the patient/theme object in an instrumental applicative may be so expressed.

At the same time, they also adduced three types of evidence against Baker's theta theoretic asymmetry.

2.2.1.1 Extraction facts

As observed by Baker (1988b), a patient or a theme can be extracted both in beneficiary (14a) and in instrumental applicatives (15a), but in contrast, it is not possible to extract a beneficiary object (14b) as an instrumental (15b).

(14) Chicheŵa

a. Īyi ndi mphátso iméné chítsîru chí-ná-gúl-ír-a atsíkāna.
9.this be 9.gift 9.REL 7.fool 7SBJ-PST-buy-APPL-FV 2.girls
'This is the gift that the fool bought for the girls.'

b. *Āwa ndi atsíkána améné chítsîru chí-ná-gúl-ír-a mphâtso.
2.these be 2.girls 2.REL 7.fool 7SBJ-PST-buy-APPL-FV 9.gift
'These are the girls that the fool bought the gift for.'

(15) Chicheŵa

a. Īli ndi dengu liméné ányǎni á-kú-phwány-ír-a
5.this be 5.basket 5.REL 2.baboons 2SBJ-PROG-break-APPL-FV
mwǎla.
3.stone
'This is the basket that the baboons are breaking with a stone.'

b. Ūwu ndi mwalá úméné ányǎni á-kú-phwány-ír-a
3.this be 3.stone 3.REL 2.baboons 2SBJ-PROG-break-APPL-FV
dēngu.
5.basket
'This is the stone that the baboons are breaking the basket with.'

Baker (1988b) explains these differences on the basis of the *nonoblique-trace filter*. Unfortunately, the whole analysis collapses given the fact that there are grammatical instances of extractions of beneficiaries or goals in a Chicheŵa passive sentence (Alsina & Mchombo 1990: 498):

(16) Chicheŵa
Āwa ndi atsíkána améné á-ná-gúl-ír-ídw-á mphâtso.
2.these be 2.girls 2.REL 2SBJ-PST-buy-APPL-PASS-FV 9.gift
'These are the girls that were bought a gift.'

2.2.1.2 Transitivity effects

Baker's proposed D-structure distinction between beneficiaries and instrumentals predicates that beneficiary applicatives cannot be formed from intransitive verbs. However, Alsina & Mchombo (1990) prove it to be incorrect again, as in (17).

(17) Chicheŵa
Yêsu a-ná-wá-f-er-a (anthu).
1.Jesus 1SBJ-PST-2OBJ-die-APPL-FV 2.people
'Jesus died for them (the people).'

2.2.1.3 Locative applicatives

According to Alsina & Mchombo (1990: 503), "locative applicatives constitute a crucial source of evidence for evaluating Baker's (1988b) theory". In Baker's theory, beneficiaries and locatives are conceptually similar because they are both theta-marked by the verb via a preposition. In contrast, the facts show that locatives behave like instrumentals and not like beneficiaries considering things like word order, object marking, and relativization.

Consequently, a classical transformational approach appears to be quite problematic when dealing with applicatives in Chicheŵa given its complex morphosyntax.

2.2.2 Object symmetries/asymmetries

So far, we have briefly discussed one asymmetrical object type: applicatives. This subsection will look deeper into this construction in parallel to the symmetrical type. The distinction between the two types is associated with *primary object* syntactic properties of passivizability, object agreement, adjacency to the verb, and the like. The asymmetrical object type language means that only one of the postverbal NPs exhibits *primary object* syntactic properties, while in the symmetrical object type language there are more than one NPs that can do so.[3] Bresnan & Moshi (1990: 149–157) identify the typological differences based on their observation on Kichaga (symmetrical) and Chicheŵa (asymmetrical).[4]

(18) Kichaga

a. N-a̋-i̋-lyì-í-à m̀-kà k-élyà. $\text{V NP}_{ben}\ \text{NP}_{pt}$
FOC-1SBJ-PROG-eat-APPL-FV 1-wife 7-food
'He is eating food for/on his wife.'

b. M̀-kà n-a̋-i̋-lyì-í-ò k-élyâ. $\text{NP}_{ben}\ \text{V}_{\text{pas}}\ \text{NP}_{pt}$
1-wife 1SBJ-PROG-eat-APPL-PASS 7-food
'The wife is being benefited/adversely affected by someone eating the food.'

c. K-èlyá k-i̋-lyì-í-ò m̀-kà. $\text{NP}_{pt}\ \text{V}_{\text{pas}}\ \text{NP}_{ben}$
7-food 7SBJ-PROG-eat-APPL-PASS 1-wife
'The food is being eaten for/on the wife.'

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[3] The asymmetrical type includes languages such as Kiswahili, Chimwi:ni, Hibena and Chicheŵa, while the symmetrical type includes languages such as Kinyarwanda, Kihaya, Kimeru, Mashi, and Luyia (or Luhya).

[4] The examples in this chapter are selected from various papers covering a wide range of African languages. We cannot guarantee their consistency in orthography. All we can do is transcribe them as originally as possible. In terms of tones, the symbol ˝ represents a superhigh tone, ´ a high tone, ˇa rising tone,^ a falling tone,` a low tone, and ¯ a superlow tone.

The Kichaga examples (18b)–(18c) show that any object in the symmetrical type can be passivized, but in Chichewâ, examples like (18c) are ungrammatical (Baker 1988b).

Another difference is related to object markers, illustrated in (19).

(19) Kichaga

a. N-a̋-i̋-m̀-lyì-í-à k-èlyâ. $\mathrm{OM}_{ben}\text{-}\mathrm{V}_{\mathrm{stem}}\ \mathrm{NP}_{pt}$
foc-1sbj-prog-1obj-eat-appl-fv 7-food
‘He/She is eating food for/on him/her.’

b. N-a̋-i̋-kì-lyí-í-à m̀-kà. $\mathrm{OM}_{pt}\text{-}\mathrm{V}_{\mathrm{stem}}\ \mathrm{NP}_{ben}$
foc-1sbj-prog-7obj-eat-appl-fv 1-wife
‘He/She is eating it for/on the wife.’

c. N-a̋-i̋-kì-ḿ-lyì-i̋-à. $\mathrm{OM}_{pt}\text{-}\mathrm{OM}_{ben}\text{-}\mathrm{V}_{\mathrm{stem}}$
foc-1sbj-prog-7obj-1obj-eat-appl-fv
‘He/She is eating it for/on him/her.’

In Kichaga, the object marker can be put on the verb from any or all of the multiple objects. Again, cases such as (19b) and (19c) are not allowed in Chichewâ.

Bresnan & Moshi (1990) also compared the two types in terms of unspecified object deletion, reciprocalization and interactions of object properties. They went on to discuss the problems posed by the data for previous theories (Gary & Keenan 1977, Perlmutter & Postal 1983, Marantz 1984, Baker 1988b, Kiparsky 1988). Along the lines of Alsina & Mchombo (1988), Bresnan & Kanerva (1989) and Alsina (1999), Bresnan & Moshi (1990) show that the LFG treatment is capable of providing a single parameter of variation for the symmetrical and asymmetrical object types from which all the typological differences follow, instead of postulating multiple unrelated differences in the grammar of the two types of languages. In doing so, they decomposed syntactic functions by two crucial properties: $[-r]$ and $[+o]$, schematized in (20).

(20)
$$\begin{bmatrix} -r \\ -o \end{bmatrix} \ \textsc{subj} \qquad \begin{bmatrix} +r \\ -o \end{bmatrix} \ \textsc{obl}_\theta$$
$$\begin{bmatrix} -r \\ +o \end{bmatrix} \ \textsc{obj} \qquad \begin{bmatrix} +r \\ +o \end{bmatrix} \ \textsc{obj}_\theta$$

However, there is a peculiarity in applicative and dative constructions. Following Alsina & Mchombo (1988), Bresnan and Moshi acknowledged that there is a limitation concerning the applied beneficiary and recipient roles, i.e., they universally lack the [+*o*] classification and receive the [−*r*] classification. An asymmetrical object parameter was therefore proposed:

(21) Asymmetrical Object Parameter (AOP)

$$* \quad \begin{array}{ccc} \theta & \dots & \theta \\ | & & | \\ [-r] & & [-r] \end{array}$$

For ditransitive constructions in Chichewâ (Mchombo & Firmino 1999), the applied NP must be adjacent to the verb if it is a beneficiary or recipient; otherwise, either the patient NP or the applied NP may be adjacent to the verb (Bresnan & Moshi 1990: 172). Serving as the parameter of variation, it states that only one role can be intrinsically classified as unrestricted. The idea is illustrated in (22).

(22)

	‘eat-for⟨	*ag*	ben_{appl}	*pt*	⟩’
AOP:		[−*o*]	[−*r*]	[+*o*]	
defaults:		[−*r*]		[+*r*]	
		SUBJ	SUBJ/OBJ	OBJ$_\theta$	
well-formedness:		SUBJ	OBJ	OBJ$_\theta$	

Based on Alsina & Mchombo’s (1988) extended version of intrinsic classifications to account for applicative and dative constructions, the applied beneficiary or recipient role (traditionally called *indirect objects*) can only be [−*r*], whereas the patient can be either [−*r*] or [+*o*]. Similarly in Kichaga, the applied beneficiary role will always be [−*r*], however, since the AOP does not apply to the symmetrical type, the patient can be either [−*r*] or [+*o*] as shown in (23) and (24). The only problem with (23) is that two unrestricted roles will lead to a violation of the final well-formedness condition of Function-Argument Biuniqueness which states that each expressed lexical role must be associated with a unique function, and conversely. So the patient role can only take the [+*o*] option in the active as shown in (24).

(23)

	‘eat-for⟨	*ag*	ben_{appl}	*pt*	⟩’
		[−*o*]	[−*r*]	[+*o*]	
defaults:		[−*r*]			
		SUBJ	SUBJ/OBJ	SUBJ/OBJ	
well-formedness:		SUBJ	OBJ	*	

(24)		‘eat-for⟨	*ag*	*ben*$_{appl}$	*pt*	⟩’
			[−*o*]	[−*r*]	[−*o*]	
	defaults:		[−*r*]		[+*r*]	
			SUBJ	SUBJ/OBJ	OBJ$_{\theta}$	
	well-formedness:		SUBJ	OBJ	OBJ$_{\theta}$	

The analysis also explains adequately why in Chicheŵa only the object that is adjacent to the verb in the active can become the subject in the passive, as seen in (25), while in Kichaga, either object can be passivized, because when one of the two [−*r*] roles is realized as the subject in the passive construction, the other may be the unrestricted object, as shown in (26).

(25)		‘eat-for⟨	*ag*	*ben*$_{appl}$	*pt*	⟩’
	AOP:		[−*o*]	[−*r*]	[+*o*]	
	Passive :		∅			
	defaults:				[+*r*]	
				SUBJ/OBJ	OBJ$_{\theta}$	
	well-formedness:			SUBJ	OBJ$_{\theta}$	

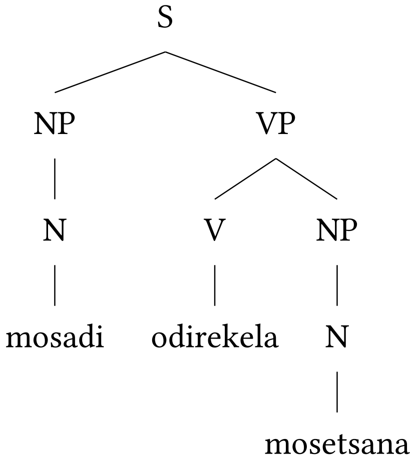
(26)		‘eat-for⟨	*ag*	*ben*$_{appl}$	*pt*	⟩’
			[−*o*]	[−*r*]	[−*r*]	
	Passive :		∅			
	defaults:					
				SUBJ/OBJ	SUBJ/OBJ	
	well-formedness:			SUBJ	OBJ	or
				OBJ	SUBJ	

The single parameter of variation under LFG provides good explanations for other typological differences equally well, namely object deletion, reciprocalization and interactions of object properties, which have been observed between the symmetrical and asymmetrical object types.

In the LFG literature, two recent works on Setswana are from Berg et al. (2013) and Pretorius & Berg (2019). The latter proposes an LFG-based analysis of the tense and aspect features of Setswana auxiliary verbs. In Setswana, auxiliary verbs indicating tense, aspect and time may appear juxtaposed inside a VP, following a specific order determined by the semantic values associated with the auxiliaries. Here we focus on Berg et al. (2013) which analyses Setswana constructions with double objects and double object agreement morphemes.

(27) Setswana
Mosadi o-**di**-rek-el-a mosetsana.
1.woman 1-8-buy-APPL-FV 1.girl
'The woman buys the girl it'.

(28) c-structure: f-structure:



$$\left[\begin{array}{ll}
\textsc{pred} & \text{`}\textsc{rek}\langle\textsc{subj},\textsc{obj}_{\theta},\textsc{obj}\rangle\text{'} \\
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{sadi}\text{'} \\ \textsc{nounclass} & 1 \end{array}\right] \\
\textsc{obj}_{\theta} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{setsana}\text{'} \\ \textsc{nounclass} & 1 \end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{nounclass} & 8 \end{array}\right] \\
\textsc{ap} & + \\
\textsc{class} & 1 \\
\textsc{tense} & \textsc{pres} \\
\textsc{verbtype} & \textsc{main}
\end{array}\right]$$

In the end, these works also provide a computational model of these phenomena using the XLE grammar development platform.[5] Other LFG work on argument structure and grammatical functions can be seen in Zaenen (1984), Mchombo (1980, 1999a, 2002, 2003, 2004), Harford (1993), and Kioko (1995). For recent papers on this topic within Bantu languages, one may refer to Matambirofa (2010) and Matambirofa & Mabugu (2014).

2.2.3 Recent work in argument structure on non-Bantu languages

As is well known, at least among LFG practitioners, LFG research on African languages has been pioneered and dominated by analyses of Bantu languages, as shown in the previous analyses. In this subsection, we bring to light a few recent studies involving four languages outside the Bantu group: Tigrinya, Wolof, Soso, and Wan, the latter two of which belong to the Mande language family.[6] Particularly, the discussion of object properties is found in all four languages.

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[5] For those who are interested in XLE implementations, they can see them both in Dione (2013b) and Berg et al. (2013).

[6] Our special thanks go to one of the reviewers who summarized for us some parts of works included in this section.

2.2.3.1 Work on Tigrinya

In previous discussions, we have seen that the correlation of properties such as pronominal marking and passive typology has been used in object asymmetries as a proof for primary objecthood (Bresnan & Moshi 1990, Alsina & Mchombo 1993, Alsina 1996a). Kifle's (2007) analysis reveals that Tigrinya exhibits symmetric properties of objects in its ditransitive constructions, and asymmetric properties in its applicative constructions.

(29) Tigrinya

a. ʔɨt-omɨ tämäharo n-ät-i mäṣɨḥafɨ-ti
def-3m.pl student.pl obj-def-3m.sg book.pl
tä-wahib-om-wo.
pass-prf.give-sm.3m.pl-om$_1$.3m.sg
'The students are given books.'

b. ʔɨt-i mäṣɨḥafɨ-ti nɨ-tämäharo
def-3m.sg book.pl obl-student.pl
tä-wahib-u-womɨ.
pass-prf.give-sm.3m.sg-om$_1$.3m.pl
'The books are given to students.'

The recipient (29a) and the theme (29b) display primary object properties in the sense that both of them function as subjects in passivization. However, it is observed that only the theme role can function as a subject in passivization when it comes to applicative constructions, as shown in (30). The type of asymmetry found in Tigrinya seems to be the reverse version of the asymmetry found in Bantu languages like Chicheŵa.

(30) Tigrinya

a. ʔɨt-i mäṣɨḥafɨ n-saba tä-gäzi-u-la.
def-3m.sg book.sg obl-Saba.f pass-prf.buy-sm.3m.sg-om$_2$.3f.sg
'The book was bought (for) Saba.'

b. *saba mäṣɨḥafɨ tä-gäzi-ʔa
Saba.F book.sg pass-prf.buy-sm.3f.sg

Therefore, in Tigrinya ditransitive clauses, the symmetric objects possess the [$-r$] features classified as objs, while the applied object in an applicative construction functions as obj$_\theta$ with the [$+r$] feature and the verbal object is obj with the [$-r$] feature. Given these facts, the Tigrinya data pose a particular challenge to the claim made about the correlation between the passive typology and the restrictions on pronominal marking. When applied to Tigrinya (Kifle 2011), the grammatical tests commonly used to distinguish between symmetrical and asymmetrical objects do not converge into a single primary object property. In Tigrinya, the applied object often displays the opposite properties to what is predicted by the lexical mapping theory (LMT).

2.2.3.2 Work on Wolof

In relatively recent research, diverse phenomena in the morphosyntax of Wolof have been analyzed in LFG, including its cleft constructions and their relations to copular constructions (Dione 2012), the interaction between Wolof clitics and different grammar components (Dione 2013a), and pro-drop and control constructions (Dione 2019). In addition, there are several recent works on Wolof that take a computational approach to handle various aspects of the language within the LFG framework (Dione 2014a,b, 2017, 2020).

Among his extensive work on Wolof, Dione (2013b) proposes an LFG-based analysis to deal with applicative-causative polysemy in Wolof using a predicate composition approach of complex predicate formation. He postulated an a-structure for each derivation (applicative and causative) by analyzing polysemous suffixes as carrying their own PRED(ICATE) argument structure which they share with other suffixes of the same derivation type. The focus of his work is on Wolof applicative and causative suffixes.

(31) Wolof

a. Móodu la Faatu wax-al.
Móodu FOC.3SG Faatu talk-APPL
'Faatu talked to MÓODU.'

b.
Faatu *Móodu*
-al comitative: SUBJ OBJ
| |
'ap⟨'wax⟨ _ ⟩', ARG ⟩'
agt com

(32) Wolof

a. Faatu daw-al woto bi.
Faatu run-CAUS car the
'Faatu made the car run.'

b.

	Faatu	*woto*
-al causative:	SUBJ	OBJ
	|	|
‘caus⟨	ARG, ‘daw⟨	_ ⟩’⟩’
	causer	causee

Dione proposed a special argument ARG as the matrix argument for each derivation type. In the applicative clause (31b), he assumed that ARG bears the matrix’s second argument and is underspecified for a comitative, while in the causative clause (32b), ARG occupies the subject position and bears the matrix first argument.

2.2.3.3 Work on Mande

Nikitina (2011a, 2019) examine a highly unusual basic word order pattern in Mande languages: the rigid S-O-V-X word order, meaning subjects and objects precede the verb, while all oblique arguments and adjuncts follow the verb. For example,

(33) Soso, Central Mande

S	O	V	[PP	]
ń	nìngéé	fíí-mà	í	má
1SG	cow	give-FUT	2SG	to

‘I will give you a cow.’

Mande languages are not regarded as “real” verb-final languages in the sense that arguments of a verb are not realized within the same verb phrase: object noun phrases must be placed next to their verb, but postpositional arguments appear in the position outside the verb phrase.

(34) Wan, Southeastern Mande

a.

è	[kúnà]$_{\text{VP}}$	ságlā	[yrɛ	é	gó]$_{\text{PP}}$
3SG	climb	started	tree	DEF	in

‘She began to climb onto the tree.’

b.

*è	kúnà	[yrɛ	é	gó]$_{\text{PP}}$	ságlā
3SG	climb	tree	DEF	in	started

c.

*è	[yrɛ	é	gó]$_{\text{PP}}$	kúnà	ságlā
3SG	tree	DEF	in	climb	started

Because the oblique argument *yrɛ é gó* does not form a syntactic constituent with the verb *kúnà* that selects for it, it cannot appear next to that verb as shown in (34b) and (34c), and only (34a) is grammatical in which the verb *kúnà* is embedded in the non-finite complement of the finite verb *ságlā*. Nikitina (2019) explains this unexpected placement of postpositional arguments in terms of a surface-oriented account of high attachment of PPs.

(35) Wan, Southeastern Mande

è	á	bɛ̰̀nì	lé	sógò-mù-è	lé
3sg	prog	fear	prog	horse-pl-def	at

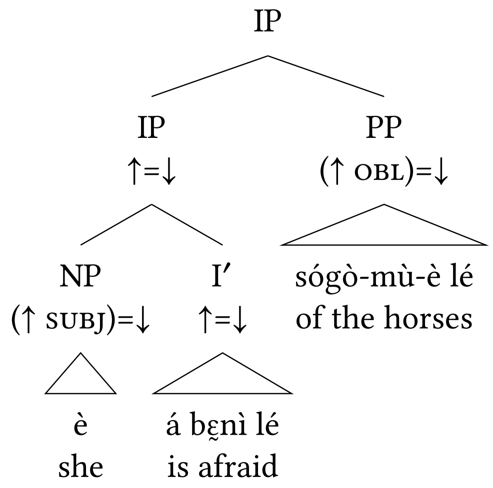
‘She fears horses.’

The phrase structure rule in (36) allows for PPs to adjoin to the clause (Nikitina 2008, 2011b):

(36)
$$\begin{array}{llcc} \text{IP} & \longrightarrow & \text{IP} & \text{PP} \\ & & \uparrow=\downarrow & (\uparrow \textsc{gf}^{*}\ \textsc{obl})=\downarrow \end{array}$$

The Kleene star indicates that the PP can contribute information regarding an oblique argument at any level of embedding, but the ambiguity at the c-structure can be solved at the f-structure where the PP is associated with the main verb to satisfy the well-formedness conditions on f-structure. The resulting structures of (35) is thus represented below:

(37) c-structure: f-structure:



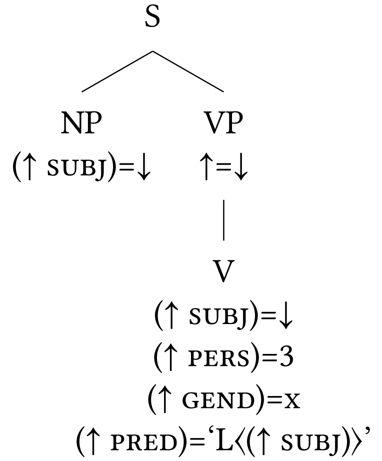
$$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{fear}\langle\textsc{subj,obj}\rangle\text{’} \\ \textsc{asp} & \textsc{prog} \\ \textsc{tense} & \textsc{pres} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \textsc{obl} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{horse}\text{’} \\ \textsc{num} & \textsc{pl} \\ \textsc{def} & + \\ \textsc{form} & \textsc{le} \end{array}\right] \end{array}\right]$$

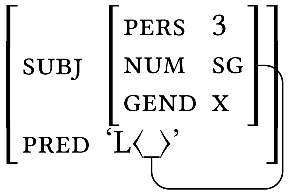
2.3 Agreement

African languages exhibit an interesting nature of agreement (Bresnan & Mchombo 1987, Culy 1996, Mchombo 2004, Nsoh 2011). This section will focus on pronouns in particular. Two particular LFG papers dealing with pronouns and agreement are Bresnan & Mchombo (1987) and Dalrymple (2015).

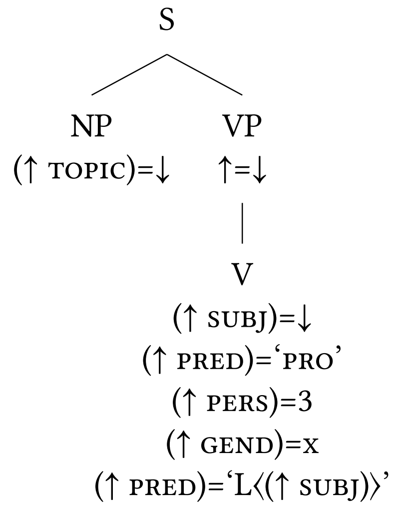
Like other Bantu languages, the subject marker (SM) and object marker (OM) in Chichewâ indicate agreement in their verbal morphology. For Bresnan and Mchombo, the OM is always an incorporated pronoun but the subject NP has two possibilities: a true subject grammatically agreeing with the verb or a topic NP anaphorically agreeing with the subject pronominal in the verb, as shown in (38).

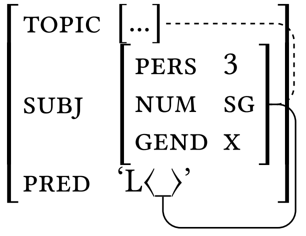
(38) c-structure: f-structure:





c-structure: f-structure:





In a recent paper, Dalrymple (2015) carries out a thorough investigation on the complicated pronominal system in Yąg Dii. According to her, Yąg Dii provides counter-evidence to the general assumption that languages do not have grammatical dependencies that are exclusively nonlocal. The following observations are made regarding the distribution of four types of Yąg Dii pronouns (Dalrymple 2015: 1113):

(39) a. MÍ: can bear any grammatical function, except for subject of ÀǸ̨ clause; antilogophoric in BI domain
  b. ÀǸ̨ : must appear as subject of ÀǸ̨ clause; antilogophoric in BI domain
  c. BI: appears only in BI domain; can bear any grammatical function (except for some subordinate subject positions within BI domain); coreferent with logophoric antecedent
  d. ÌI: appears only as subordinate subject within logophoric domain; coreferent with logophoric antecedent

Take the BI pronouns, for example (Bohnhoff 1986: 118):

(40) Yąg Dii
Nà'á Ø 'ọd bà'á [Múúsà bà Ø 'ọ [bà biǹ hį́į́
Mother$_i$ (she$_i$) tells Father Moses$_j$ that (he$_j$) says that he.BI$_{j,*i}$ wants
lààlɨ kaalɨ]].
to.go town.to
'Mother$_i$ tells Father that Moses$_j$ says that *she$_i$/he$_j$ wants to go to town.'

(41) Yąg Dii
*Nà'á Ø 'ọd bà'á [bà mí 'ọ [bà biǹ hį́į́ lààlɨ kaalɨ]].
Mother$_i$ (she$_i$) tells Father that I say that she.BI$_i$ wants to.go town.to
'Mother$_i$ tells Father that I say that she$_i$ wants to go to town.'

The analysis is built on LFG's binding theory, which is schematized in (42) (Dalrymple 2015: 1114).

(42) $$(\uparrow_\sigma \textsc{ant}) = ((\underset{\substack{\textsc{delimits}\\ \textsc{binding}\\ \textsc{domain}}}{\textsc{gf}^*} \quad \underset{\substack{\textsc{grammatical}\\ \textsc{function of}\\ \textsc{pronoun}}}{\textsc{gf}_{\textsc{pro}}} \quad \uparrow) \quad \underset{\substack{\textsc{grammatical}\\ \textsc{function of}\\ \textsc{antecedent}}}{\textsc{gf}_{\textsc{ant}}} \quad)_\sigma$$

f-structure: $$\begin{bmatrix} \textsc{gf}_{\textsc{ant}} & [\textsc{antecedent}] \\ \ldots\textsc{gf}^*\ldots\textsc{gf}_{\textsc{pro}} & [\textsc{pronoun}] \end{bmatrix}$$

The equation dictates that the antecedent must be found within the binding domain ($\mathrm{GF}^{*}\ \mathrm{GF}_{\mathrm{PRO}}\ \uparrow$). In order to constrain the distribution of the four types of pronouns, Dalrymple (2015) adds the LOG feature to the inventory of features that are universally available in the binding domain, inspired by Bresnan (2001), Adesola (2006), Asudeh (2009), and Strahan (2009, 2011).

The binding constraints for BI was proposed by Dalrymple as follows:

(43)
$$(\uparrow_{\sigma}\ \mathrm{ANTECEDENT}) = ((\begin{array}{ccc} \mathrm{GF}_{\mathrm{LOG}} & \mathrm{GF}^{*} & \uparrow) \\ (\rightarrow \mathrm{LOG}) & \neg(\rightarrow \mathrm{LOG}) & \\ 1 & 2 & \end{array}\ \begin{array}{c} \mathrm{SUBJ})_{\sigma} \\ \\ 3 \end{array}$$

The logophoric pronoun must appear within the logophoric domain which is the f-structure value of the $\mathrm{GF}_{\mathrm{LOG}}$ feature. The numbers occur under each element of binding equation where constraints are imposed. For example, the number 2 states that the BI pronoun may be embedded at an arbitrary depth within the logophoric domain, but it must be bound by the closest logophoric binder: examples (40)–(41) show the evidence that the smallest BI domain must be chosen (see Dalrymple 2015: 1116 for more details).

2.4 Reciprocal marking

African languages have also provided rich linguistic data for the analysis of reciprocity under the LFG framework (Mchombo & Ngunga 1994, Dalrymple et al. 1998, Mchombo 1999b). Hurst (2012) examined the reciprocal in Icelandic (Germanic), Malagasy (Austronesian) and Swahili (Bantu), based on Hurst (2006, 2010).

According to Hurst (2006), the Malagasy reciprocal construction is formed by way of a prefix *-if-* or *-ifamp-* to the verb, as shown in (44).

(44) Malagasy

N-ifamp-i-laza	ho	namboly	vary	Rasoa	sy	Ravelo.
PST-RECP-act-say	COMP	PST.cultivate	rice	Rasoa	and	Ravelo

‘Rasoa and Ravelo said of each other that s/he cultivated rice.’

Hurst (2006) proposes that the verb’s valency remains unchanged at the level of f-structure and the reciprocal morpheme creates a reciprocal pronoun selected by the verb as an internal argument. The lexical entries for (44) are thus given below:

(45) *n-ifamp-i-laza* V (↑ pred) = ‘say⟨(↑ subj) (↑ xcomp)⟩(↑ obj)’
(↑ xcomp subj) = (↑ obj)
(↑ obj pred) = ‘pro$_{\text{rec}}$’ (from *-ifamp-*)
(↑ voice) = active
(↑ tense) = past

namboly V (↑ pred) = ‘cultivate<(↑ subj) (↑ obj)>’
(↑ voice) = active
(↑ tense) = past

vary N (↑ pred) = ‘rice’

Furthermore, Hurst (2010) examines two reciprocal constructions in Swahili: the monadic construction that incorporates the participants into the subject NP while losing an object NP and the dyadic construction that has two participants in the subject NP and in a comitative phrase respectively. According to his LFG analyses, the syntactic and semantic (to a lesser extent) behaviour of reciprocal constructions results from more fundamental reciprocation strategies by which asymmetric predicates are made to describe symmetric situations, rather than from structural features, i.e., the formation process that may involve clitics and affixes. Khumalo (2014) also touches upon similar constructions (monadic and dyadic) in Ndebele using the Lexical Mapping Theory (LMT). Like in most Bantu languages, the Ndebele reciprocal is marked by the verbal suffix *-an-*, as shown in (46).

(46) Ndebele
Aba-ntwana ba-ya-thand-an-a.
2-children 2sm-prs-love-recp-fv
‘The children love each other.’

The monadic construction seems to violate the mapping principle in the LMT since each semantic role is assigned to a grammatical function and vice versa. According to the semantic interpretation of the reciprocal, the only participant in (46), *abantwana*, acts both as an agent and a beneficiary, as illustrated in (47).[7]

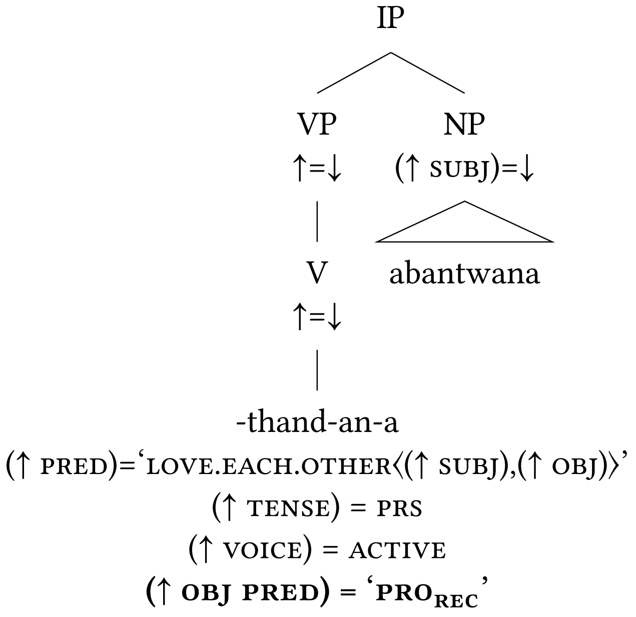
(47) A-structure: *thanda* ⟨Agent, Beneficiary⟩
F-structure: *thandana* ⟨subj⟩

---

[7] See Alsina (1996b: 260–263) for a similar analysis of the formation of reciprocal expressions in Catalan.

Following Hurst (2006, 2010), Khumalo (2014) attempts to solve the puzzle by proposing the following analysis:

(48) c-structure:



f-structure:

$$\left[\begin{array}{ll} \textsc{subj} & \left[\text{“}\textsc{abantwana}\text{”}\right] \\ \textsc{obj} & \left[\textsc{pred}\ \text{‘}\textsc{pro}_{\textsc{rec}}\text{’}\right] \\ \textsc{pred} & \text{‘-}\textsc{thandana}\langle(\uparrow \textsc{subj}),\ (\uparrow \textsc{obj})\rangle \\ \textsc{voice} & \textsc{active} \\ \textsc{tense} & \textsc{prs} \end{array}\right]$$

In this analysis, the reciprocal pronoun is licensed by the reciprocal morpheme through the definition, -**an**-: $(\uparrow \textbf{OBJ PRED}) = \text{‘}\textbf{PRO}_{\textbf{REC}}\text{’}$. As for the dyadic construction, Hurst (2010) proposes that the comitative NP should be treated as an argument-adjunct which cannot receive a theta role but is crucially licensed in the a-structure.

2.5 Locative inversion

The discussion of locatives in African languages has also attracted considerable attention (Bresnan & Kanerva 1989, Bresnan 1991, 1994, Moshi 1995, Morapedi 2010). Interestingly, unlike the PP locative in English, locatives have the structure of NP and occur freely in the subject and object positions. The locative phrase is a subject in (49a) and an object in (49b). Example (49c) is the passivized version of (49a) in which the locative is the object of the preposition "by". Obligatory subject-verb agreement can also be seen with locative subjects as shown in (49).

(49) Chichewa (Bresnan 1991: 58)

a. Ku San José kú-ma-ndi-sangalâts-a.
17 San Jose 17-sbj-prs.hab-I.sg.obj-please-ind
'It pleases me in San Jose, (Being in) San Jose pleases me.'

b. Ndí-ma-kónd-á ku San Josê.
I.sg.sbj-prs.hab-love-ind 17 San Jose
'I like it in San Jose.'

c. Ndí-ma-sangalats-ídw-á ndí ku San Josê.
I.sg.sbj-prs.hab-please-pass-ind by 17 San Jose
'I am pleased by (being in) San Jose.'

Another salient feature of locatives is exhibited by locative inversion construction.

(50) Chichewa (Bresnan 1991: 60)

a. A-lendô-wo a-na-bwér-á ku-mu-dzi.
2-visitor-2those 2sbj-rec.pst-come-ind 17-3-village
'Those visitors came to the village.'

b. Ku-mu-dzi ku-na-bwér-á a-lendô-wo.
17-3-village 17sbj-rec.pst-come-ind 2-visitor-2those
'To the village came those visitors.'

The locative *ku-mu-dzi* is the oblique complement of the intransitive verb (or passive verbs) and undergoes locative inversion as illustrated in (50b). According to Bresnan and Karneva's analysis, "the inverted subject is the thematic subject, the syntactic object, and the presentational focus in discourse" (1989: 38), which can be accounted for by generalizing the special subject default to the focus subject default:[8]

(51)
$$\begin{array}{ccc} [f] & \mathit{loc} & /\ \mathit{expl} \\ & | & \\ & [-r] & \end{array}$$

---

[8] The feature $[f]$ refers to the presentational focus attribute(s), and *expl* represents an expletive subject that may appear as an alternative to the *loc* classification.

There is a constraint regarding the distribution of the focus feature [*f*] in Chicheŵa: only the theme argument can bear an [*f*] feature, and only when it is the highest expressed role.[9]

Morapedi (2010) argues that the preverbal locative NP in Setswana is not the subject but the topic setting the scene for the focused NP in the sense that the preverbal locative NP does not pass the subjecthood test, while the post-verbal NP shows features atypical of objects.

2.6 Serial verbs and complex predicates

Complex predicates can be defined as predicates which are composed of more than one grammatical element (either morphemes or words), each of which contributes a non-trivial part of the information of the complex predicate (Alsina et al. 1997). Within the framework of LFG, the pioneer work has been done by Alsina (1993, 1994), Butt (1995, 1998), Frank (1996), Bodomo (1996, 1997), and Mohanan (1997).

Bodomo (1996) provides a series of syntactic and semantic tests on two types (causative and benefactive) of SVCs in Dagaare and Akan, arguing that the various verbs do indeed behave as a unit in the1form of a complex predicate.

(52) Dagaare

a. Báyúó dà ngmɛ-ø lá Áyúó lɔɔ-ø.
Bayuo PST beat-PRF FOC Ayuo CAUS+fall-PRF
'Bayuo knocked Ayuo down.'

b. Ò dà dé lá à bíé zѐglѐ bàrѐ.
he PST take FOC DEF child seat leave
'He seated away the child.'

(53) Akan
Kofi fa-a ntoma ma-a me.
Kofi take-PRF cloth give-PRF me
'Kofi took a cloth for me.'

Bodomo adopted and extended Alsina's (1994) idea of predicate composition to license the idea of composing the PRED features of SVCs into a single predicate-chain feature, labeled PREDCHAIN. Since in standard LFG unification is not possible with PRED values, Alsina replaces the annotation, ↑=↓, found on heads with the annotation, ↑=H↓, which will then allow the PRED values to be composed and not unified, represented below:

---

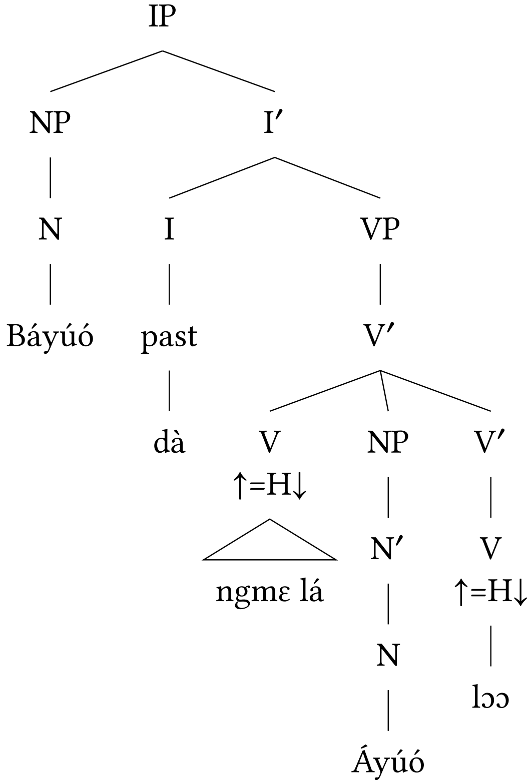
[9] Bresnan & Kanerva (1989) is another long and complex paper. For reason of conciseness, we cannot include all details here, but we encourage those who are interested in the analysis to read the whole paper.

(54) $\uparrow = \mathrm{H}\downarrow \equiv_{\mathrm{def}} \quad \uparrow\backslash_{\textsc{pred}} = \downarrow\backslash_{\textsc{pred}}$
$(\uparrow \textsc{pred}) = \mathrm{F}((\downarrow \textsc{pred}), (\rightarrow\mathrm{H}\ \textsc{pred}))$

What the definition says is that if a c-structure node has the head equation, its features are identical to the features of its mother node M except for PRED, and its PRED feature composes with that of its head sister node to yield the PRED feature of M. According to Bodomo, Alsina built his extension of the classical LFG notation on the assumption that one of the PREDs which compose must be incomplete. However, it is difficult to consider any of the verbs in the SVC data of Dagaare and Akan as any less complete than the other. A solution would be to consider, as does Baker (1989), a distinction of the notion of head into secondary and primary heads. Some of the predicates in the SVC would then be secondary to others in terms of headedness. It is these “secondary predicates” which count as the equivalents of the incomplete predicates in the sense Alsina used them. In this way predicate composition is possible with SVCs and thus licenses the existence of PREDCHAIN, as shown in (55).

(55)

c-structure:



f-structure:

$$\left[\begin{array}{ll} \textsc{predchain} & \text{‘}\textsc{ngmɛ lá}\langle\textsc{f}1, \textsc{f}2\rangle\text{’} \\ \textsc{tense} & \textsc{pst} \\ \textsc{aspect} & \textsc{prf} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{Báyúó}\text{’} \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{masc} \end{array}\right] \\ \textsc{obj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{Áyúó}\text{’} \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{masc} \end{array}\right] \end{array}\right]$$

More recent work on LFG analyses of serial verb constructions in African languages can be seen in Nyampong (2015) and Lovestrand (2018).

2.7 Discourse functions

Discourse functions have constituted another topical issue in African linguistics. The major LFG work includes Kanerva (1990), Bresnan (1995), Mchombo (2003), Marfo & Bodomo (2005) Mchombo & Morimoto (2009) and Abubakari (2018). Among them, Marfo & Bodomo (2005) stand out for attempting a constraint-based analysis, Optimality-Theoretic LFG (OT-LFG), when addressing *wh*-question fronting and focus constructions in Akan. It is shown that both *wh*-question fronting and focus constructions essentially share common representations in the c-structure and the f-structure but a variance is drawn between them in the information (i-) structure. Q-word fronting in Akan refers to the dislocation of the Q-word to the left-periphery of an extra-sentential position by using a clitic morpheme, *na*, referred to as a focus marker (FOCUS), at the right-edge of the fronted Q-word, as shown in (56).

(56) Akan

a. [$_{\text{IP}}$ Pàpá rè-sèré hwáí]
Father PROG-laugh who
'Father is laughing at who?'

b. Hwáí$_i$ nà [$_{\text{IP}}$ Pàpá ré-séré nó$_i$]
who FOC father PROG-laugh 3SG
'Whom is father laughing at?'

Both (56a) and (56b) are legitimate question forms in Akan. On the other hand, in a focus construction in Akan, contrastive information (of certainty) is intentionally employed for the purpose of emphasis as in (57). Both Q-word fronting and focus constructions essentially share a common marked categorial configuration, i.e., [$_{\text{FOCP}}$ XP *na* [$_{\text{IP}}$ …]].

(57) Akan
[$_{\text{FOCP}}$ ɛmóó$_i$ nà [$_{\text{IP}}$ ɔbáá nó [$_{\text{VP}}$ nóá [$_{\text{NP}}$ Ø$_i$]]]]
rice FOC lady DEF cook.HAB *e*
'It is rice (that) the lady cooks.'

Following Boadi (1990), Marfo & Bodomo (2005) argue that the Q-word fronting lacks semantic contrast given the fact that Q-words are actually inherently focus-marked. As a result, there is a difference in their i-structures regarding the focus type (F-TYPE):

(58) a. Q-word fronting:

$$\left[\begin{array}{ll} \text{FOCUS} & \left[\begin{array}{ll}\text{F-TYPE} & \text{NEUTRAL}\\ \text{I-PRED} & \text{‘HWAI’}\end{array}\right] \\ \text{BCK} & \left[\begin{array}{l}\text{PÀPÁ}\\ \text{RÉSÉRÉ NÓ}\end{array}\right]\end{array}\right]$$

b. Focus:

$$\left[\begin{array}{ll} \text{FOCUS} & \left[\begin{array}{ll}\text{F-TYPE} & \text{CONTRASTIVE}\\ \text{I-PRED} & \text{‘ƐMÓÓ’}\end{array}\right] \\ \text{BCK} & \left[\begin{array}{l}\text{ƆBÁÁ NÓ}\\ \text{NÓÁ}\end{array}\right]\end{array}\right]$$

This semantic distinction between the two constructions is further shown in the OT-LFG framework by ranking the following i-/c-structure correspondence/ alignment constraints (Choi 2001):

(59) a. NEW-L: [+NEW] aligns left in the construction of occurrence.
b. PROM-L: [+PROM] aligns left in the construction of occurrence.
c. NEUT-L: [+NEUT] aligns left in the construction of occurrence.
d. CONST-L: [+CONST] aligns left in the construction of occurrence.

(60) NEW-L » PROM-L » CONST-L » NEUT-L

	$[_{\text{FOCP}}$ NP$_i$ *na* $[_{\text{IP}}$ Pro$_i$ $[_{\text{VP}}$ V NP]]][10]	NEW-L	PROM-L	CONST-L	NEUT-L
a.	$[_{\text{FOCP}}$ ɛmóó$_{[\text{+CONST,+NEW,+PROM}]}$ nà $[_{\text{IP}}$ Pro$_i$ $[_{\text{VP}}$ V NP]]]				*
b.	$[_{\text{FOCP}}$ Hwáí$_{[\text{+NEUT,+NEW,+PROM}]}$ nà $[_{\text{IP}}$ na $[_{\text{IP}}$ Pro$_i$ $[_{\text{VP}}$ V NP]]]			*!	

The table in (60) signals a few things. First, since both Q-word and constituent in focus are noted as “[+PROM] [+NEW]” at the i-structure and each of them sits at Spec-FOCP, it is obvious the i-/c-structure correspondence constraints in ((59a)–(59b)) will be satisfied in both constructions. However, Q-word fronting and focus constructions have been set apart in the semantics as “discourse-neutral”

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[10] This optimal candidate emerges as $[_{\text{FOCP}}$ NP$_i$ *na* $[_{\text{IP}}$ Pro$_i$ $[_{\text{VP}}$ V NP]]] via OT for both Q-word fronting and focus constructions in an earlier section of the paper. We encourage those who are interested to read the whole paper.

and "discourse-contrast" respectively through the projected i-structure (see 58). These separate semantic orientations of Q-word fronting and focus are expressed in constraint terms ((59c)–(59d)). Second, CONST-L must crucially outrank NEUT-L where there is a need to establish i-/c-structure harmonic alignment in a focus construction (i.e., a correspondence between a constituent in focus and the Spec-FOCP position, as against harmonic alignment between a fronted Q-word and the Spec-FOCP position). Third, the ranking between CONST-L and NEW-L/PROM-L is hardly crucial because both fronted Q-word and focus constituent sit at Spec-FOCP and specify for [+new]/[+prom]. Fourth, the fact that the focus construction outperforms the fronted Q-word construction does not mean that the Q-word fronting construction is ungrammatical since CONST-L and NEUT-L are only necessary constraints motivated on individual semantic content to draw attention to the semantic distinction between Q-word fronting and focus constructions. It only explains that, unlike in a focus construction, no semantic contrast is realized in a Q-word fronting construction.

This main section of the chapter has documented a diverse set of features of African languages and shown how they have been analyzed in the LFG framework. In Section 3, we summarise the important role that LFG has played in analyzing African languages.

3 Contributions of LFG to the understanding of African language phenomena

In general, many African languages are characterized by rich morphosyntactic properties, stacked inflectional morphemes and mixed derivational and inflectional uses of the same morphemes, which have posed serious challenges to syntactic movement approaches (Mchombo 1980, Mchombo & Mtenje 1983, Bresnan 1994). The appearance of LFG in the 1970s has provided an important alternative under these circumstances. Petzell (2004) makes a comparison between LFG and transformational theories when dealing with certain phenomena in Bantu languages and concludes that LFG is more suitable for a surface-oriented, lexical analysis of syntactic and morphological issues in Bantu languages. Indeed, the Africanist research done under a constraint-based theory of grammar like LFG shows that multitiered, parallel structure analyses help understand a phenomenon at different levels of the grammar by means of unification, as we have already shown in Section 2. Bresnan & Kanerva (1989) put it accurately:

> The architecture of generative grammar has been predominantly based on the representation of independent levels of grammatical organization by

> configurations of the same kind of syntactic sentence structure; yet the need to constrain derivational relations among syntactic representations conflicts with the actual divergence of what is being represented. Although it is possible to superimpose thematic, structural, and functional relations onto the same syntactic representation, only the natural factorization of grammar will enable us to discover the deeper principles of language. (Bresnan & Kanerva 1989: 38)

There is no doubt that African languages and LFG are valuable to each other. For one thing, African languages provide a particularly rich empirical domain for testing the adequacy of the LFG framework. And for another, LFG provides a resourceful theoretical tool to look into the nature of these languages (Kroeger 2007).

4 Conclusion

In this chapter, we began with a brief outline of the language situation in Africa as well as a snapshot of the major features of African languages in Section 1. In Section 2 we then indicated how LFG has been used to analyze some of these salient features, covering topics such as the lexical integrity principle, applicative constructions, object asymmetries, agreement, reciprocal marking, locative inversion, serial verbs and complex predicates, and discourse functions. In the process of doing all this, the analyses in the chapter point to the major contributions of African languages to the development of LFG and, in turn, the major contributions of LFG to the understanding of African language phenomena, as shown in Section 3.

But, of course, there are other topics that we have unfortunately not been able to fully address here so as to keep this chapter concise enough. These include causatives (Alsina 1992), dative and passive (Mchombo 1980), comparatives (Beermann et al. 2005), negation (Bond 2016), mismatches/mixed categories (Bresnan 1995, Bresnan & Mugane 2006, Morimoto 2002), among others. It seems that most of the work has been done within the Bantu languages,[11] although there is now

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[11] As pointed out by one of our reviewers, a lot of the key LFG papers in Bantu are from the 1990s while more recently there has been comparatively less work. At the same time, there has been a bit of a Bantu boom beyond LFG, in particular in GB/MP and in comparative studies of variation, including locative inversion, applicatives, agreement, etc. However, these current trends in African linguistics have not yet been addressed fully in the LFG community. On the other hand, recent trends in LFG have not yet been linked specifically with African languages. This includes partial agreement (Sadler 2016) and information structure effects. More discussion of

an increasing availability of works in other languages in recent years. We could not agree more with Henderson (2011) that future research on African languages needs more comparative work. Such work will impact not only LFG but also syntactic theory on the whole in a more profound way.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

9-, 3-, etc.	(nominal) class 9, class 3, etc.	OM	object marker
APPL	applicative	PL	plural (also used for honorification of an individual)
ASC	associative	REC.PST	recent past
FV	final vowel	SM	subject marker
HAB	habitual	T	tense
HON	honorific		

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these African langage phenomena can be found in Downing & Marten (2019) and Agwuele & Bodomo (2018).

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Chapter 27

LFG and Australian languages

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Australian languages exhibit many interesting grammatical properties and have featured in LFG-related research since the earliest days of the framework. In this chapter I survey the features of Australian languages that have featured most prominently in work within LFG, and show how they argue strongly for the parallel architecture of LFG and in particular the separation of functional relations at f-structure from phrasal constituency and linearity at c-structure. These morphosyntactic features include non-configurationality and flexible word order, the role of morphology in encoding grammatical relations, case stacking, valence-changing phenomena and complex predicates. I show how the flexibility afforded by LFG's parallel architecture, which separates c-structure from f-structure with a many-to-many mapping between them, allows for a natural and explanatory account of these properties of Australian languages. In return, the empirical questions prompted by these theoretical analyses and their predictions have led to a more detailed understanding of the intricate grammatical structures of various Australian languages, and explain the appeal of the LFG formalism for fieldworkers engaged in Australian language documentation.

1 The languages of Australia

Across the continent of Australia there are hundreds of Indigenous languages. The literature typically cites upwards of 800 named language varieties, which can be grouped into 250-300 distinct languages (Koch & Nordlinger 2014b), but it is not always straightforward to determine language differences from dialectal differences and so these numbers are approximate to a certain extent.[1] Prior to

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[1] It is important to note that these >800 language varieties are considered different languages by Indigenous communities themselves, and thus the grouping of these into a smaller number of 'distinct languages' is a purely linguistic enterprise.

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the English invasion of Australia, these languages were spoken across a population of perhaps 750,000 to one million people, which highlights the enormous linguistic diversity of Indigenous Australia. In many cases languages were maintained by very small populations (e.g. 40–50 people), and the largest populations speaking a single language variety were probably no bigger than 4000 people. Linguistic diversity is highly valued culturally for its indexical relationship to heritage, identity and group membership (Evans 2007) and is not an impediment to communication, since high degrees of multilingualism were (and often still are) the norm across Indigenous Australia, with individuals typically speaking up to 4–6 languages of the surrounding area, as well as understanding others, given widespread practices of receptive multilingualism (Singer 2018).

Australian languages are generally considered by linguists to all be related to one another, although the detailed comparative work needed to establish this is still underway. Such research is confounded by a number of factors, the most significant of which is the extraordinary time depth (perhaps as much as 65,000 years) that Indigenous people have been living on and moving around the continent, with almost no written records of any of the languages prior to the last 200 years or so, and few detailed descriptions until substantially later. Research to date has established that the Australian languages can be grouped into around 25 different language families. One of these, the *Pama-Nyungan* family, covers approximately 85 percent of the continent, stretching from the south-west of Western Australia all the way to the tip of Cape York in far north Queensland. The other families, known collectively as the *non-Pama-Nyungan* families, are concentrated in the northern parts of Western Australia and the top half of the Northern Territory, but higher order groupings amongst these non-Pama-Nyungan families have not yet been clearly established.

The sociolinguistic situation varies enormously across these hundreds of languages and their communities (DITRC et al. 2020). Some languages remain strong, and are used by their communities as the daily language of communication and learned as first languages by the children. Many others are used fluently only by older members of the community, with younger generations having passive and varying degrees of partial knowledge of the language; while many other languages, particularly those from the areas most heavily populated by non-Aboriginal populations since the nineteenth century, have no first language speakers at all and are instead in the process of being relearned and revived by community members from (often scant) historical materials.

Australian languages are relatively similar phonologically (Fletcher & Butcher 2014) but exhibit greater variation in grammatical organisation. While all Australian languages are morphologically complex, we can see them as falling into two broad grammatical types which we can loosely call dependent-marking and head-marking (Nichols 1986) (although most of the head-marking languages have some dependent-marking as well, and some of the dependent-marking languages have bound pronominal clitics cross-referencing verbal arguments). The Pama-Nyungan languages are dependent-marking languages with grammatical relations primarily encoded through case marking. These languages are generally morphologically ergative languages, and have elaborate case systems that cover a range of grammatical and semantic case functions. Examples such as the following are typical.

(1) Jiwarli
Ngatha tharla-laartu ngurru-martu-nha pirru-ngku.
1sg.erg feed-usit old.man-group-acc meat-erg
'I used to feed the old men with meat.' (Austin 2001a: 310)

(2) Jiwarli
Wuru ngunha tharrpa-rninyja ngarti-ngka kajalpu-la…
stick.acc that.acc insert-pst inside-loc emu-loc
'(He) inserted the stick inside the emu…' (Austin 2001a: 315)

However, some other Pama-Nyungan languages combine a robust case-marking system with bound pronominal clitics cross-referencing verbal arguments, as illustrated in the following examples:

(3) Bilinarra
Liward-ba=nggu=lu garra nyununy gajirri-lu.
wait-ep=2min.obj=3aug.sbj be.prs 2min.dat woman-erg
'The women are waiting for you.' (Meakins & Nordlinger 2014: 121)

(4) Bilinarra
Jamana-lu=rni=warla=rna=rla ma-ni warlagu=ma nyila=ma,
foot-erg=only=foc=1min.sbj=3obl do-pst dog(acc)=top that(acc)=top
garndi-murlung-gulu.
stick-priv-erg
'I kicked the dog of his with just my foot, not with a stick.' (Meakins & Nordlinger 2014: 121)

The head-marking languages largely belong to non-Pama-Nyungan families of northern Australia and encode core grammatical relations primarily through verbal morphology. Some of these are characterised as polysynthetic since verbs can be so morphologically complex that they can stand alone as a single complex clause, and may even allow noun incorporation as in (5). The polysynthetic, head-marking languages of Australia have minimal grammatical case marking, although many still employ case for semantic case functions. Polysynthetic Australian languages include Bininj Gun-wok (Evans 2003) and Murrinhpatha (Blythe 2009, Nordlinger 2017, Mansfield 2019), as illustrated in the following examples.

(5) Bininj Gun-wok
Nga-ban-marne-yawoih-dulk-djobge-ng.
1sg.sbj-3pl.obj-ben-again-tree-cut-pst.pfv
'I cut the tree/wood for them again' or 'I cut another tree for them.'
(Evans & Sasse 2002: 2)

(6) Murrinhpatha
Puddan-wunku-rlarl-deyida-ngime=pumpanka.
3du.sbj.shove.nfut-3du.obj-drop-in.turn-pc.f=3du.sbj.go.nfut
'They (dual sibling) are dropping them (paucal, female, non-sibling) off, one after the other, as they go along.' (Blythe 2009: 134)

Australian languages exhibit many interesting grammatical properties that have been the focus of much theoretical and typological discussion, including flexible word order, syntactic and morphological ergativity, elaborate case systems and case marking, nominal classification, complex verb structures, polysynthesis, noun incorporation, grammaticalised expression of kin relations, and many more – see the overviews and discussions in Dixon (2002), Koch & Nordlinger (2014a), and Bowern (2023) for more details. It is not possible for me to do justice to all of this work here, so in this chapter I focus on the features of Australian languages that have featured most prominently in work within the LFG framework.

2 Overview of work on Australian languages in LFG

Australian languages have featured in LFG-related research since the early days, beginning with Jane Simpson's PhD work on Warlpiri (Simpson 1983). The non-configurational clausal structure of languages like Warlpiri, first discussed by Hale (1981, 1982, 1983), argues strongly for the parallel architecture of LFG and in particular the separation of functional relations at f-structure from phrasal constituency and linearity at c-structure. Languages like Warlpiri provide clear support for the idea that the same f-structure information can be realised across different languages with wildly diverse c-structures. This is illustrated by comparing Figure 1 and Figure 2 (based on Bresnan et al. 2016: 3–4), where we see that the same f-structure can correspond to both the highly configurational c-structure of English, and the flat non-configurational c-structure of Warlpiri. Warlpiri in addition allows multiple alternative word orders in c-structure, all of which correspond to this same f-structure.[2]

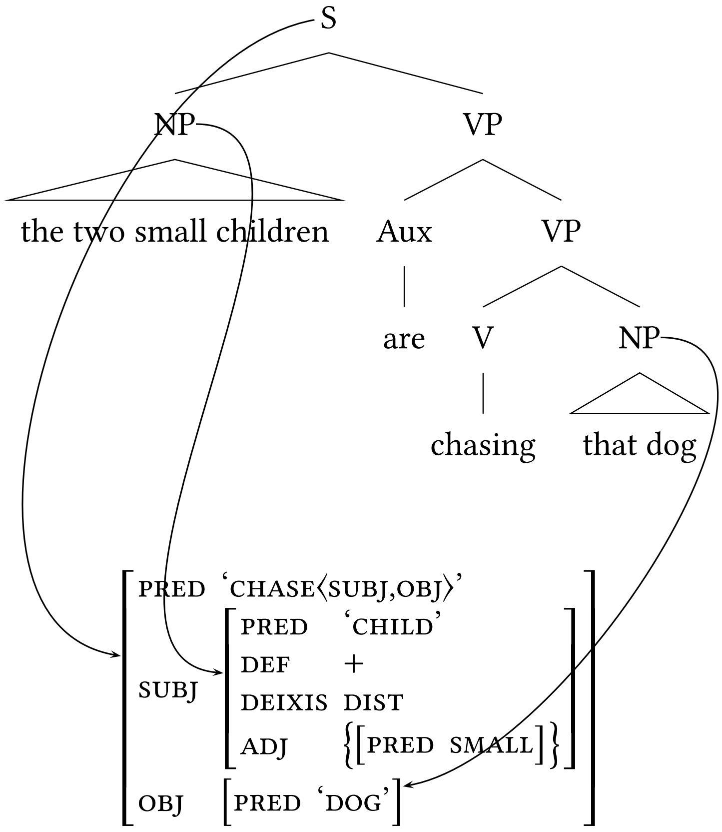

Figure 1: Simple c-structure/f-structure correspondences in English

While early work in LFG focussed on Warlpiri (Simpson 1983, Simpson & Bresnan 1983, Simpson 1991) subsequent work has brought in empirical data from a number of other Australian languages including Jiwarli (Austin & Bresnan 1996), Wambaya (Nordlinger & Bresnan 1996, Nordlinger 1998b), Dyirbal (Manning 1996), Wagiman (Wilson 1999), Kayardild (Evans & Nordlinger 2004), Wubuy

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[2] Any order of words and categories in the c-structure given in Figure 2 is grammatical and semantically equivalent, as long as *ka=pala* remains in second position. See (8) below for further exemplification.

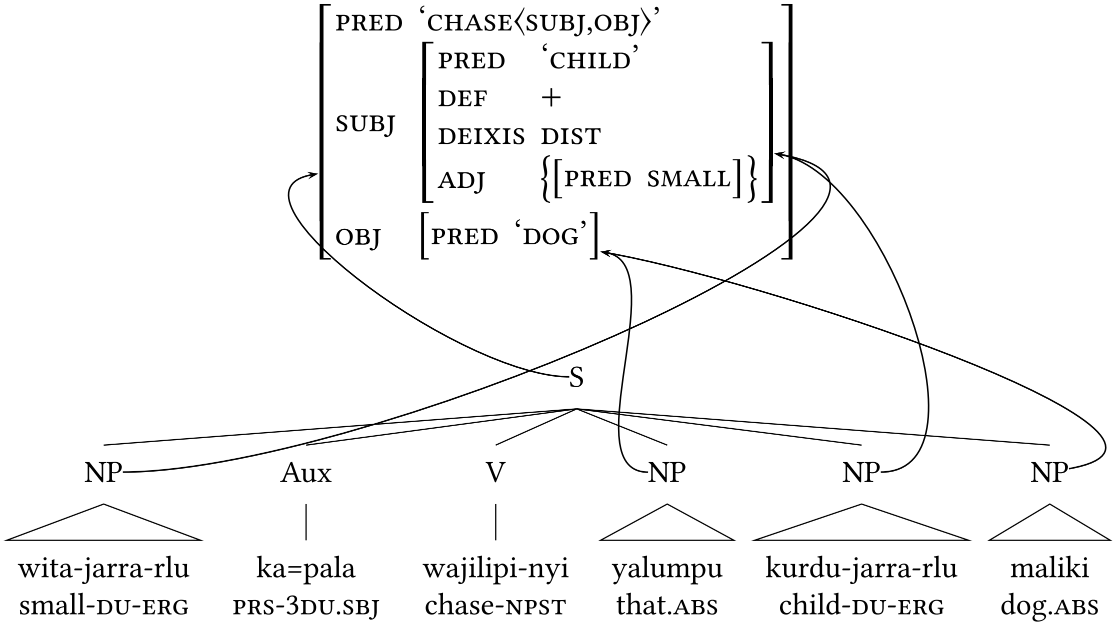


Figure 2: Simple c-structure/f-structure correspondences in Warlpiri

(Baker & Nordlinger 2008, Baker et al. 2010), Anindilyakwa (van Egmond 2008), Arrernte (Dras et al. 2012) and Murrinhpatha (Seiss & Nordlinger 2010, Seiss 2013). The morphosyntactic properties of Australian languages that have been discussed and analysed in this LFG literature range from clause structure and especially non-configurationality (Simpson 1991, Austin & Bresnan 1996, Nordlinger & Bresnan 2011, Snijders 2015; see also Andrews 2023a [this volume]); the role of morphology in encoding grammatical relations (Nordlinger & Bresnan 2011, Nordlinger 1998b) including pronominal incorporation and verbal agreement (Austin & Bresnan 1996) and case marking (Simpson 1991, Andrews 1996, Nordlinger 1998b, Andrews 2017); and flexible noun phrase structure and discontinuity (Simpson 1991, Sadler & Nordlinger 2006a, 2010, Snijders 2016) to other morphosyntactic interactions such as the marking of tense/aspect/mood on NPs (Nordlinger & Sadler 2004a), valency-changing phenomena (Austin 1997, Seiss & Nordlinger 2010) and complex predicates (Wilson 1999, Andrews & Manning 1999). These are discussed further in Section 3.

Given the morphological complexity of Australian languages – some head-marking and even polysynthetic, and others heavily dependent-marking – the LFG work on Australian languages has focussed largely on the morphology-syntax interface. It is here that the data from Australian languages contributes most to the development of LFG theory, and where the flexibility afforded by LFG's parallel architecture, which separates c-structure from f-structure with a many-to-many mapping between them, allows for a natural and explanatory account of the morphosyntax of Australian languages. Crucial to this flexibility is the fact that words (and therefore morphology) can contribute information directly to the f-structure alongside, or instead of, f-structure information coming from the c-structure. This enables the framework to capture the cross-linguistic generalisation that languages rich in morphological structure, such as the Australian languages, often make less use of phrase structure – a generalization that Bresnan (2001: 7) captures with the slogan "morphology competes with syntax" – essentially words and phrases are different means of encoding the same grammatical relations (Nordlinger & Bresnan 2011). The unification-based architecture of LFG allows for compatible information from different structural sources to integrate into a single f-structure. The independence of grammatical functions from c-structure, along with features such as economy of expression (allowing for the optionality of c-structure heads) and an exocentric S category have contributed to the analysis of Australian languages in the framework, as discussed in more detail in Section 3. In return, the empirical questions prompted by these theoretical analyses and their predictions have led to a more detailed understanding of the intricate grammatical structures of various Australian languages, and explain the appeal of the LFG formalism for fieldworkers engaged in Australian language documentation.

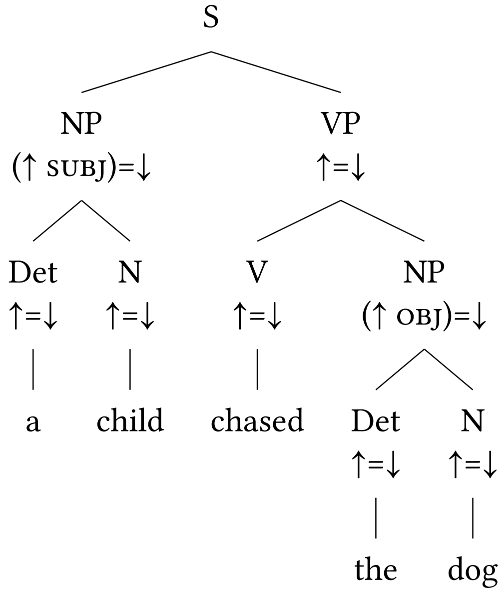
3 Phenomena analysed within LFG

3.1 Non-configurational clausal structure

Simpson (1983: 18) observes that "Warlpiri, a Pama-Nyungan language spoken in Central Australia, is a language in which the burden of representing the relations between predicates and arguments [...] is borne by the morphology rather than the syntax." Thus, many properties commonly associated with constituent structure in languages such as English are instead associated with morphological structure in Warlpiri, including the encoding of grammatical relations such as subject and object. In a configurational language like English grammatical relations can be associated with positions in a hierarchical constituent structure, as shown in (7b).

(7) a. A child chased the dog.

b.



In a language such as Warlpiri, on the other hand, constituent structure plays no role in identifying the grammatical relations of subject and object, as shown by the fact that the NPs in the Warlpiri sentence in (8) can appear in any position in the clause without affecting the meaning. Rather, it is the case marking, the morphological information carried by the nominals themselves, that plays the role of encoding grammatical relations information. In (8), the presence of the ergative case on ‘child’ and absolutive case on ‘dog’ unambiguously identifies the former as the subject NP and the latter as the object NP, irrespective of their positions in the constituent structure.

(8) Warlpiri
Kurdu-ngku maliki wajilipu-ngu.
child-ERG dog.ABS chase-PST
‘A child chased the dog.’ (Mary Laughren, pers. comm.)

Maliki wajilipu-ngu kurdu-ngku
Wajilipu-ngu kurdu-ngku maliki
Maliki kurdu-ngku wajilipu-ngu
Kurdu-ngku wajilipu-ngu maliki
Wajilipu-ngu maliki kurdu-ngku.

The disassociation of grammatical functions from hierarchical constituent structure in this way is known as ‘non-configurationality’, and discussion of Warlpiri, as well as some other dependent-marking Australian languages such as Wambaya (Nordlinger 1998b) and Jiwarli (Austin & Bresnan 1996, Austin 2001a) has been central to debates about the ways in which such languages are syntactically distinct from more configurational languages, and how best to represent these differences in formal syntactic theory. Hale (1983) identifies three key properties of Warlpiri syntax that he considers to be characteristic of its non-configurational structure: 'free word order' as illustrated in (8), 'the use of syntactically discontinuous expressions', whereby elements relating to the same grammatical relation can be discontinuous in the clause (9), and 'extensive use of null anaphora', which allows for the free omission of argument NPs (10).

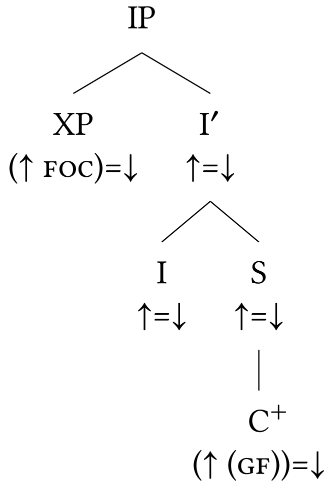
(9) Warlpiri
Wawirri kapi=rna panti-rni yalumpu
kangaroo.ABS AUX=1.SG.SBJ spear-NPST that.ABS
'I will spear that kangaroo.' (Hale 1983: 6)

(10) Warlpiri
Panti-rni ka.
spear-NPST AUX
'He/she is spearing him/her/it.' (Hale 1983: 7)

Each of these properties illustrates the fact that grammatical relations in Warlpiri (and other similarly non-configurational languages) are not uniquely determined by the phrase structure position of the relevant argument NP. The fact that argument NPs can grammatically appear in any position in the clause, and that there can be multiple, discontiguous positions associated with the same grammatical function suggest that standard endocentric principles of X′ Theory do not apply uniformly in these languages. The free omission of argument NPs indicates that information about grammatical relations can be encoded elsewhere in the clause (e.g. as part of the verb's lexical and/or morphological content), not necessarily by phrase structure position. Austin & Bresnan (1996) show that these three properties vary independently of each other and that a language may be non-configurational without allowing 'discontinuous NPs', for example; rather, what is definitional for non-configurationality is the fact that grammatical relations are not directly defined by phrase structure position.

Simpson (1983, 1991) (also Hale 1983, Austin & Bresnan 1996, Nordlinger 1998b) argue that such non-configurationality supports a theoretical model in which phrase structure constituency is separated from functional relations, as in LFG (Austin & Bresnan 1996 call this the 'dual structure' hypothesis). The principles of c-structure in LFG, in addition to the standard categories determined by X′ theory, include a non-projective category S, distinguished from these other categories by the fact that it is not headed by something of the same category as itself (exocentric) (Bresnan 2001; see also Andrews 2023a [this volume]). The availability of this category in c-structure allows for languages to have non-hierarchical, non-configurational phrase structures. Since this category is non-projective and exocentric, it can have a head of any category and, since it is not subject to the constraints of X′ Theory, it can dominate multiple constituents not bearing the typical relations of sisters in endocentric structures. Thus, S may define a totally flat phrase structure in which all constituents are sisters – all daughters of the clause – and functional annotations are assigned freely to all constituents, thereby capturing properties such as free word order and the possibility of discontinuous constituents. Following the analysis of Warlpiri c-structure provided by Austin & Bresnan (1996), the c-structure of a basic Warlpiri sentence can be given as in (11):[3]

(11)



Where C = X^0, or NP

In this structure a non-configurational category S is generated as a sister to I within IP.[4] I is the position of the auxiliary, and the (optional) specifier of IP carries the discourse function of focus. The annotation (↑ (gf)) = ↓ associated with the constituents of S indicates that the functional annotations ↑ = ↓ (the head

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[3] Note that this is a more elaborated c-structure than the simplified version shown in Figure 2, which captures the fact that the auxiliary is required to appear in second position. See Austin & Bresnan (1996) for more detailed discussion.

[4] In some non-configurational languages such as Jiwarli (Austin & Bresnan 1996) there may be no evidence for an IP so that the top node of a clause is simply S.

relation) and (↑ GF) = ↓ (where GF stands for the disjunction of all possible grammatical functions) are assigned freely within S (Simpson 1991, Austin & Bresnan 1996). Effectively this means that no specific functions are assigned within S at all. Rather, it is the information encoded in the morphology in conjunction with the principles of Completeness and Coherence (see Belyaev 2023 [this volume]) that ensures a grammatical c-structure and f-structure.

The principle of Economy of Expression in LFG (Bresnan 2001) states that all phrase structure nodes are optional unless they are required by independent principles. This allows for the possibility of null anaphora, since argument NPs are not required if the relevant grammatical function information is also contributed by morphological information (or by something else in the structure). Grammatical relations such as SUBJECT and OBJECT are encoded at f-structure and, since words in LFG can contribute information to the f-structure in the same way as syntactic phrases (Belyaev 2023 [this volume]), words can contribute grammatical function information to f-structure directly, without the need for such information to also be reflected in the phrase structure. This provides a great deal of flexibility in terms of where and how different languages may encode grammatical function information, and even allows for languages to express it redundantly in both the phrasal syntax and the morphology, as long as the information is compatible under unification at f-structure (see Nordlinger (1998b: Chapter 3) for detailed discussion). Dependent-marking non-configurational languages such as Jiwarli (Austin 2001a) encode grammatical function information primarily in case marking morphology, while head-marking non-configurational languages such as Bininj Gun-wok do this through verbal morphology. Warlpiri, with both case marking and pronominal argument clitics, combines both of these properties. These options and their treatment in LFG are shown in the following (examples repeated from (1), (5) and (9) above):

(12) Jiwarli

Ngatha	tharla-laartu	ngurru-martu-nha.
1SG.ERG	feed-USIT	old.man-GROUP-ACC

‘I used to feed the old men.’ [5]

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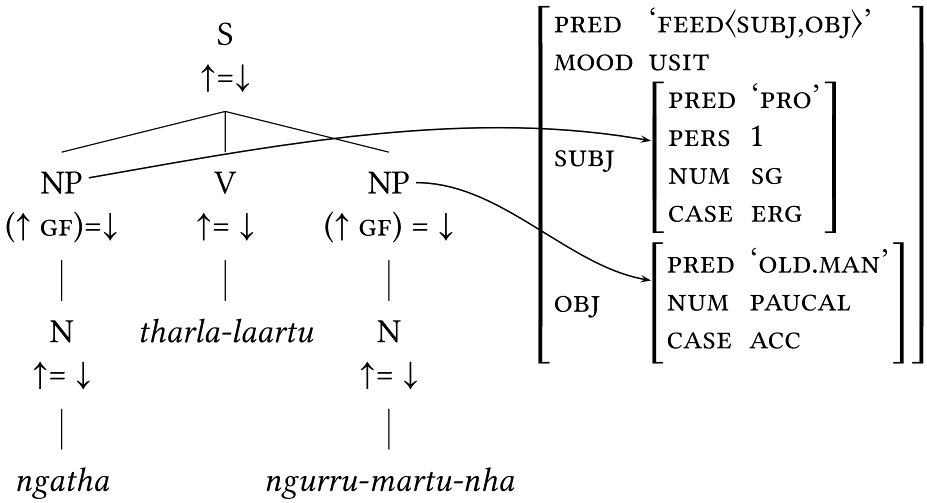
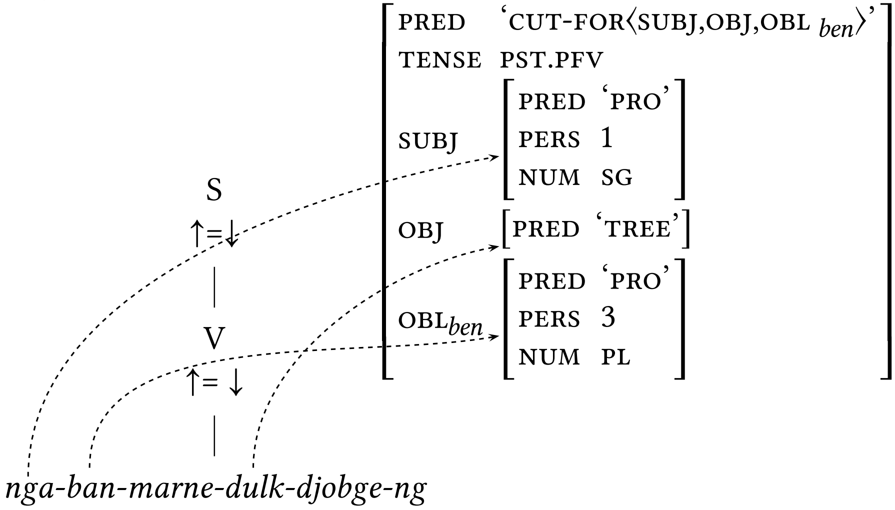
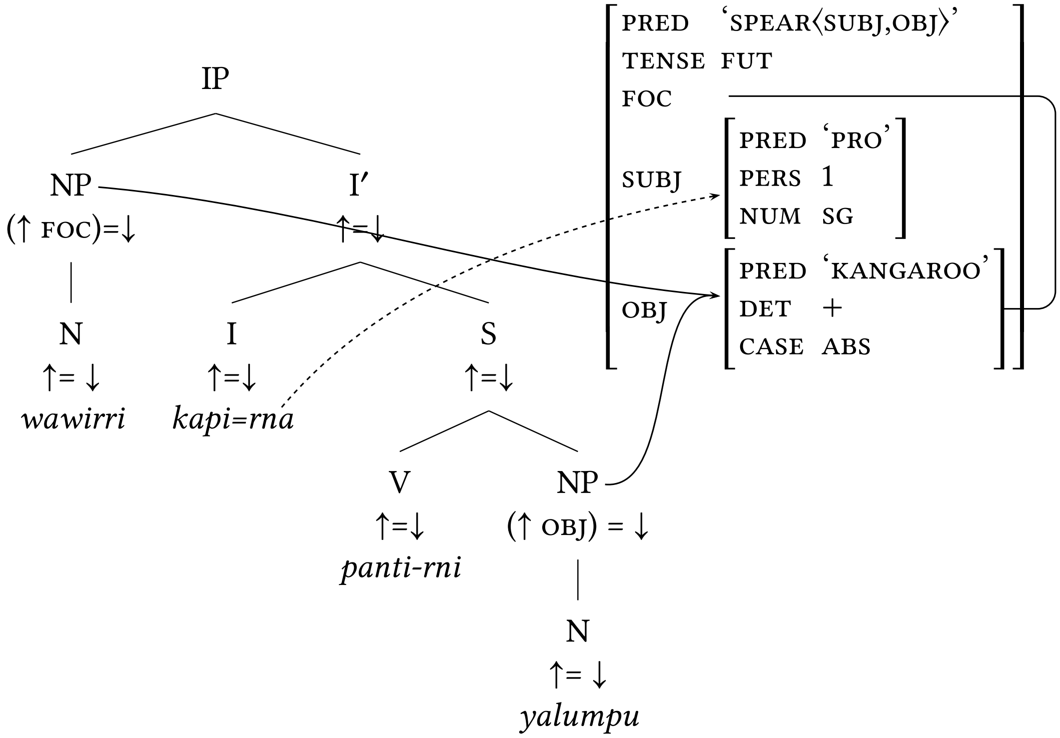
[5] This example is modified from Austin (2001a: 310). I have left the adjunct phrase *pirru-ngku* ‘with meat’ out here just to simplify the structures for presentational purposes.



(13) Bininj Gun-wok
Nga-ban-marne-dulk-djobge-ng.
1SG.SBJ-3PL.OBJ-BEN-tree-cut-PST.PFV
‘I cut the tree for them.’



(14) Warlpiri
Wawirri kapi=rna panti-rni yalumpu
kangaroo.ABS AUX=1.SG.SBJ spear-NPST that.ABS
‘I will spear that kangaroo.’



In head-marking languages, grammatical function information is encoded as part of the inflected verb's lexical entry, associated with verbal agreement morphology in the usual way (see Haug 2023 [this volume], also Börjars et al. 2019: Chapter 4 for detailed exemplification). Consider a Bininj Gun-wok verb such as that given in (15), the lexical entry for which is shown in (16). Following Bresnan & Mchombo (1987), the PRED values associated with the verbal morphology are optional to capture the fact that the verb can combine optionally with external argument NPs. When there are no co-referential NPs in the clause, the principle of Completeness will ensure that the PRED 'PRO' features are present, since otherwise the resulting f-structure will be incomplete, containing a SUBJECT and OBJECT lacking PRED features. In the presence of a co-referential NP, however, as in example (15), the OBJ PRED feature will be omitted since it will not be able to unify with the PRED value of the external object NP (see Belyaev 2023 [this volume] for discussion of the Uniqueness principle and PRED values). This flexibility captures the fact that such verbal morphology can function as pronominal arguments, and also as agreement morphology in the presence of external NPs (see Toivonen 2023 [this volume]).

(15) Bininj Gun-wok
Abanmani-na-ng bininj.
1SG.SBJ:3DU.OBJ-see-PST.PFV man
'I saw the two men.' (Evans 2003: 417)

(16) *abanmaninang* (↑ PRED) = 'SEE⟨SUBJ,OBJ⟩'
(↑ TENSE) = PST.PFV
((↑ SUBJ PRED) = 'PRO')
(↑ SUBJ PERS) = 1
(↑ SUBJ NUM) = SG
((↑ OBJ PRED) = 'PRO')
(↑ OBJ PERS) = 3
(↑ OBJ NUM) = DU

In dependent-marking languages, such as Jiwarli and Warlpiri, grammatical function information is encoded by case morphology. There have been a number of different approaches to capturing this in LFG. Simpson (1983, 1991) assumes a verb-mediated approach, where verbs select for the case values of their arguments in their lexical entries. Thus, a verb such as *panti-* 'spear' would include in its lexical entry (↑ SUBJ CASE)=ERG and (↑ OBJ CASE)=ABS, which then must unify with the case value of the NP in the f-structure, constrained by the principles of Completeness and Coherence. Nordlinger & Bresnan (2011) supplement the verb-mediated approach with case conditionals of the type in (17), thus capturing the generalisation that there is a direct relationship between case and the encoding of grammatical functions.

(17) $(\downarrow \text{CASE}) = \kappa \Rightarrow (\uparrow \text{GF}) = \downarrow$

The idea is that each case value (represented here by κ) is associated in the grammar with a set of grammatical functions. For example, the case conditional for the Warlpiri ergative case might look as in (18), which specifies that an element with ergative case is to be associated with the subject grammatical function:

(18) $(\downarrow \text{CASE}) = \text{ERG} \Rightarrow (\uparrow \text{SUBJ}) = \downarrow$

Thus, by virtue of its case value each NP is assigned a grammatical function (or set of possible functions). In addition, verbs and other lexical predicators select for the case features of their arguments.[6] The unification of the possible functions

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[6] In the majority of cases this is predictable from the argument structure of the verb, so can be covered by a lexical rule.

of the NP and the requirements of the predicator, in conjunction with the general principles of Uniqueness, Completeness and Coherence, ensures that the NPs in the c-structure are associated with the appropriate grammatical functions in the corresponding f-structure.

For example, a transitive verb stem such as *wajilipi-* 'chase' requires that its subject have ergative case and its object have absolutive case, thus corresponding to an f-structure such as the following:

(19)

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{chase}\langle\textsc{subj,obj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix}\textsc{case} & \textsc{erg}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{case} & \textsc{abs}\end{bmatrix} \end{bmatrix}$$

The only f-structures for a sentence headed by this verb stem that satisfy Completeness and Coherence will be those in which an absolutive NP is identified with the OBJ grammatical function and an ergative NP is identified with the SUBJ grammatical function. Thus, the f-structure for the sentence in (20a) is that given in (20b).

(20) a. Warlpiri
Kurdu-ngku maliki wajilipu-ngu.
child-ERG dog.ABS chase-PST
'A child chased the dog.'

b.

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{chase}\langle\textsc{subj,obj}\rangle\text{'} \\ \textsc{tense} & \textsc{pst} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{child}\text{'} \\ \textsc{case} & \textsc{erg}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{`}\textsc{dog}\text{'} \\ \textsc{case} & \textsc{abs}\end{bmatrix} \end{bmatrix}$$

Nordlinger (1998b) provides a third approach to the analysis of case morphology and its role in encoding grammatical relations, known as 'constructive case'. This is discussed in more detail in Section 3.3.

The discussion of non-configurationality in Australian languages and its treatment in LFG has been expanded in more recent years to integrate information structure and its interaction with different word order possibilities. Simpson (2007) focusses on Warlpiri and the pragmatic constraints on its different word orders; this is also discussed for Jiwarli in Austin (2001a). Snijders (2015) builds on and expands the earlier LFG work to provide a typology of configurationality that integrates information structure into the analysis, and extends the discussion beyond just the languages of Australia.

3.2 Flexible NP structure

Another feature common to many Australian languages that has been the subject of theoretical work in LFG is flexibility of NP structure.[7] While some researchers (including Hale 1983) consider this phenomenon to be central to the issue of non-configurationality, in fact – as Austin & Bresnan (1996), Nordlinger (1998b) and others have argued – the two phenomena are logically distinct, although they may co-exist in a single language of course, as found in Warlpiri (Hale 1983), Jiwarli (Austin 2001a), Wambaya (Nordlinger 1998b) and many other Australian languages. It is possible, however, for a language to be non-configurational at the clausal level while having strictly defined and non-flexible NPs. This is what we find in the Australian languages Kayardild (Evans 1995) and Murrinhpatha (Mujkic 2013), for example, both of which have clearly defined NP constituents with little or no discontinuity, while allowing great word order freedom at the clausal level and no clear association of grammatical relations with phrase structure. Languages such as these are thus non-configurational as discussed in Section 3.1 despite not allowing discontiguous nominal phrases.

The flexibility of NP structure in (some) Australian languages has been addressed within the LFG literature with regards to two different aspects. The first of these is NP discontinuity, the general LFG approach to which was discussed in Section 3.1 above (see also Snijders 2016 and Börjars & Lowe 2023 [this volume]). The second is nominal juxtaposition – whereby many semantically different NP structures, including coordination, are expressed through the simple juxtaposition of nominals in seemingly flat NP structures (Sadler & Nordlinger 2006a, 2010). Sadler & Nordlinger (2010) provide the following illustrative examples:

(21) Coordination (Nyangumarta)
Pala-nga ngatu jarri-nya-pinti-ngi, mima-nikinyi-yi puluku,
that-LOC stationary INCH-NMLZ-ASSOC-LOC wait.for-IPFV-3PL.SBJ 3DU.DAT
kujarra kangkuru-jirri waraja yalapara.
two kangaroo-DU one goanna
'And there, on the finishing line, the two kangaroos and one goanna waited for those two.' (Sharp 2004: 315)

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[7] Recent work investigating this aspect of Australian languages in more detail includes Louagie & Verstraete (2016), Louagie (2020) and Reinöhl (2020). The details of these typological studies have not yet been fully addressed within LFG analyses.

(22) Generic-Specific (Yidiny)
Gana mayi jimirr jula:lin.
try vegetable(abs) yam(abs) dig.going.imp
'Go and try to dig some yams up!' (Dixon 1977: 247)[8]

(23) Apposition (Wambaya)
Garidi-ni bungmanyi-ni gin-amany yanybi.
husband-erg old.man-erg 3sg.m.sbj-pst.twd get
'(Her) old man husband came and got (her).' (Nordlinger 1998a: 133)

(24) Inclusory (Kayardild)
Nga-rr-a kajakaja warra-ja thaa-th.
1-du-nom daddy.nom go-act return-act
'Daddy and I will go.' (lit. 'We two, including daddy, will go') (Evans 1995: 249)

Sadler & Nordlinger (2010) draw on the standard LFG treatment of coordination (Dalrymple & Kaplan 2000) to account for asyndetic coordination structures such as (21). Thus, the coordination structure is licensed by the c-structure rule in (25), where X is a metavariable ranging over N and NP, and the syntactic resolution of pers and num features that is characteristic of coordination is captured by the template @np-cnjt associated with each coordinand, which is defined as in (26). The resulting f-structure of the coordinated NP in (21) is given in (27).

(25)
$$\textsc{x} \longrightarrow \begin{array}{c} \textsc{x} \\ \downarrow \in \uparrow \\ @\textsc{np-cnjt} \end{array} \quad , \quad \begin{array}{c} \textsc{x} \\ \downarrow \in \uparrow \\ @\textsc{np-cnjt} \end{array}$$

(26)
$$\textsc{np-cnjt}\textit{:} \quad \begin{array}{l} (\downarrow \textsc{ind pers}) \subseteq (\uparrow \textsc{ind pers}) \\ (\downarrow \textsc{ind num}) \subseteq (\uparrow \textsc{ind num}) \end{array}$$

(27)
$$\begin{bmatrix} \textsc{index} & \begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{pl} \end{bmatrix} \\ \multicolumn{2}{l}{\left\{ \begin{array}{l} \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{goanna}\text{’} \\ \textsc{index} & \begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \end{bmatrix} \end{bmatrix} \\ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{kangaroo}\text{’} \\ \textsc{index} & \begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{du} \end{bmatrix} \end{bmatrix} \end{array} \right\}} \end{bmatrix}$$

---

[8] This Yidiny example has been rewritten in a standard practical orthography which uses 'ny' for a palatal nasal, 'j' for a palatal stop and 'rr' for an alveolar trill.

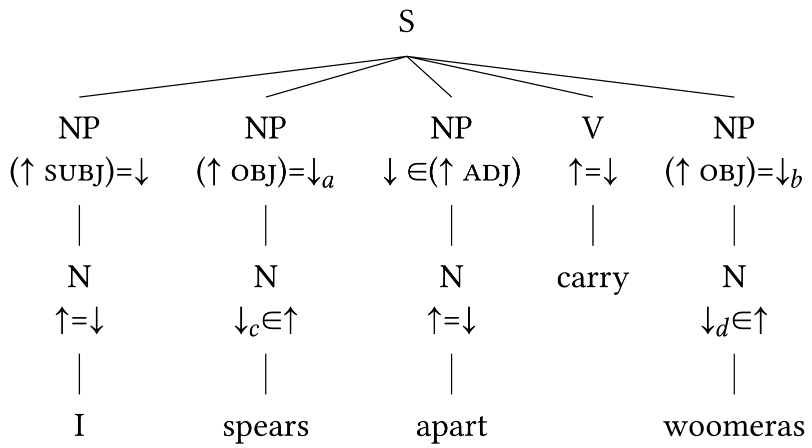
Sadler & Nordlinger (2010) show how this approach to coordination also extends naturally to discontinuous examples such as (28) by combining the standard LFG approach to discontinuity and non-configurationality discussed in Section 3.1 above. Since Economy of Expression allows all nodes to be optional unless independently required, each of the discontiguous coordinands can be represented at c-structure as a coordinate structure with just one daughter present (29), corresponding to the f-structure in (30).

(28) Kuuk Thaayorre

Ngul	ngay	kirk	kempthe	kal-m	thul=yuk.
then	1SG(ERG)	spear(ACC)	apart	carry-PST.IPFV	woomera(ACC)=STUFF

‘I used to carry spears and woomeras separately.’ (Gaby 2006: 320)

(29)



(30)

$$\left[\begin{array}{ll}
\text{PRED} & \text{‘CARRY}\langle\text{SUBJ,OBJ}\rangle\text{’} \\
\text{ADJ} & \left\{\left[\text{PRED ‘APART’}\right]\right\} \\
\text{SUBJ} & \left[\begin{array}{ll}\text{PRED} & \text{‘PRO’} \\ \text{INDEX} & \left[\begin{array}{ll}\text{PERS} & 1 \\ \text{NUM} & \text{SG}\end{array}\right]\end{array}\right] \\
\text{OBJ} & {}_{\substack{a\\b}}\left[\begin{array}{ll}
\multicolumn{2}{l}{\left\{\begin{array}{l}
{}_{c}\left[\begin{array}{ll}\text{PRED} & \text{‘SPEAR’} \\ \text{CASE} & \text{ACC} \\ \text{INDEX} & \left[\begin{array}{ll}\text{PERS} & 3 \\ \text{NUM} & \text{PL}\end{array}\right]\end{array}\right] \\
{}_{d}\left[\begin{array}{ll}\text{PRED} & \text{‘WOOMERA’} \\ \text{CASE} & \text{ACC} \\ \text{INDEX} & \left[\begin{array}{ll}\text{PERS} & 3 \\ \text{NUM} & \text{PL}\end{array}\right]\end{array}\right]
\end{array}\right\}} \\
\text{INDEX} & \left[\begin{array}{ll}\text{PERS} & 3 \\ \text{NUM} & \text{PL}\end{array}\right]
\end{array}\right]
\end{array}\right]$$

All of the other instances of nominal juxtaposition exemplified above are also assumed to have the same syntactic structure with the differences between them arising from differences in the distribution of agreement features, and semantics. An appositional phrase such as (23), for example, is generated by the c-structure rule in (31), which is the same as the c-structure rule for coordination given in (25) except for the fact that each coordinand is associated with the appositional template @NP-APPOS instead of @NP-CNJT. The appositional template governs the distribution of agreement features as shown in (32). This ensures that the coordinated structure has the same INDEX features as each coordinand, as shown in the f-structure in (33).

(31)
$$\text{X} \longrightarrow \begin{array}{c}\text{X}\\ \downarrow\in\uparrow\\ @\text{NP-APPOS}\end{array} \quad , \quad \begin{array}{c}\text{X}\\ \downarrow\in\uparrow\\ @\text{NP-APPOS}\end{array}$$

(32) NP-APPOS: $(\downarrow \text{IND}) \subseteq (\uparrow \text{IND})$

(33)
$$\left[\begin{array}{l} \begin{array}{ll}\text{INDEX} & \left[\begin{array}{ll}\text{PERS}&3\\ \text{NUM}&\text{SG}\\ \text{GEND}&\text{MASC}\end{array}\right]\end{array}\\ \left\{\begin{array}{l} \left[\begin{array}{ll}\text{PRED}&\text{`HUSBAND'}\\ \text{INDEX}&\left[\begin{array}{ll}\text{PERS}&3\\ \text{NUM}&\text{SG}\\ \text{GEND}&\text{MASC}\end{array}\right]\end{array}\right]\\ \left[\begin{array}{ll}\text{PRED}&\text{`OLD.MAN'}\\ \text{INDEX}&\left[\begin{array}{ll}\text{PERS}&3\\ \text{NUM}&\text{SG}\\ \text{GEND}&\text{MASC}\end{array}\right]\end{array}\right]\end{array}\right\}\end{array}\right]$$

Sadler & Nordlinger (2010) show how the different juxtaposed structures can be captured in LFG by assuming that they all share the same syntactic structure (modulo differences in the distribution of agreement features, as illustrated above), while mapping onto different semantics. In this way the flexible architecture of LFG provides a unified account of a range of juxtaposed nominal constructions common to many Australian languages, while still accounting for their semantic differences, through the use of hybrid structures already motivated independently for analyses of coordination (Dalrymple & Kaplan 2000) (see also Patejuk 2023 [this volume]).

3.3 Constructive case and case stacking

In Section 3.1 above we saw that case marking in non-configurational languages can encode grammatical relations, and saw that one way of capturing this in LFG is through the use of case conditionals. Nordlinger (1998b) provides an alternative approach, known as constructive case, which uses inside-out function application (see Belyaev 2023 [this volume]) to capture the fact that the grammatical function information comes directly from the case morphology itself. Returning to the Warlpiri example discussed in (20a), on the constructive case approach the functional information associated with the ERG case would be that in (34):[9]

(34) (↑ CASE) = ERG
(SUBJ ↑)

The second line in this functional description specifies that the f-structure with which the case morphology is associated (i.e. ↑) is the value of a SUBJ function in a higher f-structure. Thus, the inflected nominal *kurdu-ngku* ‘child-ERG’ does not just encode the fact that the nominal is inflected with ergative case, but also that the nominal is functioning as a subject of the higher clause, corresponding to the f-structure given in (35):

(35)
$$\left[\text{SUBJ}\ \left[\begin{array}{ll}\text{PRED} & \text{‘CHILD’}\\ \text{CASE} & \text{ERG}\end{array}\right]\right]$$

This approach has the benefit of capturing the essence of dependent-marking more accurately than the verb-mediated approaches described in Section 3.1 since the case-inflected nominal itself carries information about the grammatical function that it holds in the higher clausal f-structure. A further benefit, as discussed in detail by Nordlinger (1998b), is that it can straightforwardly capture other case behaviour found in dependent-marking Australian languages such as case stacking (Dench & Evans 1988, Andrews 1996), and the use of case morphology to mark clausal information such as tense/aspect/mood.

Case stacking arises through abundant case agreement, where a single nominal can carry multiple case markers, each one signalling a relationship to a higher level of structure. Consider the following examples:

---

[9] This is a slightly simplified representation for expository purposes. Nordlinger (1998b: 73) in fact suggests that the grammatical function information would be ((SUBJ ↑) OBJ) for ergative case, to capture the fact that it is only used with transitive subjects (i.e. subjects of f-structures that also contain an OBJ grammatical function).

(36) Warlpiri
Karnta-ngku ka=rla kurdu-ku miyi yi-nyi parraja-rla-ku.
woman-ERG PRS=3.DAT baby-DAT food.ABS give-NPST coolamon-LOC-DAT
'The woman is giving food to the baby (who is) in the coolamon.'
(Simpson 1991: 206)

(37) Martuthunira
Ngayu nhuwa-lhala tharnta-a kupuyu-marta-a thara-ngka-marta-a.
1.SG.NOM spear-PST euro-ACC little-PROP-ACC pouch-LOC-PROP-ACC
'I speared a euro with a little one in its pouch.' (Dench & Evans 1988: 7)

In (36) the locative-marked nominal *parraja-rla* 'coolamon' carries an additional case marker in agreement with the dative nominal *kurdu-ku* 'baby' which it modifies. Thus, the case marking on 'coolamon' specifies two different structural relationships: first, the locative case specifies that 'coolamon' functions as part of a locative adjunct, and then the dative case specifies that this locative adjunct is part of a higher dative-marked oblique argument. In (37), the most deeply embedded nominal *thara* 'pouch' is inflected with three case markers, each one specifying a successively higher structural relationship. Thus, the single inflected nominal *thara-ngka-marta-a* constructs the f-structure shown in (38).

(38)
$$\left[\text{OBJ}\ \left[\begin{array}{ll}\text{CASE} & \text{ACC}\\ \text{ADJ}_{\text{PROP}} & \left\{\left[\begin{array}{ll}\text{CASE} & \text{PROP}\\ \text{ADJ}_{\text{LOC}} & \left\{\left[\begin{array}{ll}\text{PRED} & \text{‘POUCH’}\\ \text{CASE} & \text{LOC}\end{array}\right]\right\}\end{array}\right]\right\}\end{array}\right]\right]$$

Nordlinger (1998b) shows that this approach can account for a range of case stacking structures in Australian languages, as well as the interaction of case stacking with number marking and possession (see Chapters 4 and 5 therein). Sadler & Nordlinger (2004, 2006b) extend and improve Nordlinger's formal account to provide an analysis that integrates better with an LFG approach to the morphology-syntax interface (Sadler & Nordlinger 2004), and also show how Nordlinger's original morpheme-based account can be recast using a realizational approach to morphology (Sadler & Nordlinger 2006b). In some Australian languages, case morphology can also be used in complex clauses to encode cross-clausal reference and clause linkage relations. For discussion of how this use of case can be accounted for within the constructive case approach see Nordlinger (2000) and Austin (2016).

The fact that case morphology provides information to the clausal f-structure (by attributing a grammatical function to it) allows for case morphology to contribute other types of clausal information as well, such as tense/aspect/mood.[10]

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[10] A different type of interaction between case morphology and the clause arises with semantic cases that can also function as clausal predicates; see Simpson (1991) for discussion.

Nordlinger (1998b: Chapter 4) shows that this is also found in some Australian languages, and can be accounted for straightforwardly with the constructive case approach. In Pitta Pitta (Blake 1987), for example, there are two ergative case morphs, one which is used in the future tense and the other in the non-future tense. The information associated with each of these can be represented as below, where the second f-description in each case specifies that the f-structure within which the case-marked nominal has a grammatical function (namely, the clausal f-structure) has a particular value for TENSE. The tense information associated with the case marker will be unified with the clausal f-structure and any tense information associated with the verb, thereby contributing to the overall tense value of the clause.

(39) *-lu* (↑ CASE) = ERG
((SUBJ ↑) TENSE) ≠ FUT

(40) *-ngu* (↑ CASE) = ERG
((SUBJ ↑) TENSE) = FUT

While it is typologically unusual for nominal morphology such as case to contribute clause-level information such as tense/aspect/mood, it is in fact found across languages of the world as shown by Nordlinger & Sadler (2004a,b). For a more detailed discussion of case in the LFG framework, see Butt 2023 [this volume].

3.4 Complex predicates

A number of Australian languages have complex predicates that take the form of light verb and coverb structures (see Andrews 2023b [this volume] for a more detailed discussion; the construction type focussed on here corresponds to type (1b) in this chapter). Detailed discussion of these constructions across Australian languages can be found in Schultze-Berndt (2000), McGregor (2000) and Bowern (2014). An example from Schultze-Berndt's discussion of Jaminjung is provided in (41).

(41) Jaminjung
walig gani-ma-m barrig.
go.round 3SG:3SG-HIT-PRS paddock
'He walks around the fence (in a full circle).' (Schultze-Berndt 2000: 4)

In this construction the clausal predicate is formed through the combination of a finite inflected verb (e.g. *gani-ma-m*) with a coverb (e.g. *walig*). The two elements of the construction belong to distinct lexical classes, and thus are morphologically and syntactically different. Finite verbs are inflected for tense/aspect/

mood and other verbal inflectional categories such as subject and object features. They form a closed class – in many languages restricted to between 10 and 30 members – and tend to have more general semantics (at least within the complex predicate). Coverbs, on the other hand, are usually uninflected, form a large open class and contribute more specific semantic content. The two elements together jointly determine the argument structure and event semantics, and therefore jointly construct the clausal predicate. In the languages of northern Australia where these constructions are found (see Bowern 2014), the majority of predicates are complex in this way.

Wilson (1999) provides a detailed LFG analysis of such complex predicates in Wagiman. Wilson shows that both the finite verb and the coverb in Wagiman are argument-taking predicates, and therefore each have their own PRED values, yet the complex predicate heads a single syntactic clause which in LFG requires a single clausal PRED at f-structure. To account for this, Wilson develops an account of complex predicate formation which uses a type of predicate fusion, modelled using lexical-conceptual structures (Jackendoff 1990), drawing on earlier work in LFG by Alsina (1993, 1996), Butt (1995, 1997), Mohanan (1994, 1997) and Andrews & Manning (1999).

Wilson's analysis follows that of Butt (1995, 1997) in using lexical conceptual structures (LCSS) to model complex predicate formation, but follows Andrews & Manning (1999) in locating these in f-structure (rather than a-structure as Butt does), replacing the PRED attribute with the more elaborated LCS attribute instead. Wilson proposes that the LCS of the coverb fuses into any position of the LCS of the finite verb where it is able to unify (Wilson 1999: 142). As an illustrative example, consider the complex predicate in (42):

(42) Wagiman
guk-ga nge-ge-na gahan warri-buga?
sleep-ASP 2SG-put-PST that child-PL
'Did you put the kids to sleep?' (Wilson 1999: 136)

According to Wilson's analysis, the finite verb *nge-ge-na* has the LCS in (43), and the coverb *guk-* has the LCS in (44).[11]

(43) $[_{\text{Event}}\ \text{CAUSE}([_{\text{Thing}}\ ]_A, [_{\text{Event}}\ \text{BECOME}\ ([_{\text{State}}\ \text{BE}([_{\text{Thing}}\ ]_A,[_{\text{Place}}\ -])])])]$

---

[11] The abbreviations used in the LCSS and associated attribute value matrices (AVMS) are as follows: the subscripted As denote positions which have to be linked to grammatical functions – in the AVMS these correspond to the attribute A-MARK with the value 'yes'; 'Ident' stands for Identificational and is used to extend otherwise spatial functions (such as BE or AT) to the semantic field of ascription (thus, AT_{Ident} describes a property rather than a location); the value of the FUNC attribute in the AVMS is the function which expands the entity (e.g. GO, CAUSE, etc.). 'Thing' entities are not expanded by functions, but they can contain information about their referent, which is stored in the CONTENT attribute.

(44) $[_{\text{State}}\ \text{BE}_{\text{Ident}}\ ([_{\text{Thing}}\ ]_{A}, [_{\text{Place}}\ \text{AT}_{\text{Ident}}\ ([_{\text{Property}}\ \textit{asleep}])])]$

These can be presented as attribute value matrices, as shown in (45) and (46) respectively.

(45) From Wilson (1999: 145: example (36)):

$$\left[\begin{array}{ll} \text{TYPE} & \text{Event} \\ \text{FUNC} & \text{CAUSE} \\ \text{ARG1} & \left[\begin{array}{ll} \text{TYPE} & \text{Thing} \\ \text{CONTENT} & \varnothing \\ \text{A-MARK} & \text{yes} \end{array}\right] \\ \text{ARG2} & \left[\begin{array}{ll} \text{TYPE} & \text{Event} \\ \text{FUNC} & \text{BECOME} \\ \text{ARG1} & \left[\begin{array}{ll} \text{TYPE} & \text{State} \\ \text{FUNC} & \text{BE} \\ \text{ARG1} & \left[\begin{array}{ll} \text{TYPE} & \text{Thing} \\ \text{CONTENT} & \varnothing \\ \text{A-MARK} & \text{yes} \end{array}\right] \\ \text{ARG2} & \left[\begin{array}{ll} \text{TYPE} & \text{Place} \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right]$$

(46) From Wilson (1999: 147: example (39)):

$$\left[\begin{array}{ll} \text{TYPE} & \text{State} \\ \text{FUNC} & \text{BE} \\ \text{FIELD} & \text{Ident} \\ \text{ARG1} & \left[\begin{array}{ll} \text{TYPE} & \text{Thing} \\ \text{CONTENT} & \varnothing \\ \text{A-MARK} & \text{yes} \end{array}\right] \\ \text{ARG2} & \left[\begin{array}{ll} \text{TYPE} & \text{Place} \\ \text{FUNC} & \text{AT} \\ \text{FIELD} & \text{Ident} \\ \text{ARG1} & \left[\begin{array}{ll} \text{TYPE} & \text{Property} \\ \text{CONTENT} & \text{asleep} \end{array}\right] \end{array}\right] \end{array}\right]$$

The c-structure rule which creates the complex predicate in (42) includes functional annotations that license and constrain predicate fusion through the unification of these LCSs. This is shown in (47), where C is the category ‘coverb’ (Wilson 1999: 144).

(47)
$$\overline{\text{V}} \quad \longrightarrow \quad \begin{pmatrix} \text{C} \\ \uparrow\backslash_{\text{LCS}}{=}\downarrow\backslash_{\text{LCS}} \\ (\uparrow \text{LCS SF}^{*}){=}(\downarrow \text{LCS}) \end{pmatrix}, \quad \begin{array}{c} \text{V} \\ \uparrow{=}\downarrow \end{array}$$

The finite verb is annotated with ↑=↓ so that its inflectional features such as tense, aspect, and the information about the subject and object contribute to the f-structure of the complex predicate, and ultimately that of the clause. The annotations associated with the coverb ensure that (i) all information associated with the coverb apart from the lcs (e.g. any aspectual information) is contributed to the f-structure of the complex predicate, and (ii) the lcs of the coverb is fused into the lcs of the finite verb: (↑ lcs sf*) = (↓ lcs). Here sf stands for 'semantic function' and is defined as the set of attributes which can be contained in lcss such as (45) and (46) (e.g. type, func, arg1, arg2). The use of functional uncertainty allows the lcs of the coverb – (↓ lcs) – to unify with any part of the lcs of the finite verb (the path consisting of any sequence of sfs, including none). So the f-structure will only be licit if the expansion of sf* picks out a place in the lcs of the finite verb where unification with the lcs of the coverb is possible. In the case of the complex predicate given in (42), based on the lcss in (45) and (46), this path must be (↑ lcs arg2 arg1), since the coverb *guk* 'sleep' is of type State, and there is only one place in the lcs of the finite verb where this can unify. Thus, the fused lcs for the complex predicate *guk -ge-* 'put to sleep' is that given in (48):

(48) From Wilson (1999: 147: example (39)):

$$\left[\begin{array}{ll}
\text{TYPE} & \text{Event}\\
\text{FUNC} & \text{CAUSE}\\
\text{ARG1} & \left[\begin{array}{ll}\text{TYPE} & \text{Thing}\\ \text{CONTENT} & \varnothing\\ \text{A-MARK} & \text{yes}\end{array}\right]\\
\text{ARG2} & \left[\begin{array}{ll}
\text{TYPE} & \text{Event}\\
\text{FUNC} & \text{BECOME}\\
\text{ARG1} & \left[\begin{array}{ll}
\text{TYPE} & \text{State}\\
\text{FUNC} & \text{BE}\\
\text{FIELD} & \text{Ident}\\
\text{ARG1} & \left[\begin{array}{ll}\text{TYPE} & \text{Thing}\\ \text{CONTENT} & \varnothing\\ \text{A-MARK} & \text{yes}\end{array}\right]\\
\text{ARG2} & \left[\begin{array}{ll}
\text{TYPE} & \text{Place}\\
\text{FUNC} & \text{AT}\\
\text{FIELD} & \text{Ident}\\
\text{ARG1} & \left[\begin{array}{ll}\text{TYPE} & \text{Property}\\ \text{CONTENT} & \textit{asleep}\end{array}\right]
\end{array}\right]
\end{array}\right]
\end{array}\right]
\end{array}\right]$$

Wilson shows that this approach to complex predicates in Wagiman can account for the range of different complex predicates found in the language, without requiring a radical extension of the LFG formalism beyond that already proposed by other complex predicate analyses (e.g. Alsina 1993, 1996; Butt 1995, 1997; Mohanan 1994, 1997; Andrews & Manning 1999). This general approach to the formal analysis of complex predicate formation in Australian languages has also been adopted by Bowern (2004) for Bardi, and Nordlinger (2010) for associated motion and motion serial verb constructions in Wambaya. An alternative approach to complex predicate formation using glue semantics as suggested in Andrews & Manning (1999) is proposed for the analysis of similar complex predicates in the central Australian language Arrernte by Dras et al. (2012).

Seiss (2013) provides a comprehensive analysis of the complex predicate system in Murrinhpatha which builds on the LCS-based approaches discussed above, but combines LCSs with a relational approach to lexical semantics, modelled with hierarchies of selectional restrictions. These hierarchies are then used to derive the argument structure of the complex predicates in the form of what Seiss calls LCS blueprints (based on the idea of templates, e.g. Dalrymple et al. 2004). The blueprint LCS for causative complex predicates such as those in (49) and (50) is defined as in (51). The LCS blueprint states that the complex predicate expresses the meaning that something or someone (α) causes something (β) to become a certain result state with the help of some specific instrument. In Murrinhpatha the complex predicate forms a single morphological word, and combines a classifier stem in first position in the verb, with a lexical stem (here *lerrkperrk*) in a subsequent position in the template. In a causative complex predicate, the result state is provided by the lexical stem while the instrument is provided by the classifier stem. For example, the lexical stem *lerrkperrk* 'crush' contributes the result state 'crushed', while the classifier stems 'do with HANDS' and 'do with FEET' contribute the instruments 'hand' and 'foot' respectively.

(49) Murrinhpatha
ku tumtum mam-lerrkperrk
CLF:ANIM egg 1SG.SBJ.HANDS.NFUT-crush
'I crushed the egg in my hand.' (Seiss 2013: 127)

(50) Murrinhpatha
ngunungam-lerrkperrk
1SG.SBJ.FEET.NFUT-crush
'I crushed the egg with my foot.' (Seiss 2013: 127)

(51)
$$\begin{bmatrix} \text{CAUSE}\left(\left[\text{Thing}\right]^{\alpha}_{A}, \left[\text{BECOME}\left(\left[\text{BE}\left(\left[\text{Thing}\right]^{\beta}_{A},\left[\text{RESULT}\right]\right)\right]\right)\right]\right) \\ \left[\text{BY}\left[\text{CAUSE}\left(\left[\text{Thing}\right]^{\alpha}_{A}, \left[\text{AFF}^{-}\left(\left[\text{INSTRUMENT}\right],\left[\text{Thing}\right]^{\alpha}_{A}\right)\right]\right)\right]\right] \end{bmatrix}$$

On this view, the classifier stem and the lexical stem do not each bring a complete LCS, but instead just a specific instrument (the classifier stem) or a specific result state (the lexical stem). The rest of the LCS is provided by the LCS blueprint. The lexical entries of the classifier stem and the lexical stem thus only consist of this information, as is illustrated in (52).

(52) do with HANDS: instrument = hand
do with FEET: instrument = foot
lerrkperrk: result = crushed

The LCS blueprint used by a particular combination is determined by the classifier and lexical stem together, whose compatibility is modelled by the hierarchies of selectional restrictions; the reader is referred to the comprehensive discussion in Seiss (2013) for further details. A notable aspect of Seiss's work on this topic is that, in addition to providing a comprehensive analysis of complex predicate combinations in Murrinhpatha, Seiss presents an implementation of Murrinhpatha's morphology using the Xerox finite-state technology tools XFST and LEXC (Beesley & Karttunen 2003), and an implementation of some parts of Murrinhpatha's syntax using the XLE grammar development platform (Crouch et al. 2011).

Valence-changing constructions such as applicatives and causatives have also been analysed as complex predicates in many languages, including by Austin (1997), who draws on Alsina's (e.g. 1997) approach to complex predicates in analysing causatives and applicatives across a number of Australian languages (see Andrews 2023b [this volume] for further discussion of Austin's analysis in the context of LFG approaches to complex predicates).

4 Conclusion

In this chapter, I have covered the primary linguistic phenomena in Australian languages that have been given detailed analysis in LFG research, focussing particularly on the morphology-syntax interface, where the morphological complexity of Australian languages has made the most significant contributions to theoretical debate and development. Other areas where there has been some work on Australian languages, but for which space was not available for discussion here, include control and obviation constructions in Warlpiri (Simpson & Bresnan 1983), zero anaphora (Austin 2001b) and noun incorporation (Nordlinger & Sadler 2008, Baker & Nordlinger 2008, van Egmond 2008, Baker et al. 2010). Work on Australian languages within the LFG framework has also contributed to the discussion and analysis of grammatical relations cross-linguistically, in such areas as syntactic and morphological ergativity (Manning 1996), information structure and its role in case marking patterns (Simpson 2012), distinctions between syntactic and semantic cases (Andrews 2017) and the role of dative-marked NPs as core arguments or adjuncts (Simpson 1991). The majority of LFG researchers working on Australian languages are also descriptive linguists engaged in fieldwork and language documentation. This crossover has ensured that theoretical questions and implications arising from LFG analyses are fed back into language description work unearthing new findings about the languages and how they are structured, and ensuring that this research both contributes to the development of the LFG framework and to our understanding and description of these fascinating languages.

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Abbreviations

Abbreviations in glosses in this chapter follow the Leipzig Glossing Rules wherever possible. Non-standard abbreviations used are:

ACT	actual mood	AUG	augmented number
ANIM	animate	EP	epenthetic morph
ASP	aspectual suffix	INCH	inchoative
ASSOC	associative case	PC	paucal number

PRIV	privative case	TWD	direction towards
PROP	proprietive case	USIT	usitative mood
MIN	minimal number		

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Chapter 28

LFG and Austronesian languages

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Austronesian (AN) languages are known for their diverse grammatical characteristics in many typological and descriptive works. Their properties provide fertile grounds for testing assumptions in syntactic theories. In this chapter, we demonstrate that the parallel correspondence architecture of LFG can be used as a powerful tool for language-specific linguistic analysis, while also precisely capturing the cross-linguistic differences within and between Western and Eastern AN languages. LFG is flexible in incorporating analytical tests, such as adverbial insertion and clitic placement for examining constituency; reflexive binding, nominal marking and pronominal-indexing for syntactic status of an argument. Although AN languages have posed challenges to traditional syntactic notions of subject, as well as the mapping between grammatical relations and functions, we show that such multi-dimensional views of grammar, and projection design, can deal with these challenges efficiently, and also lead to a coherent comparative representation of AN languages for the purpose of tracking morphosyntactic stages according to their respective typological categories.

1 Introduction

The world of Austronesian (AN) languages comprises a huge and diverse language family, which covers a wide geographical span ranging from Formosan languages in the northwest of the Pacific, Malagasy at its westernmost point, Māori in south Oceania, Hawaiian in the northeast and Rapanui at its most eastern point. In fact, this geographical spread is a historical outcome of the prehistoric settlement by AN speaking communities (Pawley & Pawley 1998; Bellwood

I Wayan Arka & Li-Chen Yeh. 2023. LFG and Austronesian languages. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1289–1367. Berlin: Language Science Press. DOI: 10.5281/zenodo.10186000

2007: 242). The histories of the people in the widespread Asian-Pacific region are testimony to the genealogical continuity of AN languages that form one single language family.

Initially, the AN dispersal began from the island of Taiwan in the northern part of the Pacific island chain, outside the east Asian continental mainland (Pawley 2002, Bellwood 2007, Skoglund et al. 2016, Blust 2019). The languages natively spoken on the island of Taiwan are direct descendants of the Proto-AN language (Blust 1999). These languages are collectively called Formosan languages, and are sisters to the common ancestor of the remaining AN languages, Proto-Malayo-Polynesian (PMP).

The AN expansion took place in subsequent waves, as laid out chronologically below (Adelaar 1989, Bellwood 2007: 201-254). The PMP subgroup began to split up as it spread from Taiwan to the Philippines (est. 2200 BCE), along with early migration settling in Micronesia. There were also dispersals from the Philippines into Indo-Malaysia and eastward to New Guinea and the Bismarck Archipelago. The settlement in the Bismarck has been dated to around 1350 BCE. Later on, the dispersal went further eastwards into the Pacific (e.g. Solomons, Vanuatu, New Caledonia, Fiji, Tonga and Samoa) between 1200 and 900 BCE. After 600 CE, the AN occupation of eastern Polynesia occurred, and immigrants from Borneo arrived in Madagascar around 500 CE.

The AN migration history above shows the geographical distribution of AN languages. Meanwhile, it similarly indicates a diachronic progression in the varying prototypical features of AN morphosyntax and offers a general guideline for the typology of AN languages. A major typological distinction can be made between Western AN and Eastern AN.

The Western AN group[1] includes languages of Taiwan, the Philippines, western Indonesia, Malaysia and Madagascar. These languages are typically characterised by their robust 'alternating' and 'symmetrical voice' systems, which use verbal morphology to mark a non-Agent argument as grammatical subj(ect) or pivot without demoting the Agent argument to oblique (discussed in Section 4). This non-demotion property of the Western AN voice system differs from the commonly observed active-passive voice alternation system in Indo-European languages like English.

The symmetrical voice systems in Western AN pose challenges to many grammatical frameworks, including some versions of the standard Lexical Mapping

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[1] In this chapter, Western AN is used as a cover term for symmetrical voice languages. It differs from Himmelmann's (2005) geographic label of 'Western Austronesian' which encompasses all non-Oceanic languages.

Theory analysis in LFG. The non-demotion property of the symmetrical voice system licenses a passive-like structure with a non-actor thematic role selected as subject, called Patient (or Undergoer) voice, but unlike in the passive, the non-subject actor role has the most prominent core status. This leads to a mismatch between its semantic and syntactic prominence: the most prominent semantic (agent) argument is not the most privileged (SUBJ) argument. The diagnostic tool for identifying this mismatch involves reflexive binding (see Section 2). The surface realisation of reflexive binding allows reflexive pronouns to be bound by antecedents bearing both the least and most prominent grammatical functions. While posing challenges to many grammatical frameworks, this unusual and intricate variation of voice alternation is best explained by the multi-layered argument structure of LFG's architecture which tackles associations between grammatical functions and grammatical relations.

The Eastern AN language group[2] includes languages of Timor-Leste, New Guinea and Oceania. In contrast to symmetrical-voice languages, Eastern AN languages no longer maintain the layered distinctions at the semantics-morphology-syntax interface. We refer to these languages as the non-alternating type because the typical alternative selection of a semantic role as grammatical SUBJ, as seen in Western AN languages, is not observed. Instead, Eastern AN languages are characterised by other properties such as the emergence of systematic pronominal indexing, as well as increased complexity in other parts of its grammar as seen in their rich serial verb constructions (SVCs) and clausal complementation (see Section 5). The pronominal indexing paradigm is an exclusive feature of Eastern AN languages, and in this regard, they may be referred to as indexing-type languages.

Indexing-type languages show distinct properties in complex constructions that are intriguing for typological comparisons and important for theoretical testing. These languages show a striking consistency in the distinction of (X)COMP (i.e. clausal complementation with(out) shared missing SUBJ: see Vincent 2023 [this volume] and Section 5 of this chapter) while also revealing a significant difference with regard to the structural tightness between regular complementation and complex predicates. The latter has usually been subsumed under the general heading of SVCs. It is not always straightforward in many syntactic theories to capture the distinction among different kinds of (X)COMP (e.g. control, SVCs and multi-verb constructions in coordination and subordination). Nonetheless, a few clear cases of the distinction in argument gapping strategies can be effectively demonstrated from the LFG perspective where, crucially, no movement is

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[2] Eastern AN languages have been commonly referred to in the literature as preposed-possessor languages, Oceanic languages or isolating languages of eastern Indonesia.

required (cf. Sells's (2023 [this volume]) comparison of LFG with the traditional analysis of control/raising complementation in transformational grammars). Instead, the LFG perspective can clearly present how a verb form with/without an overt voice marker can serve as a diagnostic tool for testing the core status of (x)COMP, and how voice morphology (as well as negation) forms a criterion for teasing apart the differences between complementation and SVCs. Even the compound-like structure of the complex event-composition in SVCs can be captured via the interrelated specifications on different linguistic dimensions (see Section 5.2).

Even though the above description has provided a general indication of the major typological differences between Western and Eastern AN languages, two important points should be made on the typological diversity of AN morphosyntax.

First, not all Western AN languages behave alike. Symmetrical-voice languages are typically further subcategorised into 'Philippine-type' and 'Indonesian-type', due to their distinct characteristics in word order (cf. Section 3), the number of semantic roles allowed as privileged arguments (cf. Section 4.2), and the use of case-marking flagging and applicative constructions (cf. Section 4.3). Although most Western AN languages may be subcategorised further, some transitional languages do not adhere to the typological profile of either type (Kroeger 2023). Certain Western AN languages in Taiwan even appear to show disputable traits of asymmetry in syntax (cf. Section 4.4).

Moreover, geography and typology do not always neatly align. For instance, certain Barrier Island languages off the south coast of Sumatra, such as Mentawai (Lenggang et al. 1978, Arka 2006), Enggano (Crowley n.d., Hemmings in preparation) and Nias (Brown 2001), do not show a symmetrical voice property of the type seen in the Western AN group, but they have developed person-marking prefixes on verbs that encode subject similar to NOM(inative) subject prefixes in outlier AN languages in southern/eastern Indonesia, such as Kambera in Sumba (Klamer 1998) and Wooi in West Papua (Sawaki 2016). Makassarese, spoken in Sulawesi, has unmarked word order like the Philippine-type, but it also exhibits systematic pronominal indexing on the verbal predicate. In Makassarese, a transitioning state of word order change is observed in the expression of contrastive focus through clefting (cf. Section 6).

Typologically, the AN language family is intensely diverse with a variety of transitioning languages comprising two heterogeneous macrogroups. This diversity has posed difficulties for descriptive and comparative analysis, particularly for long-standing and often controversial topics of typological and theoretical significance, such as ergativity or the complex interconnection between surface grammatical relations and deeper semantic-syntactic argument structures. Nonetheless, LFG's parallel correspondence architecture provides the necessary flexibility for a coherent and comparable descriptive representation of AN grammar on these topics.

In this chapter, we show how LFG can be used as a descriptive and analytical tool to capture the typological range of AN linguistic diversity on these selected topics. We begin by highlighting the LFG modular design, and its application in modelling the morphosyntactic operation of AN voice systems (Section 2), then illustrate how the LFG framework can capture word order variation (Section 3), grammatical functions and alignment (Section 4), complex argument sharing constructions (Section 5) and information structure (Section 6).

2 LFG modular design and Austronesian linguistics

LFG is modular in its design. From the LFG perspective, a language is construed as multiple dimensions of linguistic information, and each dimension constitutes an individual module, or structure, that comes with its own formal properties. Different structures are parallel but are linked by principles of correspondence, as introduced in Belyaev 2023b [this volume].

In the standard LFG framework, traditional syntactic structure is primarily represented on two structural levels: constituent structure (c-structure) and functional structure (f-structure). Ordering of constituents and syntactic categories are analysed in c-structure, whereas grammatical functions (gfs) of arguments and grammatical features are dealt with in f-structure, as detailed in Belyaev 2023a [this volume]. In subsequent developments, semantic argument structure (a-structure) was proposed in Lexical Mapping Theory (LMT) to capture cross-linguistic gf alternations (Bresnan & Kanerva 1989); see also Findlay et al. 2023 [this volume]. Bresnan & Kanerva (1989) propose that a-structure is represented as a list of semantic roles which are directly mapped onto gfs. Bresnan & Kanerva's (1989) LMT works well to account for voice and alternative argument realisations in languages like English; e.g. the agent's subj(ect)-obl(ique) alternation in passivisation.

However, the rich voice systems of western AN languages pose a problem for this version of LMT such that semantic a-structure and the traditional analysis of gfs cannot be maintained. Based on data from western AN languages, which will be discussed in detail in this chapter, we argue against Bresnan & Kanerva's (1989) version of mapping theory; see Arka (2003a: 119–124) for a comprehensive examination of the evidence and justification. Consider the following examples from Balinese (1) and Puyuma (2):

(1) Balinese (WMP, Indonesia) (Arka, own knowledge)[3]

a. [Tiang]$_{\text{SUBJ}}$ ng-ejang [nasi]$_{\text{OBJ}}$ [*(di) bodag-e]$_{\text{OBL}_{\text{LOC}}}$.
1SG AV-put rice in basket-DEF
'I put rice in the basket.'

b. [Nasi-ne]$_{\text{SUBJ}}$ ∅-ejang [tiang]$_{\text{OBJ}}$ [*(di) bodag-e]$_{\text{OBL}_{\text{LOC}}}$.
rice-DEF UV-put.rice 1SG in basket-DEF
'I put rice in the basket.'

(2) Puyuma (Formosan) (Teng 2008: 47-48)

a. Tr<em>akaw [dra paisu]$_{\text{OBL}}$ [i isaw]$_{\text{SUBJ}}$.
⟨AV⟩steal INDF.OBL money SG.NOM Isaw
'Isaw stole money.'

b. [Tu=]$_{\text{OBJ}}$ trakaw-anay [i tinataw]$_{\text{SUBJ}}$ [dra paisu]$_{\text{OBL}}$.
3GEN= steal-CV SG.NOM his.mother INDF.OBL money
'He stole money for his mother.'

The examples above represent two salient features of the AN voice system and related argument realisations. First, verbal voice morphology marks SUBJ selection (cf. Section 4). The ACTOR VOICE (AV), indicated by *ng-* in Balinese (1a) and ⟨*em*⟩ in Puyuma (2a), selects the most agent-like role, or A (*tiang* and *Isaw* respectively) as SUBJ.[4] The UNDERGOER VOICE (UV) in Balinese is indicated by a zero prefix and selects a patient-like (P) role as SUBJ as in (1b), whereas the CONVEYANCE VOICE (CV) in Puyuma selects a peripheral role, as in the beneficiary 'mother' in (2b)[5] (see Section 4.2 for the properties of SUBJ/PIVOT and the typology of AN voice

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[3] In this chapter, a language is presented with its linguistic and geographical classification in the first instance based on information from Glottolog for the purposes of locating genealogical and typological relations between languages. WMP and CEMP stand for Western Malayo-Polynesian and Central-Eastern Malayo-Polynesian respectively.

[4] Following standard conventions in language typology (Comrie 1978, Dixon 1979, Croft 2003, Haspelmath 2007, among others), we adopt the following abbreviations to denote generalised semantic roles: A represents the argument that is most actor-like, while P represents the argument that is most patient-like in a transitive predicate. It is worth noting that P is approximately synonymous with the undergoer (U) macro-role in Role and Reference Grammar (Foley & Van Valin 1984).

[5] In AN linguistics, non-AV or UV is also often called Objective Voice (Kroeger 1993). It is the voice type that selects certain semantic roles other than the actor as SUBJ/PIVOT. In the AN languages of the Philippines and Taiwan, there are typically different types of UV named after the associated semantic role of the SUBJ and each has its own verbal morphology, e.g. *-anay* for Conveyance Voice (CV) in Puyuma in (2).

systems). The voices in these AN languages are called symmetrical voice. Evidence for their symmetricality comes from the fact that agent and non-agent roles are equally selectable by the voice morphology as the "privileged argument", which is analysed as subj/pivot in LFG (Kroeger 1993, Manning 1994, Arka 2003a, Falk 2006). In addition, symmetricality is seen in verbal marking, particularly in Puyuma, where different voice types (e.g. av and cv) are equally marked.[6]

Second, non-av alternations in (1b) and (2b) are not passivisation. That is, in both Balinese uv and Puyuma cv, the promotion or selection of a non-A role as subj is not accompanied by the demotion of A to obl, a lower ranked function. Functionally, the A argument is the obj(ect); it retains its core status in the structure. This is clearly seen in Balinese, where the A of the uv structure in (1b) appears immediately after the verb as a bare Noun Phrase (NP), like the obj of the av verb in (1a). Note that obl in Balinese is flagged by a preposition. In addition, Balinese does have a passive, in which case the agent appears as obl (see Arka 2003a). Likewise, the A of the cv verb in Puyuma is realised as a bare gen(itive) clitic. A free obl nominal in Puyuma is also prepositionally flagged, and if it is a pronominal, it has a special obl form distinct from the gen or nom(inative)[7] form (see Teng 2008: 63). Bresnan & Kanerva's (1989) classic LMT approach cannot account for the agent's alternative realisation as obj in uv, as in Balinese (1b) and cv in Puyuma (2b), since the agent is inherently classified as [−*o*] (i.e. not object-like), thus only allowing for the subj-obl alternation as seen in passives.

To capture the non-demotion of A in uv and other salient typological and morphosyntactic properties of AN voice alternation in LFG, we distinguish gfs from grs (Grammatical Relations). grs are clause-internal relations that reflect semantic-syntactic dependency between a predicate and its dependents. They form the so-called syntacticised a-structure in Manning (1994), Arka (2003a) and Arka & Manning (2008). This syntacticized a-structure, as distinct from the semantic a-structure in Bresnan & Kanerva's (1989) classic LMT, incorporates syntactic information regarding coreness/obliqueness alongside its structural prominence, which includes thematic ranking. Although grs and gfs belong to different layers of structure, the two are interrelated and are mapped together through

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[6] Balinese and Puyuma belong to two different subcategories of Western AN languages: the Indonesian-type and Philippine-type, respectively. They differ in their number and type of voice distinctions, and the syntactic properties of their non-subj arguments (e.g. the obliqueness of P in av) (cf. Section 4). Note that the uv verb in Balinese is also analysed as being 'marked'; it is realized as a zero uv prefix on the basis of its contrasting form with the av verb.

[7] Note that Puyuma is an ergative language. In Teng (2008), nom refers to the case assigned to subj. It should not be confused with nominative case in nom-acc languages. See the discussion in Section 4.4.

linking principles. In AN languages, the mapping is marked by verbal voice marking and/or indexing, depending on the available coding resources. Although the GF-GR distinction may not be assumed and embraced in all LFG analyses, we contend that it is essential to provide a consistent explanation for voice alternations and related alternative argument realizations in languages that exhibit both accusative and ergative properties, as seen in western Austronesian languages such as Balinese and Indonesian.

We use different convention labels for GRs and GFs to avoid confusion: small caps for GFs (e.g. SUBJ, OBJ) and lower case for GRs (e.g. subject, object). We illuminate the significance of the GF-GR distinction by taking into account recent findings (e.g. reflexive binding) in descriptive and typological research in AN linguistics. The informal GR or a-structure representation is given in (3a) for the Balinese verb *jang* 'put', and its simplified representation is given in (3b). The a-structure in (3) outlines that *jang* is a three-place predicate with core arguments (i.e. agent and patient) and a third non-core oblique locative (LOC) (i.e. location). In our analysis, we adopt the convention of using a vertical line (|) to explicitly delineate argument classes, distinguishing between core and oblique or non-core arguments within the argument structure list. This convention supplements the valency information specified in the a-structure representation in the lexicon.[8]

(3) Syntacticised argument structure of *jang* (Balinese):

a. 'put⟨ ARG1:agent , ARG2:patient | ARG3:location ⟩'
(subject) (object) (oblique)

b. 'put⟨ 1:agt, 2:pt | 3:loc⟩'

The following should be noted regarding the representation of GRs in (3). First, GRs conceptually reflect event construal and participant roles, which signify 'who

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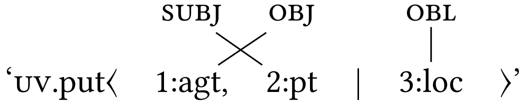
[8] Syntactic coreness/obliqueness and valency are distinct syntactic properties that pertain to whether an argument is core or not and the number of arguments a predicate takes, respectively. These properties are not always predictable from the semantics of the predicate, as evidenced by the variation observed across languages when expressing the same event using equivalent verbs with different syntactic argument structures. For example, the verb *give* is semantically a three-place predicate involving a giver, givee, and gift. However, languages differ in how they syntactically realize these arguments. Balinese *baang* 'give' exclusively permits ditransitive constructions without a dative alternation (Arka 2003b: 63–63), while English allows the verb 'give' to function as either ditransitive, like in Balinese, or monotransitive with an oblique as the third argument, depending on the context. Furthermore, languages such as Indonesian exhibit ditransitive/transitive alternations facilitated by applicative morphology. Consequently, this lexically specific syntactic information must be encoded in the syntacticized a-structure rather than the semantic structure within the lexicon. Arka's (2003a) work provides detailed evidence from Balinese supporting this perspective.

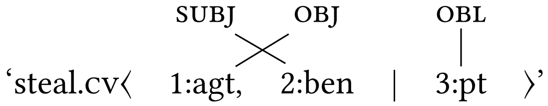
does what to whom'. This is the semantic-conceptual basis underlying valency and transitivity information in the syntacticised a-structure. The valence information specifies the number of arguments (e.g. one, two, or three arguments) and syntactic/semantic transitivity specifies types of arguments (i.e. core or oblique, and the associated semantic roles). The Balinese verb *jang* in (3) is a three-place transitive predicate with two core arguments, 1:agent and 2:patient, and one non-core argument, 3:location. For the purposes of comparative typology, 1:agent and 2:patient will be referred to as *subject* and *object*, respectively (noting lower case). They roughly correspond to the typologists' labels A and P/O respectively),which are distinguished from surface GFs, SUBJ and OBJ.

Voice morphology on the verb regulates GR-GF mapping. For example, the Balinese UV in (1b) and Puyuma CV in (2b) select 2:patient and 2:beneficiary respectively as SUBJ/PIVOT. These UV structures result in a mismatch between GF and GR prominence, informally represented by crossing lines.

(4) a. Balinese UV in (1b)



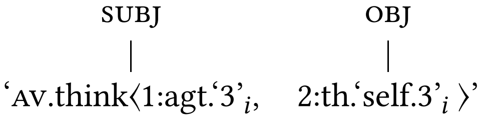
b. Puyuma CV in (2b)



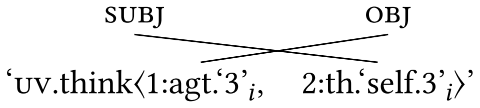
By distinguishing GRs and GFs, we can reflect a prominence mismatch in the non-AV structures in (4) above. This is evident from the interaction between reflexive binding and voice alternation in AN languages. For instance, the AV-UV voice alternation does not affect the acceptability of reflexive binding, exemplified by *awakne* in Balinese (5) and *izipna* in Kavalan (6). For simplicity, the f-structures showing reflexive binding are only given for the examples below.

(5) Balinese (Arka 2003a: 178)

a. [Ia]$_{\text{SUBJ}}$ ngenehang [awakne]$_{\text{OBJ}}$.
3 AV.think self.3
'(S)he thought of herself/himself.'

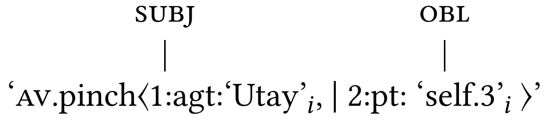


b. [Awakne]$_{\text{SUBJ}}$ kenehang[=a]$_{\text{OBJ}}$.
self.3 uv.think=3
'(S)he thought of *herself/himself*.'

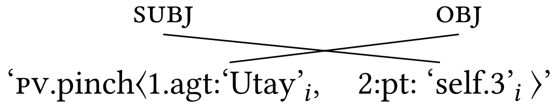


(6) Kavalan (Formosan) (Shen 2005: 57)

a. K⟨em⟩nit [ci Utay]$_{\text{SUBJ}}$ [tu izipna]OBL.
⟨av⟩pinch pn Utay obl body:3gen
'Utay pinched at himself.'



b. Kenit-an=na [ni Utay]$_{\text{OBJ}}$ [ya izipna]$_{\text{SUBJ}}$.
pinch-pv=3erg erg Utay abs body:3gen
'Utay pinched *himself*.'



c. f-structure of sentence (6a)

$$\begin{bmatrix} \text{PRED} & \text{`PINCH}\langle\text{SUBJ OBL}\rangle\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`UTAY'} \\ \text{NTYPE} & \text{PROPER} \\ \text{INDEX} & \begin{bmatrix} \text{PERS} & \text{`3'} \\ \text{NUM} & \text{SG} \end{bmatrix}_i \end{bmatrix} \\ \text{OBL} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{REFLEXIVE} \\ \text{INDEX} & i \end{bmatrix} \\ \text{VOICE-TYPE} & \text{AV} \end{bmatrix}$$

d. f-structure of sentence (6b)

$$\begin{bmatrix} \text{PRED} & \text{`PINCH}\langle\text{SUBJ OBJ}\rangle\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{REFLEXIVE} \\ \text{INDEX} & i \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`UTAY'} \\ \text{NTYPE} & \text{PROPER} \\ \text{INDEX} & \begin{bmatrix} \text{PERS} & \text{`3'} \\ \text{NUM} & \text{SG} \end{bmatrix}_i \end{bmatrix} \\ \text{VOICE-TYPE} & \text{PV} \end{bmatrix}$$

The above data points show that reflexive binding in Balinese and Kavalan takes place at the level of a-structure, as shown in the a-structure representations on the right side. In Balinese, for example, both (5a) and (5b) share the same a-structure, but differ in their respective mapping to GFs: consider the crossing line in (5b) in the UV structure. In Kavalan, both (6a) and (6b) are similar in their a-structure representations except that the non-actor argument in (6a) is non-core, as represented by the vertical line (|). Both languages demonstrate that the reflexive is bound by the subject, as indicated by the subscript *i*. However, the voice alternations trigger a difference in the resulting GFs of the reflexive. It is realised as OBJ in the AV in (5a) and SUBJ in UV in (5b) for Balinese. In Kavalan, on the other hand, the patient is realised as OBL flagged by an OBL marker *tu* in the AV verb in (6a) (due to the ergative system of this language), and it is realised as SUBJ and flagged by the marker *ya* in Patient Voice (PV) in (6b). In both instances, the relationship between the reflexive pronoun (*izipna* 'body.3GEN') and its binder (i.e., the intended antecedent) is expressed through coindexation in the f-structure, indicated by the subscript *i*. The PERS and NUM values (i.e., 3SG) of the INDEX attribute of the bindee (*izipna*) are linked or bound to the INDEX values of the binder (*Utay*). This binding of INDEX values between the binder (*Utay*) and the reflexive pronoun (*izipna*) is permissible due to a binding requirement associated with the reflexive pronoun (cf. Rákosi 2023 [this volume]). Crucially, being the first core agent (i.e. ⟨1:agent⟩) argument, *Utay* outranks the reflexive pronoun (*izipna*) in the a-structure.

The acceptable reflexive binding of SUBJ (i.e. the most privileged argument) by OBJ in (5b) and (6b) would be unexpected if binding took place at the surface grammatical function level because the antecedent (OBJ) has lower syntactic prominence. The occurrence of reflexive binding in non-AV structures confirms the prominence outranking in the a-structure (i.e., A > P). This finding emphasizes the necessity of a separate syntacticized a-structure to provide an accurate analysis of reflexive binding phenomena in Austronesian languages, including Balinese and Kavalan.

In LFG, the important characteristics of the AN voice system can be captured using the layered a-structure, and cross-linguistic variation in the voice system is effectively illustrated by the varying transparency of the mapping. A distinction between GFs (the primitives of f-structure) and GRs (the primitives of a-structure) is maintained in western AN, but collapses in accusative languages like English, and Eastern AN languages that lack a symmetrical voice system (see Section 4).

Without this notion of layered structures, the unusual variation in the surface realisation of reflexive binding cannot be easily captured in other theories.[9]

Having shown how the basics of the AN voice system work from an LFG perspective, we now move on to an overview of some typologically interesting phenomena in AN languages in the subsequent sections.

3 Clausal word order

In Western AN languages, there are two broad patterns of clausal word order that are geographically distributed (Blust 2013: 461–461). Verb-initial order is encountered in the AN languages of Taiwan, the Philippines, northern and central Sulawesi, and Madagascar. Philippine-type languages tend to be verb-initial, whilst Indonesian-type languages, including Balinese, Madurese and Indonesian, are verb-medial. Diachronically speaking, the development of these two types of word orders appears motivated primarily by information structure—such as clefting to express contrastive FOCUS (see Section 6)—resulting in synchronic word order variation. The broad classification of Western AN will be used in the ensuing discussion with regard to the typology of word order. However, it should be noted that there is also a great deal of variation across the Philippine-type and Indonesian-type languages due to the flexibility of the order of agent and non-agent arguments relative to the head verb, giving rise to languages with or without a VP and languages with a rigid or flexible subject position (see Riesberg et al. 2019 for further details). In addition, language-internal variation exists, and it has been claimed that some AN languages do not have a fixed basic word order, or that word order choice may differ by voice construction, among other things (cf. Riesberg et al. 2019).

Unlike most Western AN languages, word order varies among Eastern AN languages. The AN languages of eastern Indonesia and many Oceanic languages have typically developed systematic pronominal indexing systems,[10] and therefore show a greater degree of freedom and variation for the ordering of cross-referencing NPs. Thus, there are Eastern AN languages that show SVO clausal

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[9] For the sake of brevity, a detailed comparation with other theories is omitted here. We confine our illustration to the use of LFG in analysing AN languages. An in-depth comparative discussion of LFG and other frameworks is provided in Part VII.

[10] Some Formosan languages (e.g. Puyuma and Kavalan) have pronominal indexes on verbs. While they closely interact with robust voice verbal morphology, they do not usually contain a complete set of forms exhibiting the full range of case/role alternations. For this reason, we propose that the systematic pronominal indexing systems in Eastern AN languages are distinct from those in Formosan languages.

word order with indexed NPs ordered flexibly (e.g. Kambera), and there are others that are verb-initial (e.g. Fijian), and further still, there are other languages which are verb-final as a result of Papuan contact (e.g. Tobati, an AN language spoken in Jayapura Bay, west Papua, and Torau, an Oceanic language spoken in Bougainville; cf. Lynch et al. 2002).

In LFG, word order variation reflects the surface differences between 'default' (or unmarked) clausal order and pragmatically marked order. These are dealt with in terms of variation at the level of c-structure (see Andrews 2023 [this volume]).[11] Below we illustrate word order variation in Philippine-type, Indonesian-type and indexing type languages, from an LFG perspective.

Verb-initial sentences in Philippine-type languages are finite clause structures with the (inflected verbal) predicate, or the auxiliary, occupying the left-headed inflection (I) node. Hence, a sentence is head (or predicate) initial. However, the precise structures of post-verbal elements vary, with certain languages like Squliq Atayal (Formosan) showing a rigid hierarchical Verb Phrase (VP) structure, whereas others like Tagalog have a non-configurational structure. Evidence for a VP in Atayal comes from an adverbial insertion test. As shown in (7a), *hira'* 'yesterday' cannot intervene between a transitive verb and its object. The c-structure of (7a) is represented in (7b). Note that LFG adopts a version of X-bar syntax that allows nonbinary branching, as seen in the top/root node of IP in (7b).

(7) Squliq Atayal (Formosan) (Liu 2017: 41)

a.

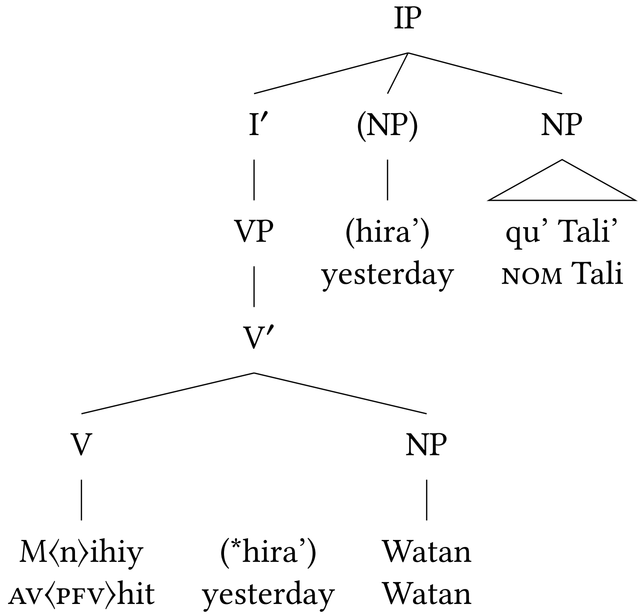
M⟨n⟩ihiy	(*hira')	Watan	(hira')	qu'	Tali'.
AV⟨PFV⟩hit	yesterday	Watan	yesterday	NOM	Tali

'Tali hit Watan yesterday.'

---

[11] While c-structure in LFG is modelled using phrase structure trees, with properties possibly following an X-bar schema, it does not represent a deeper 'universal' syntactic relation in which, for example, the object or patient argument is uniformly represented in the complement position of a VP as typically characterised by Chomskyan generative models. Further, there is no constituent movement in LFG, even though we may informally refer to 'fronting'; see Bresnan & Kaplan (1982), Bresnan et al. (2016: chapter 6), Dalrymple et al. (2019: chapter 3), Andrews 2023 [this volume].

b.

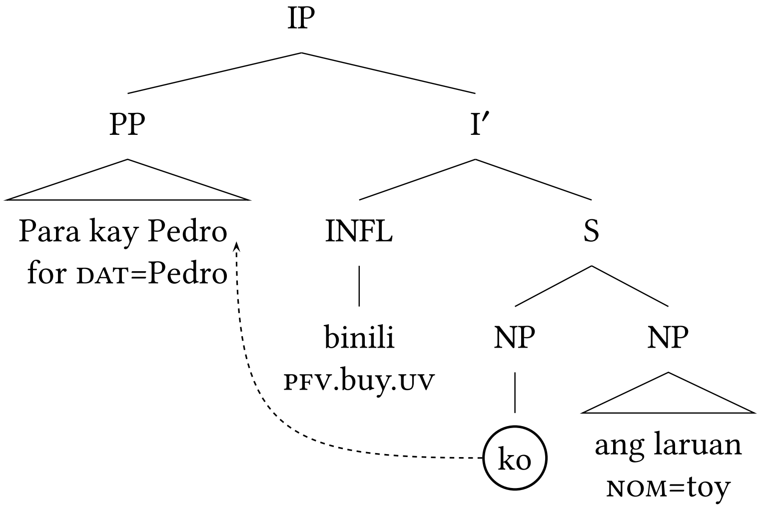


Turning to Tagalog, we can posit that the finite sentence (IP) in this language contains a non-configurational (i.e. exocentric, flat) Sentence (S), as shown in (8b) for the example in (8a); for further discussion of exocentricity and the category S, see Andrews 2023 [this volume]. Evidence for this comes from the fact that post-verbal arguments of non-verbal predicates (e.g. subj and obl) can be freely ordered (Kroeger 1993: 133). There is no surface VP in Tagalog because a second-position (2P) clitic – which must appear in the second syntactic position of a clause in order to obey syntactic-phonological constraints – is hosted by the finite verb alone and not the verb complement if the clause is verb-initial (not exemplified here), or by the first/fronted X(P) as exemplified in (8). Any attempt for a VP (i.e. V and its argument) to host a 2P clitic is ungrammatical (Kroeger 1993: 136).

(8) Tagalog (WMP, Philippines) (Kroeger 1993: 129)

a. [Para kay=Pedro]=ko binili ang=laruan.
for dat=Pedro=1sg.gen pfv-buy-pv nom=toy
‘For Pedro I bought the toy.’

b.



Variation in predicate-initial word order is pragmatically driven, and allows a unit to be 'fronted' to a sentence-initial position before the verb. This position bears a Discourse Function (DF) and is not uniquely associated with a particular grammatical function. In the Tagalog example (8a), the fronted DF, the OBL 'for Pedro', structurally occupies the Specifier position of the finite sentence, [Spec,IP], as shown in the c-structure in (8b). While generated under the S node by the phrase structure rule, because *=ko* is a 2P clitic, it is hosted by the Prepositional Phrase (PP), the first syntactic unit, following the final word of the phrase, *Pedro*.[12] Additionally, as in example (9) for Squliq Atayal, the sentence-initial position can be occupied by a grammaticalised topic that co-references SUBJ. This results in a pragmatically marked order for the pseudo-SV(O), namely, SUBJ-VERB-(OBJ/OBL). A pause, indicated by a comma in (9), is observed between the adjoined topic and the IP.

(9) Squliq Atayal (Liu 2017: 202)
Pagay qani (ga), kguh-an na' ngta'.
rice this TOPIC scatter-LV OBL chicken
'(Speaking of) the rice, (it) was scattered by the chicken.'

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[12] Kroeger's analysis of clitic placement follows the standard approach in LFG (cf. Bresnan et al. 2016: 155), which treats a clitic as a syntactically independent unit like any other word. It occupies a terminal c-structure node, but is post-lexically hosted by another X(P) node due to a prosodic requirement in the syntax-phonology interface in the grammar. A different approach is to treat a clitic as a phrasal affix which does not occupy a terminal syntactic node on its own (cf. O'Connor 2002). See Halpern (1995), Halpern & Zwicky (1996), King (2005), and Bögel et al. (2010), among others, for further discussion of (2P) clitic placement.

The distribution of pronominal special clitics, such as 2P clitics, may also be determined by syntactic-pragmatic conditions that give rise to variations in clausal ordering. This is observed in Pazeh-Kaxabu (Formosan). Pazeh-Kaxabu has two types of bound pronominals: a full set of 2P clitics, and a 'peripheral' clause-final clitic. Crucially, the 2P pronominals are strictly used as an operational device so the speaker can direct an addressee's attention to the predicative element that is syntactically intransitive, as seen in examples (10a–b).

(10) Pazeh-Kaxabu (Formosan) (Li & Tsuchida 2001: 106, 140)

a. [[Ma-desek]$_{\text{V:FOCUS-C}}$ [=siw]$_{\text{SUBJ}}$]$_{\text{IP}}$.
STAT-belch =2SG.ABS
'You *belch*!' (emphasis added)

b. [[M⟨in⟩e-ken]$_{\text{V:FOCUS-C}}$ [=siw]$_{\text{SUBJ}}$ sumay=lia]$_{\text{IP}}$?
AV ⟨PFV⟩eat =2SG.ABS rice(meal)=MODAL
'Have you *eaten* meals?' (emphasis added)

c. [M⟨in⟩e-ken asai paj= [isiw]$_{\text{SUBJ}}$]$_{\text{IP}}$?
AV ⟨PFV⟩eat what MODAL= 2SG
'*What* have you eaten?' (emphasis added)

In (10a–b), the 2P clitic pronoun *=siw* appears as the sole argument of a simple stative intransitive verb (*madesek* 'belch' in 10a) and an intransitive clause[13] (*meken* 'eat' in actor voice in 10b). These sentences come with an emphatic focus on the predicates[14] (indicated by italicisation in the free translation; cf. 10b and 10c). The free pronoun *isiw* that encodes the SUBJ of a wh-question in sentence (10c) differs from the 2P clitic pronoun in its pragmatic function. Unlike the predicate host in (10b), there is no emphatic focus on the verb in (10c), and meanwhile, the pronominal SUBJs in the two sentences differ in their clausal positions — the free pronoun appears clause-finally, while the 2P clitic appears in an immediately post-verbal position.

Unlike 2P clitics and free pronouns, the host of the peripheral pronominal in Pazeh-Kaxabu is the last word of the clause. The peripheral pronominal clitic, while neutral in case, bears DF for contrastive meaning to encode a highly top-

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[13] The issue of semantic versus syntactic transitivity of actor-voice clauses in some AN languages is discussed in Section 4.4.

[14] The term "focus" is used in this chapter to refer to the notion in information structure (Zaenen 2023 [this volume]), which is different from the term for the "focus system" that is primarily used by Formosan linguists. The latter will be discussed in Section 4 as "voice alternation."

ical entity.[15] The use of the peripheral pronominal entails that the post-verbal core arguments are pragmatically ordered according to their df roles, giving rise to order variation for VOS with a focused subj in (11a) and VSO with a salient referent of obj in (11b).

(11) Pazeh-Kaxabu (Li & Tsuchida 2002: 96)

a. [Ka-kan-en [nimisiw]$_{\text{obj}}$ =lia [=aku]$_{\text{subj:focus-c}}$]$_{\text{ip}}$.
dur-eat-pv 3erg =modal =1sg.neutral
'She (the leopard) would surely eat *me*.' (emphasis added)

b. [Ta-padudu-i [isiw]$_{\text{subj:focus-c}}$ =na [=aku]$_{\text{obj:topic}}$]$_{\text{ip}}$.
hortative-consult-pv 2sg =modal =1sg.neutral
'Perhaps, let *me* consult you.' (emphasis added)

Non-predicate-initial Indonesian-type languages, such as Balinese (Arka 2003a), Batak (Erlewine 2018), Madurese (Davies 2010: 249) and Sasak (Wouk 2002), have slightly different structural properties. First, the [Spec,IP] position is occupied by the grammatical subj, accounting for the verb-medial (SVO) structure in these languages. This is exemplified by Balinese in (12) and Madurese in (13).

(12) Balinese (Arka 2003b: 78)
[[Tiang]$_{\text{subj}}$ [[nunas kopi-ne niki]$_{\text{VP}}$]$_{\text{I}'}$]$_{\text{IP}}$.
1 av.take coffee-def this
'I took this coffee.'

(13) Madurese (WMP, Indonesia) (Davies 2010: 149)
Sengko' ng-enom kopi.
1 av-drink coffee
'I drink coffee.'

Unlike Tagalog, Indonesian-type languages, such as Toba Batak (Erlewine 2018), Indonesian (Arka & Manning 2008) and Balinese (Arka 2003a), appear to have a VP. Evidence for this comes from constituency tests such as material intervention

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[15] The 1st person singular pronominal form in Pazeh-Kaxabu lends empirical support to the emergence and development of split-subjecthood in Formosan languages, where a non-subj agent that bears a high degree of topicality in the discourse is developed to possess syntactic and morphological subject properties. Readers are directed to Liu (2017) for discussion of split-subjecthood.

and joint-fronting. This is particularly evident when the patient/agent argument is indefinite. The material-intervention test is given in (14) for Toba Batak, where a clausal adjunct cannot intervene between a verb and its argument.

(14) Toba Batak (WMP, Philippines) (Erlewine 2018)
Man-jaha (*nantoari) buku (nantoari) si Poltak (nantoari).
AV-read yesterday book yesterday PN Poltak yesterday
'Poltak read a book yesterday.'

The joint-fronting test is evident when the verb receives Contrastive Focus (FOCUS-C) and is required to appear sentence-initially. The whole V+NP string should be included, otherwise the structure is ungrammatical. For example, in contrast to the default SVO order in Balinese in (12), sentence (15a) is a pragmatically marked VOS sentence (as seen from its translation).[16] A postverbal subject is unacceptable, as depicted in (15b).

(15) Balinese (Arka, own knowledge)
a. [[Nunas kopi-ne niki]$_{\text{VP}}$, [[tiang]$_{\text{SUBJ}}$]$_{\text{IP}}$]$_{\text{IP}}$.
AV.take coffee-DEF this (pause) 1
'Taking this coffee was what I did.'
b. *[[Nunas]$_{\text{V:FOCUS-C}}$, [[tiang]$_{\text{SUBJ}}$ [kopi-ne niki]$_{\text{VP}}$]$_{\text{IP}}$]$_{\text{IP}}$.

Clause structure variation in Indonesian-type languages is usually driven by pragmatic considerations, primarily to express varying levels of informational salience or attention, for example, emphatic or contrastive focus and frame setting or topic (Arka 2003a: 257–260, Arka & Sedeng 2018, Davies 2010: 175–176, Norwood 2002: 104–107). The unit that functionally bears a Contrastive Discourse Function is fronted sentence-initially. Following Arka (2021), we explicitly represent contrastive FOCUS and TOPIC as FOCUS-C and TOPIC-C, respectively, where necessary.

In order to integrate the latest advancements in the study of information structure within Austronesian languages (Riesberg et al. 2018) and beyond (Dalrymple & Nikolaeva 2011, Zaenen 2023 [this volume], among others), we deviate slightly from the LFG representation of TOPIC and FOCUS proposed by, for example, Bresnan & Mchombo (1987). Our approach introduces distinct types of Discourse

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[16] VOS order is also possible when the subject is an afterthought TOPIC. This is a different structure, and the pragmatics and related prosody are different.

Functions, including focus-c, beyond the traditional analysis assumed in LFG during the 1980s and early 1990s. Apart from contrastive topic and focus, the fine-grained realm of topic and focus encompasses additional types such as 'new, first mentioned topic', 'default topic', 'secondary topic', and 'new/completive focus'. Arka & Sedeng (2018) provide examples of these categories in Sembiran Balinese. The suggested contrastive df is ideally situated within an independent i-structure (King 1997, Andréasson 2007, Butt 2014, among others), although it can also be, for simplicity, integrated within LFG's conventional unified f-structure representation (cf. (16c) below). The focus-c case is exemplified by (15) in Balinese above and by (16) in Indonesian below.

However, the precise structural position of contrastive dfs may vary depending on whether or not a language has a functional complementiser (C) word. For a language like Indonesian, which has a C (*bahwa* 'that'), the contrastive df is in [Spec,CP]. That is, a finite clause is CP, the maximal projection of C. The finite CP in Indonesian is evident in the relative clause (RC) with *yang* bearing focus-c, as exemplified in (16a) (cf. Arka 2011: 78-80 and Arka (2021) for details). The c-structure tree is given in (16b), showing that the pronominal relativiser *yang* is grammatically obj, and the RC is structurally OSV. The f-structure is shown in (16c).[17]

(16) Colloquial Indonesian[18] (WMP, Indonesia) (Arka, own knowledge)

a. [Yang mereka akan curi]$_{\text{CP}}$ adalah mobil.
rel 3pl fut av.steal be car
'The thing that they were going to steal was a car.'

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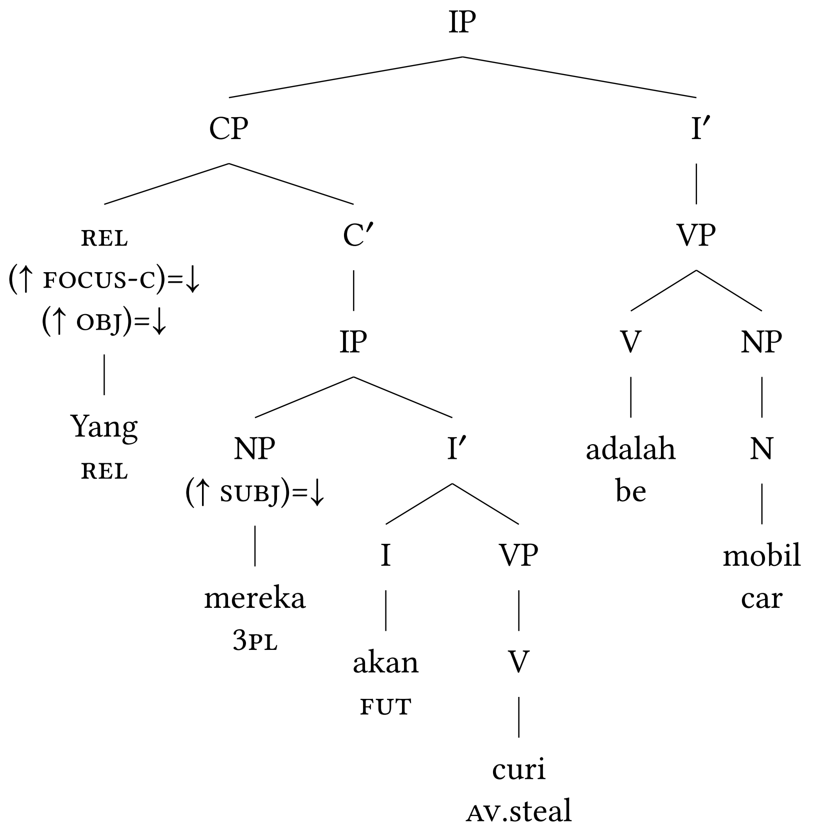
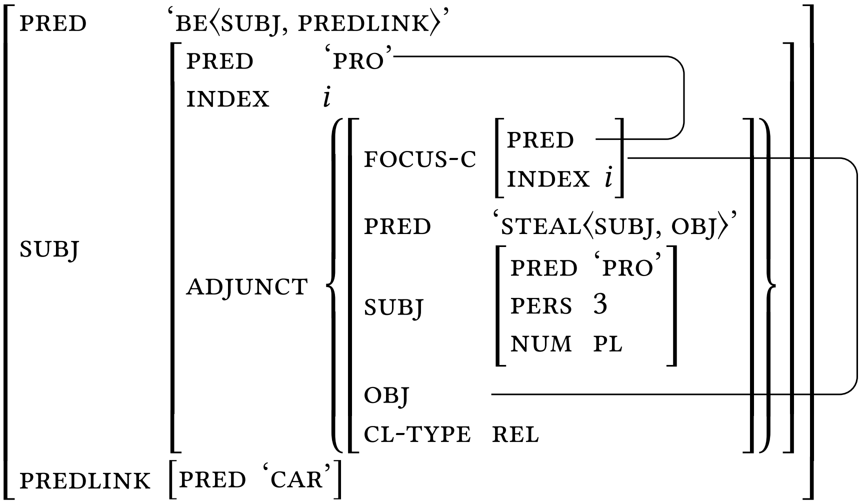
[17] Note that the Indonesian copular verb *adalah* is analyzed as requiring predlink, which is one way of analyzing a nominal predicate in LFG. For discussion of single-tier/double-tier analysis of non-verbal predicates, see Andrews (1982), Butt et al. (1999), Dalrymple et al. (2004), among others.

[18] Standard Indonesian and Colloquial Indonesian differ in their morphological properties of verbs and the formation of relativisation. See Arka (2021) for more exemplification.

b.



c.



Unlike Indonesian, Balinese has no complementiser C equivalent to English *that* (Arka 2003a).[19] A fronted element bearing a contrastive DF can be analysed as being left-adjoined to IP. This structure is shown by the IP subscripts in example

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[19] However, certain prepositions (e.g. *unduk* ‘about’) and conjunctions (e.g. *apang* ‘so that’) may function like complementisers in particular contexts (Natarina 2018: 54).

(15a). Note that the fronted element bearing a marked focus-c is typically given stress with a clear pause after it (indicated by a comma above) resulting in a VOS structure.

Like Tagalog, the clausal linear order in Indonesian-type languages may also vary if the subj is a 2P clitic. The variation may involve contrastive dfs. For instance, Sasak has a 2P clitic subj (Austin 2004) which appears after the first constituent for independent syntactic-phonological reasons, giving rise to clausal word-order variation. Thus, while S-(Auxiliary)-V-O is the unmarked order in Sasak, the subject may also be cliticised to an auxiliary if it is the first word in the sentence; this results in an Aux-S-V order, as seen in (17a). In (17b), however, the verb is fronted sentence-initially, as it bears focus-c. Therefore, it hosts the subject clitic and results in a VSO order.

(17) Ngenó-ngené Sasak (WMP, Indonesia) (Asikin-Garmager 2017: 29, 32)
a. Kenyengken=ne tokol.
prog=3 sit
'They (the women) were sitting.'
b. M-pantòk=ne$_i$ begang inó (isiq lóq Mus$_i$).
predfoc-hit=3 rat that by art.m Mus
'Mus hit the rat. (He finally got it!)' (emphasis added)

In contrast, the clausal word order is typically fixed when an argument is generic or indefinite (see Section 4.4 for further discussion of definiteness). For example, the Balinese generic statement about a cow in (18a) must be in SVO; a VOS variant is unacceptable, as in (18b).

(18) Balinese (Arka 2019: 261)
a. Sampi ngamah padang.
cow av.eat grass
b. *Ngamah padang sampi.
av.eat grass cow
'A cow eats grass.'

Some AN languages in the peripheral regions, geographically distant from their original homeland of Taiwan, are morphologically isolating and typically exhibit rigid SVO clause order. These languages are encountered on Flores Island in Indonesia and other peripheral areas, such as in Southeast Asia and the Pacific. Structurally, their clauses are like Indonesian-type languages with good evidence for a surface VP. Consider the following intervention test in Rongga (central Flores), a highly isolating language, where the verb and object form a VP:

(19) Rongga (CEMP, Indonesia) (Arka 2016: 192)

a. Ardi [ngedho wolo]$_{\text{VP}}$ **nembumai**.
Ardi see mountain yesterday
'Ardi saw a/the mountain.'

b. *Ardi ngedho **nembumai** wolo.

Rongga has developed a relativiser (REL) from the noun meaning 'person', *ata*, exemplified in (20a). As in Indonesian, it may also be analysed structurally as appearing in [Spec,CP], bearing a contrastive DF (Arka 2016). The c-structure is given in (20b), which shows that sentence (20a) is a highly marked structure. Both TOPIC and FOC are present, with TOPIC preceding FOC in the left periphery. Note that FOCUS-C in this example is associated with two elements having the same referent (indicated by the subscript *i*). Hence, it is doubly marked: first by the relativiser, *ata*, and second by the fronted question word (Q), *sei* 'who'. The sentence is a cleft structure with the Q, *sei*, being the (fronted) predicate and the relative clause being the SUBJ (as shown by the literal translation). Considering that relativization introduces a contrasting emphasis by focusing on or restricting a specific referent under discussion or question, we analyze the relativizer as carrying FOCUS-C. In example (20a), for instance, multiple individuals were present, and the relative clause singles out one of them through the event of 'taking (my) water'.[20]

(20) Rongga (Arka 2016: 212)

a. Wae ja'o, sei ata neku ndia?
water 1SG who REL take just.now
'As for my water, who's the one taking (it) just now?'
(Lit. 'As for my water, the one taking (it) just now is who?')

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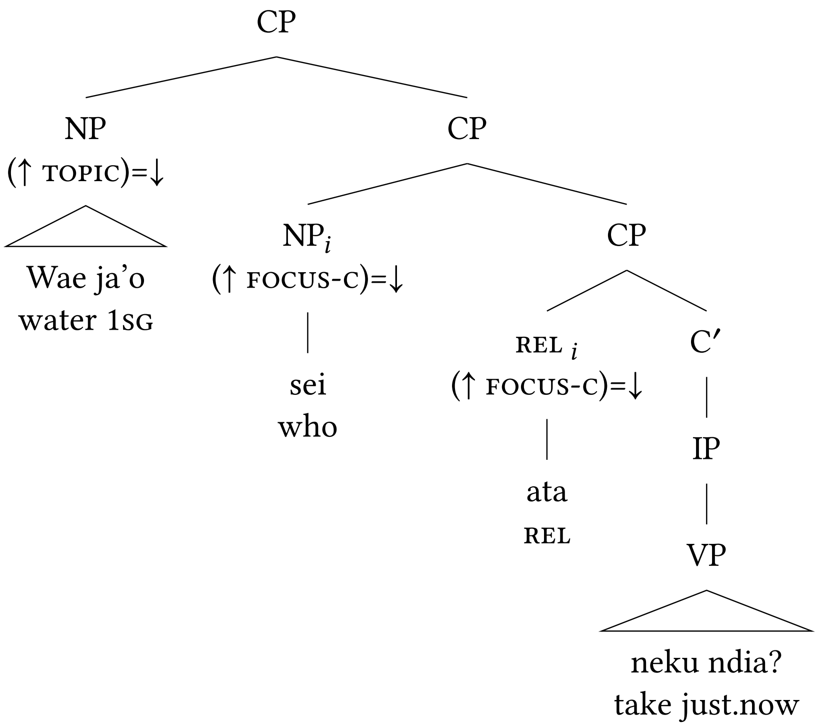
[20] It should be noted that, from the broader viewpoint of the matrix noun phrase, the relativizer is linked to the specific referent being talked about, to which the relative clause adds its semantic restriction. Therefore the relativizer can also be analyzed as a topic (cf. Bresnan & Mchombo 1987).

b.



Unlike Philippine-type and Indonesian-type languages, the indexing-type AN languages of eastern Indonesia and Oceania have developed systematic pronominal indexing systems. The salient grammatical trait of AN (symmetrical) voice is either disappearing or already lost in these languages. As a result, these languages have relatively free word order determined largely by discourse pragmatics.

For example, Kambera in Sumba, eastern Indonesia, has developed different sets of bound pronominal indexes (nom, acc, gen and dat) that appear on the predicate with a fixed order (Klamer 1998: 79). In example (21) below, *na-* and *-nya* are subject and object arguments, respectively. They appear with free cross-referencing NPs. These free NPs are optional and freely ordered, hence allowing NP$_i$-[subj$_i$-V-obj$_j$]=NP$_j$ (or SVO: (a)) and NP$_j$-[subj$_i$-V-obj$_j$]=NP$_i$ (or OVS: (b)) orders. OSV, despite not being shown here, is also possible. The SVO structure in (21a) is the default/unmarked order for transitive clauses, and OVS is a marked order when obj is contrastive topic (Klamer 1996: 22). The basic word order for an intransitive sentence is, however, VS (Klamer 1998: 85). Kambera syntax is typologically like Chicheŵa (albeit with a difference in the 'agreement' status of the verbal subj marker),[21] and it can be analysed in LFG in the same way as outlined in Bresnan & Mchombo (1987): the bound pronominal indexes are the actual syntactic arguments whereas the free NPs bear dfs, and are pragmatically linked to the arguments, which gives rise to some kind of anaphoric agreement.

(21) Kambera (CEMP, Indonesia) (Klamer 1996: 13)

a. Ka nyuna$_j$ na$_j$-tinu-nya$_k$ na lau$_k$.
cnj she 3sg.nom-weave-3sg.dat art sarong
'So that she weaves the sarong.' (Lit. 'she she-weaves-it the sarong.')

b. Ka na lau$_k$ na$_j$-tinu-nya$_k$ nyuna$_j$.
cnj art sarong 3sg.nom-weave-3sg.dat she
'So that the sarong was woven (by her).' (Lit. 'the sarong she-weaves-it she.')

To sum up this section, LFG is well-suited for analysing word order variation across different types of AN languages based on a few parameters that are empirically motivated (e.g. VP vs non-configurational, head-initial vs head-final, a contrastive df in [Spec,CP], [Spec,IP] or left-adjoined to IP). This is made possible by the c-structure representation in LFG which follows a flexible version of X-bar Theory, and which not only captures cross-linguistic structural similarities (e.g. headedness in lexical and functional categories), but also varying language-specific properties (e.g. the distinction between the endocentric phrase and an exocentric S that is not X′-theoretic, and their multiple branching units).

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[21] The verbal subj/obj markers in Chicheŵa differ from those in Kambera in the following ways. As in Kambera, the subj marker in Chicheŵa is obligatory in the verbal template. However, the Chicheŵa subj marker is only optionally pronominal. It serves as the actual argument when there is no free subj NP. Therefore, unlike in Kambera, it can also function as a 'syntactic' agreement marker when there is a free subj NP present. The subj/obj markers in Kambera hold a compulsory position within the verbal template and are consistently pronominals, meaning they refer to entities even in the absence of their corresponding free NPs. Consequently, these markers do not serve as syntactic agreement markers. In this regard, these affixes share similarities with verbal affixes found in Papuan languages (Arka et al. forthcoming) and certain Australian Aboriginal languages like Wambaya and Warlpiri. In these languages, the affixes exhibit ambiguity as they can function both as (anaphoric) agreement markers and incorporated pronominals (see Austin & Bresnan 1996 and references therein).

4 Grammatical functions and alternative argument realisations

4.1 Introduction

In LFG, grammatical functions are dealt with independently from the a-structure. Recall that in Section 2, we briefly introduced the basics of the voice system in Western AN and the rationale behind adopting a syntacticised a-structure in LFG (following Manning 1994, Arka 2003a, Arka & Manning 2008). Certain aspects of our architecture and related representations/mechanisms differ slightly from the assumptions generally adopted in LFG. One example is the argument linking/ mapping mechanism (cf. Findlay et al. 2023 [this volume]). The presentation used in this chapter is to account for salient symmetrical AN voice system where both accusative and ergative properties are observed within the same grammatical system, as in Balinese (Arka 2003a), which allows an underlying argument to have alternative gf realisations, like the a-subject/object to be the surface obj/subj as seen in Balinese in (5) and Kavalan in (6). These languages are classified as alternating languages for our discussion here.

On the other hand, AN languages of the indexing type, like Kambera, Wooi, and Taba, lack symmetrical voice and the associated subj/pivot distinction, and thus tend to be non-alternating languages (Klamer 1996, Bowden 2001, Sawaki 2016). Typically, their AN voice morphology and related voice system have disappeared. Consequently, core arguments (subject/object) do not have surface gf alternations like the kind witnessed in the alternating languages. The transitive subject and object are consistently surface subj and obj, respectively.

In other words, non-alternating languages tend to have fixed argument linking. In a genuinely non-alternating system, there is typically no distinction between gfs and grs. This gives rise to the salient typological property of non-alternating systems that gfs are typically semantically transparent. For a transitive predicate, subj is therefore always the most agent-like argument as seen, for example, in Kambera in the examples in (21) above. The bound (nom) proclitic *na=* is always the arg1:agent/subj argument of a transitive verb in this language, even when it is cross-referenced by a postposed free NP as in (21b). That is, sentence (21b) is not grammatically passive despite being given a passive translation in English; the agent is neither obl nor an adjunct (cf. the pronominal marking in a verbal cluster in Klamer 1996). Given the semantic transparency of gfs, intransitive predicates unsurprisingly show a split-S property in non-alternating AN languages. This is seen in, for example, Acehnese in examples (45)-(46) below.

In the ensuing sub-sections, we present, from the LFG perspective, how GFs (e.g. SUBJ, OBJ, OBL) are realised differently in the languages that have robust voice systems (i.e. alternating languages) and in those that do not (i.e. non-alternating languages). Specific diagnostics to identify SUBJ, OBJ and OBL, or their grouping as core versus non-core arguments, vary depending on the language type and morphosyntactic resources available (such as verbal morphology, pronominal marking, and phrase/case marking) in a given language. The complexity of the properties has led to a wide variety of competing analyses, for example, in the context of grammatical alignment systems to be discussed in Section 4.4. We begin by clarifying the subtle and crucial difference between SUBJ and PIVOT.

4.2 SUBJECT and PIVOT

There have been competing proposals within LFG for analysing and representing the predicate's most prominent argument, traditionally referred to as 'subject' (cf. subjecthood in Falk 2006, Belyaev 2023a [this volume]). In this book chapter, we keep the standard LFG conception of SUBJ(ECT) (i.e. in upper case): it is the surface grammatical subject, the most prominent GF on the relational GF hierarchy. It is part of f-structure, distinct from the thematic subject (or $\hat{\theta}$), the most prominent role on the thematic hierarchy, and part of the semantic argument structure (Bresnan & Kanerva 1989, 1992).[22] It is also distinct from the a-subject, the syntacticised a-structure subject (Manning 1994). Separating SUBJ from a-subject is necessary to account for symmetrical voice alternations and related properties in AN languages (cf. the separation of GF-GR in Section 2), otherwise certain unusual phenomena, such as the binding of SUBJ by OBJ (e.g. in Balinese example [5]) cannot be accounted for.

Furthermore, it is essential to distinguish SUBJ from PIVOT to account for the complex morphosyntax/pragmatics interface, which constrains voice alternation in certain constructions such as fronted questions in Balinese and Amis (to be discussed in Section 4.2.2). We also want to emphasize our conception of PIVOT as schematised in (22a): PIVOT is at the interface of syntax and pragmatics; that is, it shows grammatical properties (i.e. GF-related, typically intersecting with SUBJ, though not always) as well as discourse-pragmatic (DF) properties (e.g. FOCUS-C). In this sense, PIVOT is an 'overlay' or 'intersection' of GFs and DFs (Arka 2021). PIVOT is evident in the formation of bi-clausal structures, such as relativisation and coordination, and other grammatical mono-clausal structures involving

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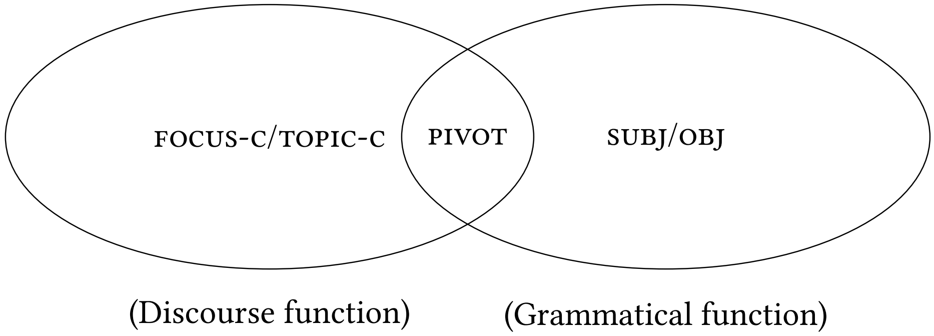
[22] The thematic subject roughly corresponds to the so-called 'logical subject', or the most prominent role-based A/S in linguistic typology (i.e. agentive argument of transitive verb, or sole argument of intransitive verb; see Jespersen (1924) and Manning (1994: 7).

marked DFs, such as FOCUS-C in Balinese fronted questions. Informally, licensing SUBJ to bear FOCUS-C as PIVOT can be represented as (22b), thus [DF-C=SUBJ] PIVOT for SUBJ PIVOT.

(22) a.



b. $[\text{FOCUS-C=SUBJ}]_{\text{PIVOT}}$

The notion of 'pivot' has been discussed and used in previous typological research. In what follows, we briefly provide some context for the conception of PIVOT adopted in this chapter. Its usage here is broadly aligned to descriptive functional and typological linguistics in place of 'Subject' and 'Topic' in the analysis of ergativity (Chao 1968, Heath 1975, Dixon 1979, Foley & Van Valin 1984, Van Valin & LaPolla 1997). The explicit incorporation of PIVOT into LFG was proposed by Manning (1994) to replace the GF attribute label SUBJ in f-structure (or Manning's GR-structure) and also to account for 'inverse' mapping in ergative languages while maintaining LFG's ability to account for 'straight-through' mapping in familiar accusative languages. In short, Manning's PIVOT is intersubstitutable with the standard LFG's SUBJ to capture the cross-linguistic variation and similarity of ergative and accusative systems. Like SUBJ, PIVOT in Manning's proposal is a subcategorised GF that is licensed by the head PRED. This is an important point that makes Manning's PIVOT different from Falk's proposal, to which we now turn.

Falk (2000, 2006) also incorporates PIVOT into LFG. While his conception of PIVOT is broadly in line with PIVOT in typological/functional linguistics (Dixon 1979, Foley & Van Valin 1984, Dixon 1994) and with PIVOT in Manning's proposal, Falk's PIVOT in LFG is different in the following respects. First, Falk's PIVOT is a slightly narrower notion than the generally understood PIVOT in language typology, and in Manning's interpretation. It is only related to what Schachter (1977) calls reference-related properties of subject, not role-related ones. That is, in Falk's conception, pivot is a syntactic function primarily for cross-clausal, combinatoric purposes (Falk 2006: 76).[23]

Second, given that it is a syntactic function, like in Manning's conception, Falk's pivot is an attribute in the f-structure. However, it should be noted that there is an element of grammaticalisation of topichood in clause combining processes. For example, the zero or unexpressed argument in control structures is strongly motivated by topicality and pragmatic efficiencies in cognitive processing (Givón 2001: 219; Hawkins 2004: 163-165). Thus, our conception of pivot as schematised in (22) is slightly different from Falk's in that it is not purely syntactic. pivot should also be understood as carrying a (grammaticalised) element of discourse-pragmatics in the interface with syntax.

Third, the crucial difference between Falk's and Manning's proposals relates to the status of pivot in relation to the deeper conception of argument structure. Falk's pivot is more like dfs or adjuncts in that it is not part of the pred's argument structure. In contrast, Manning's pivot is like subj in that it is licensed by the predicate argument structure. There is good evidence that pivot is grammatically constrained due to its tight link to the pred's argument structure. For instance, pivot selection in relativisation and fronted qs in Balinese impose a verbal voice constraint. Such a constraint is unexpected on Falk's conception of pivot as a non-subcategorised or adjunct-like gf. For this reason, our conception of pivot is in line with Manning's interpretation rather than Falk's. Our pivot is also in agreement with the widely used notion of pivot in typological linguistics.

Finally, it is worthwhile briefly commenting on Falk's conception of pivot and $\widehat{\text{gf}}$, and their related mapping. The notation of $\widehat{\text{gf}}$ (parallel to $\hat{\theta}$ in thematic structure) means the highest gf in the subcategorisation frame of the head pred. Since there is no syntacticised a-structure (distinct from f-structure) in Falk's framework, his $\widehat{\text{gf}}$ is equivalent to the conflated subj in the traditional LFG analysis of gfs (cf. Bresnan & Kanerva 1989), and Manning's syntacticised a-structure. Crucially, the gf-pivot mapping in Falk's analysis does not result in gf alternations. For example, unlike in our analysis where the av-uv alternation changes the mapping of agent and patient, which results in the patient being mapped onto subj in uv, the uv structure in Falk's analysis keeps the patient as syntactic obj and the agent as $\widehat{\text{gf}}$ (i.e. his subj). This is surprising and not empirically supported: the patient of the uv in Balinese shows up in the surface syntax as

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[23] Falk's (2006) conception of pivot as a syntactic function has been extended in Falk (2007) to account for pragmatic-semantic information in NP syntax (i.e. construct state nominals (CSN) in Hebrew: cf. Sadler 2023 [this volume]. The function of pivot in AN languages differs from the CSN in Hebrew in its application at the clausal level, where it operates exclusively in the symmetrical voice systems, and is most evident in clause combining.

grammatical SUBJ, not OBJ. The evidence comes from the fact that the patient is structurally in the preverbal SUBJ position. In contrast, the agent (which would be SUBJ in AV) appears as OBJ in UV, appearing in the post verbal position (cf. examples 1a–b).

To conclude, our conception of PIVOT is more in line with Manning's interpretation than Falk's interpretation. However, unlike Manning's proposal, we keep the standard LFG conception of SUBJ in f-structure, as we want to keep SUBJ as the clause-internal and most prominent GF, licensed by the head PRED. This is the SUBJ in its role-related dimension in connection to the PRED, distinct from PIVOT (which encapsulates its other clause-external reference-related dimension; Schachter 1977). In addition, and unlike in Falk's and Manning's proposals, we do not represent PIVOT as a separate attribute in f-structure, given the nature of PIVOT with overlapping GF-DF properties as shown in (22a). Its presence can be captured as a construction-type (or language-specific) constraint: see Section 6.3.

In what follows, we discuss and exemplify AN SUBJ and PIVOT further. We begin by illustrating the major differences among AN in the morphosyntactic and behavioural properties of clause-internal SUBJ, and then move on to cases where PIVOT is also present. While SUBJ and PIVOT are oftentimes the same argument, they may diverge (Arka 2021).

4.2.1 SUBJECT: Voice marking and argument flagging

Voice marking encodes SUBJ selection. There are at least three types of voice marking across the AN languages: (i) a multi-way voice system without distinct passive/applicative morphology; (ii) a two-way (AV versus UV) voice system, typically with distinct passive/applicative morphology, and; (iii) a restricted and mixed voice-indexing system. Each is discussed below, including its related argument flagging, from an LFG perspective.

SUBJ selection in multi-way voice systems is encountered in Formosan/Philippine-type languages such as Puyuma (Teng 2008), Tagalog, Kelabit (Borneo), Talaud (North Sulawesi; see Utsumi 2013) and Malagasy. The systems in these languages exhibit several salient properties. First, verbal morphology selects SUBJ as having a specific semantic role rather than a generalised role. This role-specific linking of SUBJ is particularly clear in non-actor voice types. Tagalog, for example, shows Patient Voice (PV), Locative Voice (LV), Instrumental Voice (IV), and Dative Voice (DV, including dative/goal/benefactive), in addition to Actor Voice (AV: Foley & Van Valin 1984: 135; Arka 2003b). Kelabit, on the other hand, shows a simpler system with a three-way opposition between AV, UV, and IV. For simplicity, only AV-PV-LV alternations, like in Tagalog, and AV-PV alternations, like in Kelabit, are given in (23)-(24) below.

(23) Tagalog (Kroeger 1993: 14)

a. M⟨um⟩ili **ang**=lalake ng=isda sa=tindahan.
⟨PFV.AV⟩buy SUBJ=man CORE=fish NONCORE=store
'The man bought fish at the store.'

SUBJ $\text{OBJ}_{\text{PATIENT}}$
'AV.buy⟨1:agt, 2:pt ⟩'

b. B⟨in⟩ili-∅ ng=lalake **ang**=isda sa=tindahan.
⟨PFV⟩buy-PV CORE=man SUBJ=fish NONCORE=store
'The man bought the fish at the store.'

$\text{OBJ}_{\text{AGENT}}$ SUBJ
'PV.buy⟨ 1:agt, 2:pt⟩'

c. B⟨in⟩ilih-an ng=lalake ng=isda **ang**=tindahan.
⟨PFV⟩buy-LV CORE=man CORE=fish SUBJ=store
'The man bought fish at the store.'

$\text{OBJ}_{\text{AGENT}}$ $\text{OBJ}_{\text{PATIENT}}$ SUBJ
'LV.buy⟨ 1:agt, 2:pt, 3:loc⟩'

(24) Kelabit (WMP, Indonesia) (Hemmings 2021: 161)

a. **La'ih sineh** nenekul nuba' ngen seduk.
man DEM AV.PFV.spoon.up rice with spoon
'The man spooned up his rice with a spoon.'

SUBJ OBJ
'AV.spooned.up⟨1:agt,2:pt⟩'

b. **Nuba**' sikul la'ih sineh ngen seduk.
rice PV.PFV.spoon.up man DEM with spoon
'That man spooned up rice with a spoon.'

OBJ SUBJ
'PV.spooned.up⟨1:agt, 2:pt⟩'

SUBJ selection is also indicated by structural properties, such as syntactic position and flagging. In Tagalog, SUBJ is flagged by *ang*= in (23) above.[24] In Kelabit,

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[24] The intransitive ⟨1:agt⟩ (or S) argument in Tagalog is also flagged by *ang*=, providing robust evidence for clause-internal subjecthood (i.e. the sole core intransitive argument is SUBJ):

(i) Nagsalita ang=babae.
spoke SUBJ=woman
'The woman spoke.' (De Guzman 1988: 323-324)

subj is a bare NP that occurs preverbally, and has no prepositional flagging to distinguish it from obl.

Second, the data points above exemplify the hallmarks of the AN symmetrical voice system in two respects: morphologically and syntactically (Foley 1998, Arka 2003b, Himmelmann 2005, Riesberg 2014). In terms of morphological marking, all voice types are equally marked, as clearly seen in Tagalog and Formosan languages, such as Puyuma (Teng 2008) and Pazeh-Kaxabu (Yeh 2019). None of their voice marking is morphologically 'default'. As for Kelabit, the root of the pv verb is *sikul*, and the pv marking involves *i*-ablaut and sibilation of /t/ to /s/, analysable as a variant of the infix *in-* also seen in Tagalog.[25] In LFG, semantically transitive predicates, such as 'buy' in (23) and 'spoon up' in (24), are listed in their lexical entries as verbal roots with a-structures containing ⟨1:agt, 2:pt⟩ (i.e. the most actor-like and patient-like arguments are the first two ordered core arguments). Voice morphology is a marker for subj linking, following general principles in Lexical Mapping Theory (LMT), and will be further discussed in Section 4.3.

Another syntactic hallmark of the AN symmetrical voice system is that core arguments are equally selectable as subj without obligatory demotion of any other core argument in the argument structure. This results in a non-av alternation with cross-linking as depicted in (4), where ⟨1:agt⟩ remains the most prominent argument. Evidence for the non-demotion of ⟨1:agt⟩ comes from reflexive binding as demonstrated in Balinese (5) and Kavalan (6). Other evidence comes from argument marking/flagging. This is clearly demonstrated in the av-pv alternation in Tagalog in (23a–b). The alternative linking between ⟨1:agt⟩ and ⟨2:pt⟩ to subj and obj correlates with the alternative flagging with *ang=* and *ng=*. The phrase markers *ang=* and *ng=* in Tagalog flag subj and obj respectively. Hence, in the pv in (23b), ⟨1:agt⟩ remains core as it is flagged with *ng=*. This non-demotion property is what typologically distinguishes the AN symmetrical voice system from Indo-European languages like English.

Next, subj selection in AN languages with two-way voice systems is typically encountered in the Indonesian-type. It shows similar symmetrical voice properties to those observed in Tagalog with the exception that the selection of a peripheral semantic role as subj requires a specific applicative marker. Consider the Balinese examples in (25b)-(25c) below, which is a near equivalent of the LV in Tagalog, as seen previously in (23c):

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[25] We thank an anonymous reviewer for pointing this out.

(25) Balinese (Arka 2014b: 60, 75)

a. Ia meli baas (sig dagang-e ento).
3 AV.buy rice at trader-DEF that
'(S)he bought rice from the trader.'
SUBJ OBJ OBL
'AV.buy⟨1:agt, 2:th | 3:loc/source⟩'

b. Ia meli-**nin** **dagang-e** **ento** baas.
3 AV.buy-APPL trader-DEF that rice
'(S)he bought rice from the trader.'
SUBJ OBJ OBJ$_{\text{THEME}}$
'AV.buy⟨1:agt, 2:loc/source, 3:th ⟩'

c. **Anak-e** **nto** belin-**in** tiang potlot.
person-DEF that UV.buy-APPL 1 pencil
'I bought a pencil from the person.'
OBJ SUBJ OBJ$_{\text{THEME}}$
'UV.buy⟨1:agt, 2:loc/source, 3:th ⟩'

In Balinese, the two-place transitive verb *beli* 'buy' obligatorily requires the applicative marker -*(n)*in order to add a locative/source to the base structure as a core argument. Compare the locative/source role flagged by *sig*[26] in (25a) and the unflagged locative/source argument in (25b). The latter is licensed by the verb that contains the applicative morpheme -*in*, and receives a P(atient)-like core status, resulting in a ditransitive construction. Crucially, with an applicative verb (25b–c), the locative/source argument is promoted to the second most prominent position among the core arguments (i.e. ⟨2:loc/source⟩), essential for its selection as SUBJ; hence, it can appear sentence-initially without flagging as shown in (25c). Similar to Formosan/Philippine languages, core arguments are equally selectable as SUBJ in two-way voice systems (i.e. evidencing the symmetricality of syntax), except that the latter languages require a distinct applicative marker, while the former have more robust verbal voice morphology.

Additionally, AN languages of the Indonesian type often have a real passive voice. Sundanese, for example, has a passive marked by *di*-. In passive voice, ⟨1:agt⟩ is demoted to non-core status, resulting in the promotion of patient to the first argument and its link to SUBJ, as shown in (26b).

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[26] The noun phrase flagged by *sig* in (25a) differs from other non-thematic locatives of OBL adjunct in terms of its thematic animacy (versus inanimate location marked by *ka*). See Arka (2014b) for other syntactic properties targeting the distinction between arguments and adjuncts.

(26) Sundanese (WMP, Indonesia) (Davies & Kurniawan 2013: 123)

a. **Asép ngirim** buku ka Enéng.
Asep AV.send book to Eneng
'Asep sent a book to Eneng.'

SUBJ OBJ OBL
'AV.send⟨1:agt, 2:pt |3:go⟩'

b. **Buku éta di**-kirim ka Enéng ku Asép.
book that PASS-send to Eneng by Asep
'The book was sent to Eneng by Asep.'

SUBJ OBL OBL
'PASSV.send⟨1:pt | 2:agt, 3:go⟩'

AN languages of the indexing type, such as Kambera, Kodi and Wooi, also show clause-internal evidence for SUBJ even in the absence of a typical voice system. In these languages, SUBJ is expressed by a pronominal index (clitic/affix) that commonly exhibits a NOM pattern. In Wooi, for example, the verbal prefix *he*- indexes the intransitive SUBJ in (27a) and transitive SUBJ in (27b). Incidentally, a free NP would optionally cross-reference the SUBJ index for pragmatic reasons (e.g. to express contrastive FOCUS) or for semantic reasons (e.g. to express an associative plural as seen in 27b). In our LFG analysis, the index *he*- fills the SUBJ slot in the verbal template. Since *he*- is referential, it contributes [PRED='PRO'], [NUM=PL], and [PERS=3] to the value of SUBJ.

(27) Wooi (CEMP, Eastern-Indonesia) (Sawaki 2016: 203, 206)

a. Henda.
he-t-ra
3PL-PL-go
'They went.'

b. Jon hendora Agus hia na ramdempe.
Jon **he**-t-rora **Agus hia** na ramdempe
John 3PL-PL-hit Agus 3PL LOC yesterday
'John and associates hit Agus and associates yesterday.'

4.2.2 Behavioural properties of SUBJECT/PIVOT

In the introduction to Section 4, we clarified the theoretical orientation for the terminology used here to denote the distinct notions of SUBJ and PIVOT. In this section, we focus specifically on how PIVOT is motivated, and exemplify cases in AN languages where PIVOT must be strictly identified with SUBJ (henceforth, SUBJ/PIVOT) and other cases where PIVOT is not necessarily SUBJ. We begin with SUBJ/PIVOT cases.

Evidence for the SUBJ/PIVOT constraint is observed in the fronted QS in Balinese and Amis. Consider the QS *apa* 'what' in Balinese (28a) and *cima* in Amis (29) below. They appear *in situ* because they are simply 'weak' FOCUS. By contrast, when the QS are placed sentence-initially (i.e. fronted) as in (28b) and (30), they must be understood as SUBJ. This discourse prominent property of FOCUS-C has turned SUBJ into the highly privileged status of SUBJ/PIVOT that is borne by the fronted Q. Now consider the contrasting status of arguments that do not involve the overlay function of PIVOT. In the Balinese example (28a), the Q is not fronted. Even for the fronted Q in example (28b), the sentence is only acceptable with reading (i) (indicated by the solid line). While the NP *ci* is closer to the subject position, it can only be understood as OBJ.

(28) Balinese (Arka 2003a: 27)

a.

[Ci	ngalih	**apa**	ditu	ibi]$_{\text{IP}}$?
2	AV.search	OBJ	there	yesterday

'What did you look for there yesterday?' (in-situ Q=OBJ$_{\text{TH}}$)

b.

Apa	ci [	__	ngalih	__	ditu	ibi]$_{\text{IP}}$?
[what]$_{\text{FOCUS-C}}$	2	SUBJ	AV.search	OBJ	there	yesterday

(PIVOT)

i) 'What looked for you there yesterday?' (fronted Q=SUBJ/PIVOT.agt)
(e.g. a ghost might have disturbed the addressee)
ii) NOT FOR 'What did you look for there yesterday?'

(29) In-situ Q (Central Amis - Formosan) (Yeh, fieldwork data)

a.

[Mi-palo'-ay	[**cima**]$_{\text{SUBJ/FOC}}$	ci	Mayaw-an]$_{\text{IP}}$?
AV-whip-REAL	who	PN	Mayaw-LOC

'Who whipped Mayaw?' (in-situ Q=SUBJ.agt)

b.

[Mi-palo'-ay	ci	Panay	[**cima**-an]$_{\text{OBL/FOC}}$]$_{\text{IP}}$?
AV-whip-REAL	PN	Panay	who-LOC

'Who did Panay whip?' (in-situ Q=OBL.pt)

(30) fronted Q (Central Amis - Formosan) (Yeh, fieldwork data)

a. [U **cima**]$_{\text{FOCUS-C}}$ [ku mi-palo'-ay __ ci Mayaw-an]$_{\text{COMP}}$?
PRT who CN.ABS AV-whip-REAL SUBJ PN Mayaw-LOC
(PIVOT)
'WHO was the one that whipped Mayaw?' (fronted Q=SUBJ/PIVOT.agt)

b. [U **cima**]$_{\text{FOCUS-C}}$ [ku ma-palo'-ay ni Panay __]$_{\text{COMP}}$?
PRT who CN.ABS PV-whip-REAL PN.GEN Panay SUBJ
(PIVOT)
'WHO was the one that Panay whipped?' (fronted Q=SUBJ/PIVOT.pt)

c. * U cima ku mi-palo'-ay ci Panay?

d. * Cima-an ku mi-palo'-ay ci Panay?

Likewise, the difference between SUBJ and PIVOT is evidenced by the distinct status of SUBJ PIVOT in (30) and SUBJ in (29). In the latter, no FOCUS-C is involved, and thus SUBJ remains in-situ. By contrast, the fronted QS in (30) specifically privilege SUBJ PIVOT as seen by the verbal voice morphology (e.g. unacceptability of 30c in contrast to 30b), and they are associated with the extra-syntactic function FOCUS-C in the discourse. Pragmatically, there is a difference between the fronted QS and in-situ QS. The in-situ Q in (29a) forms an open question without the presupposition of contrasting entities in the given context (Wei 2009: 348). In contrast, the fronted Q in (30a) is used when the SUBJ agent in question is one among a group of people present in a given situation. This indicates that the fronted Q comes with a pragmatic meaning of contrast that is not present with the in-situ Q.

Note that Amis differs from Balinese in that in-situ QS in Balinese are OBJ, whilst those in Amis can be either SUBJ or non-SUBJ. This is because the two languages differ in their word order. SUBJ is pre-verbal in Balinese, whereas Amis is verb-initial like Squliq and Tagalog (cf. Section 3) and thus, SUBJ is realised preverbally in pragmatically marked constructions.

In particular, the essence of PIVOT as the overlay function for clause-combining is evidenced by the structure of fronted QS in Amis. Structurally, the sentences with fronted QS in (30a–b) are pseudo-clefts in a bi-clausal structure. The QS are fronted nominal predicates in FOCUS, followed by a headless relative clause flagged by *ku* (i.e. the ABS case nominal marker) in which SUBJ is obligatorily relativised. The SUBJ marker supplies the pronominal value that is coreferential with the fronted Q (cf. Section 6.3 for the LFG representation of bi-clausal structures with a nominal predicate).

However, the Balinese data point in (28b) also shows that the subj/pivot constraint is not necessarily related to clause combining. This is expected as focus-c (the critical element of pivot) is pragmatically driven for communicative purposes, applicable to a mono-clausal sentence.

q fronting interacts with verbal voice morphology. In Amis, only the most prominent argument (i.e. subj) takes part in this pivot function for fronting qs. For instance, when understood as A, its selection as subj is indicated by the same av morphology for an in-situ subj, as in (29a), and a fronted subj, as in (30a) (i.e. subj/pivot). However, when the q *cima* bears the patient role, its fronting (i.e. linking Patient as the subj in focus-c) requires pv morphology as seen in (30b). Retaining av morphology on the verb renders the structure with a fronted q ungrammatical, as seen in (30c). Likewise, in contrast to (29b), the structure is ungrammatical when the fronted q *cima* is obl marked by *-an*, as in (30d).

In short, we have seen how pivot as a syntactic-pragmatic function combines the syntactic property of subj and the focus-c function in giving rise to the subj/pivot constraint associated with q fronting in Balinese and Amis. Other behavioural properties targeting subj as pivot typically encountered in Philippine-type and Indonesian-type AN languages include control/raising and relativisation (see Arka 2003a: 11-26).

Recent research in Indonesian relativisation demonstrates strong evidence that pivot is not always subj.[27] The distinction between subj and pivot in Indonesian receives further empirical support by the fact that obj can also be pivot, as seen in relativisation in (31). However, this obj relativisation through gapping (i.e. obj pivot) is highly constrained. It is only possible in a specific construction when both subj and obj are highly salient with the presence of certain contrastive adverbs, such as *hanya* 'only', where the subj-only constraint that is typically imposed in complex clause formation in Standard Indonesian is not maintained. Thus, while the agent *kamu* '2sg' is subj in (31), as evidenced from the verbal av morphology, it is not the pivot for relativisation. Readers are directed to Arka (2021) for a detailed discussion of these relativisation facts in Indonesian, and the puzzles they pose for analysis.

(31) Standard Indonesian (Arka 2021: 196)
[**Gadis** [yang [(barangkali) [**hanya kamu** bisa menaklukkan __]$_{\text{CP}}$]$_{\text{CP}}$]$_{\text{NP}}$
girl rel perhaps only 2sg can av.conquer
'the girl who perhaps only you can control'

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[27] This is evident in relativisation in familiar languages, like English, where non-subj can be pivot (i.e. gapped in relativisation).

4.3 Non-subj functions: obj and obl

In LFG, there are three non-subj functions: obj, obj_θ, and obl. In this subsection, we explore their realisation in AN languages, and show that distinguishing these three non-subj functions is useful in the transitivity analysis of the av patient, and in the analysis of Indonesian-type applicatives. This is because LFG's modular design and conception of gfs as 'natural' classes allow us to not only distinguish obj from obl at the level of syntactic f-/a-structure, but also to capture the gradient nature of the obj-obl distinction in Prototype theory (cf. Taylor 2003) and a core index analysis (Arka 2017). We begin with a characterisation of objs.

On the basis of cross-linguistic gf classifications, and research on syntactic prominence and semantic role associations (Comrie 1989, Bresnan 2001), we define obj syntactically as a class of core complements that is prototypically and thematically unrestricted. The syntactic property of complementation distinguishes obj from subj since subj is not a complement, and the coreness property differentiates it from obl since obl is not a core argument. Defining obj as a class of gf in this way allows us to capture the varied characteristics of obj cross-linguistically, but also within the same language (cf. Dalrymple & Nikolaeva 2011). It also allows us to identify language-specific object-like patterns, which provide empirical grounds for identifying different kinds of obj: prototypical or primary obj (thematically unrestricted obj) and secondary non-prototypical obj (also thematically restricted, and otherwise known as obj_θ in LFG) (Bresnan & Kanerva 1989, Haspelmath 2007). In what follows, we show the variation in the actual morphosyntactic realisations of different types of obj in AN languages, starting with the prototypical obj.

The prototypical obj in descriptive/typological linguistics is patient-like in its semantic role. In our LFG analysis, this obj is linked to the a-object (i.e. ⟨2:pt⟩) in the a-structure representation. In AN languages with voice systems, it is the core argument of the verb in the av structure, and typically appears postverbally, like the NP *Watan* in (7) (Squliq Atayal) and *apa* 'what' in (28) (Balinese). Squliq Atayal and Balinese represent languages where free obj arguments have no specific obj flagging. obj NPs are bare, in contrast to prepositionally flagged obls.

However, there are also AN languages that specifically flag arguments with non-subj core status, like *ng=* in Tagalog in (23) above, and *te* in Tukang Besi in (32) below. In Tukang Besi, the pronominal indexing system on the main (finite) verb of an embedded clause shows diminished voice morphology (Donohue 2008: 8). The underlying ⟨2:pt⟩ 'you' surfaces as obj in (32a) and is flagged by *te*, and not indexed on the verb. It appears as subj, which is indexed by the enclitic *=ko*, and is optionally cross-referenced by the nom NP that is flagged by *na* in (32b).

(32) Tukang Besi (WMP, Indonesia) (Donohue 2002: 85)

a. No-kiki'i [te iko'o]$_{\text{OBJ}}$ [na beka]$_{\text{SUBJ}}$.
3REAL-bite CORE you NOM cat
'The cat bit you.' SUBJ OBJ
'bite⟨1:agt:'cat',2:pt:'you'⟩'

b. No-kiki'i[=ko]$_{\text{SUBJ}}$ ([na iko'o]$_{\text{SUBJ}}$) [te beka].
3REAL-bite=2SG.OBJ NOM you CORE cat
'The cat bit you.' or 'You, the cat bit.' OBJ SUBJ
'bite⟨1:agt:'cat',2:pt:'you'⟩'

Note that the GF alternation in Tukang Besi in (32) is equivalent to the AV-UV alternation in Indonesian-type languages, like the Balinese example in (5). The key differences relate to verbal voice marking and argument flagging. Unlike in Balinese, the AV structure in Tukang Besi in (32a) has no verbal AV morphology, and its OBJ is overtly flagged.

The thematically unrestricted property of OBJ is captured by the [−*r*] feature in LMT (Bresnan & Kanerva 1989; Dalrymple 2001: 21). That is, it is linkable to a range of roles other than patient. In our definition in this chapter, it is indeed a non-SUBJ core argument, as seen in Tukang Besi in (32b) where the OBJ flagged by *te* is linked to the agent. Additionally, other roles associated with OBJ include instrumental, benefactive/recipient, goal, and locative, as seen in the Indonesian-type languages that show applicative morphology (e.g. Indonesian, Balinese, Madurese, among others). Madurese has two applicative suffixes, namely *-e* (for locative/goal applicative) and *-agi* (for benefactive/instrumental), both of which are equivalent to *-i*/*-kan* in Indonesian (Arka et al. 2009) and *-in*/*-ang* in Balinese (Arka 2003a). The Madurese examples in (33) show that the post-verbal OBJ is the thematically unrestricted OBJ, which is linked to patient/theme in (33a), locative/goal in (33b) (with the verb containing the locative applicative, *-e*), and recipient/benefactive in (33c) (with the verb containing the recipient applicative, *-agi*).

(33) Madurese (Davies 2010: 283, 299)

a. Embuk ngerem [paket]$_{\text{OBJ}}$ [ka Ebu']$_{\text{OBL}}$.
elder.sister AV.send package to mother
'Big Sister sent a package to Mother.' SUBJ OBJ OBL
'AV.send⟨1:agt,2:pt |3:goal⟩'

b. Embuk ngerem-**e** [Ebu']$_{\text{OBJ}}$ [paket]$_{\text{OBJ}_\theta}$.
elder.sister AV.send-APPL mother package
'Big Sister sent Mother a package.' SUBJ OBJ $\text{OBJ}_{\text{THEME}}$
'AV.send.for⟨1:agt,2:goal. 3:th⟩'

c. Sa'diyah melle-**yagi** [na'-kana']$_{\text{OBJ}}$ [permen]$_{\text{OBJ}_\theta}$.
Sa'diyah AV.buy-APPL REDUP-child candy
'Sa'diyah bought the children candy.'
SUBJ OBJ $\text{OBJ}_{\text{THEME}}$
'AV.send.for⟨1:agt,2:goal, 3:th⟩'

While primary OBJ is thematically unrestricted, secondary non-prototypical OBJ is typically thematically restricted. This is evidenced in the important effect of applicativisation whereby the a-structure is restructured with OBJ and OBJ_θ surfacing differently. Consider, firstly, the PP in (33a), *ka Ebu'* 'mother', which is prepositionally flagged as OBL (i.e. non-core). Yet, the argument is promoted to the secondmost prominent slot in the applicative structure in (33b). Its realisation as a bare NP, and its structural position immediately following the verb, indicate that it is OBJ, while the underlying displaced theme *paket* is demoted to the third core position, and surfaces as OBJ_θ. This results in a ditransitive structure of SVOO. Likewise, the same restructuring of a-structure occurs with the benefactive applicative in (33c).

In LFG, the NP *paket* in (33b) is an instance of $\text{OBJ}_{\text{THEME}}$ in Madurese. Semantically, it is restricted to a displaced theme only. Crucially, and unlike OBJ (*Ebu'*), it is restricted in the sense that it does not surface as SUBJ in the UV voice, as seen in the ungrammaticality of (34b) in contrast to (34a). This provides clear evidence that the applied argument occupies the second argument in the restructured transitive a-structure. Hence, it is 'mappable' to OBJ in AV in (33b), or SUBJ in UV in (34a).[28]

(34) Madurese (Davies 2010: 284)

a. Ebu' e-kerem-e [paket]$_{\text{OBJ}}$ bi' Embuk.
mother UV-send-APPL package by elder.sister
'Mother was sent a package by Big Sister.'
OBJ SUBJ $\text{OBJ}_{\text{THEME}}$
'UV.send⟨1:agt,2:goal, 3:th⟩'

---

[28] The preposition *bi'* 'by' is optional in Madurese. There is no identifiable grammatical difference between the pairs with/without *bi*; the verb in this structure is therefore analysed as UV, not passive (Davies 2010: 256-258).

b. *[Paket rowa]$_{\text{subj}}$ e-kerem-e (ka) Ebu' bi' Embuk.
package that uv-send-appl to mother by elder.sister
('The package was sent (to) Mother by Big Sister.')

In AN languages with a systematic argument indexing system, obj is typically semantically transparent from its case form. That is, the obj index is part of a verbal complex structure, either as a pronominal affix or clitic, and surfaces differently according to semantic roles. In Kambera, for example, the prototypical patient-like obj is expressed by an acc enclitic immediately following the verb, whereas the benefactive obj is marked differently via dat. Hence, the first-person patient obj is *ka* '1sg.acc' in (35a), but *ngga* in (35b), since it is thematically beneficiary. Note that the displaced theme, obj$_{\text{theme}}$, in (35b) is dat. In LFG, the Kambera ditransitive sentence in (35b) has the same a-/f-structures as the Madurese examples in (33b–c), with the key differences being in the coding and feature values of the surface gfs. For the right enclitic form of obj to be selected, the lexical entry must be specified by the relevant constraints, as shown in (35c) with *=ngga*. The shorthand (↑ obj)$_\sigma$=(↑$_\sigma$ 2:ben) constraint relies on a sigma projection relating f-structure to a-structure, here establishing a correspondence between the obj in the f-structure and the second benefactive argument in the a-structure (see Belyaev 2023b [this volume] for discussion of LFG's projection architecture).

(35) Kambera (Klamer 1998: 63)

a. (Na tau wútu) na=palu=ka (nyungga).
art person be.fat 3sg.nom=hit=1sg.acc I
'The big man hit me.'
subj:nom obj:acc
'hit⟨ 1:agt, 2:pt⟩'

b. (I Ama) na=kei=ngga=nya.
art father 3sg.nom=buy=1sg.dat=3sg.dat
'Father buys it for me.' subj:nom obj:dat obj$_{\text{theme}}$:dat
'buy⟨ 1:agt, 2:pt 3:th⟩'

c. *ngga* CLITIC (↑ obj pred)='pro'
(↑ obj pers)=1
(↑ obj num)=sg
(↑ obj case)=dat
(↑ obj)$_\sigma$=(↑$_\sigma$ 2:ben)

The different coding of obj, as seen in Kambera, is not typologically unusual. It is known as Differential Object Marking (henceforth DOM) (Dalrymple & Nikolaeva 2011). For instance, Palauan has DOM that is primarily regulated by semantic features. However, unlike Kambera, Palauan demonstrates DOM that is determined by definiteness, instead of semantic roles. Definite obj receives pronominal indexing on the verb, as in (36a), whereas indefinite obj does not, as in (36b). In an LFG analysis, Palauan DOM can be captured by annotating the suffix slot in the verb formation rule with the constraining equation: (↑ obj def)$=_c$+. The suffix *-ii* also carries a definiteness feature in its lexical entry, (↑ def)=+, in addition to person and number features.

(36) Palauan (WMP, Palau) (Georgopoulos 1991: 45)

a. Te-'illebed-**ii** a bilis a rengalek.
3pl-pfv.hit-3sg dog children
'The kids hit the dog.'

b. Te-'illebed a bilis a rengalek.
3pl-pfv.hit dog children
'The kids hit a dog/the dogs/some dog(s).'

Obliques in AN languages are typically phrasally flagged. The common pattern is that obl is flagged by an adposition, like *ka* 'to' for obl locative/goal in Madurese (33a), and *teken* 'by' for obl agent in Balinese (Arka 2019: 262). However, AN languages of the Philippine type have phrasal markers that specifically mark obl status in contrast to the core status of subj. This is the case in Puyuma where the obl and subj are equally flagged. However, Puyuma shows differential obl marking on the basis of differences in nominal type (e.g. common versus proper) and definiteness (as seen in DOM) rather than differences in semantic roles. Consider example (37) below, where *kana* is used as the phrasal obl marker for a definite common noun like in (37a), and *dra* for an indefinite common noun as in (37b–d). The same phrase marker, *dra*, is used for indefinite obliques irrespective of their roles as patient, instrument, location, etc.

(37) Puyuma

a. Ku=tuLud-anay na sarekuDan **kana** temumuwan.
1sg.gen-pass-iv def.nom stick def.obl offspring
'I passed the stick to the offspring.' (Teng 2005: 23)

b. Tr⟨em⟩aka-trakaw=ku **dra** akan-an.
⟨av⟩redup-steal=1sg.nom indf.obl eat-nmlz
'I stole food repeatedly.' (Teng 2008: 146)

c. Tu=pa-ladram-aw **dra** lrangetri pa-karun.
3GEN=CAUS-know-PV INDF.OBL stick CAUS-work
'They used a stick to teach them to work.' (Teng 2008: 245) (translation adapted)

d. Ka-sa-sanan **dra** dalran.
ka-REDUP-stray INDF.OBL road
'He will get lost.' (Teng 2008: 168)

4.4 Alignment systems and related phenomena

The syntactic status of the non-SUBJ argument is relevant to the question of alignment. There is a long-standing debate in AN linguistics as to whether syntactic alignment has properties of ergativity, accusativity or split-ergativity. There are competing proposals in the literature, as well as claims that Western AN languages vary in their alignment; see Aldridge (2004), Katagiri (2005), and references therein for further discussion. In the following section, we present cases where morphosyntactic ergativity is firmly observed, like in Puyuma, then move to borderline cases.

Puyuma exhibits syntactic properties that are typical for an ergative system. However, unlike well-known ergative languages such as Dyirbal (Dixon 1972), there are no morphologically 'basic' or unmarked transitive verbs in Puyuma because they are all marked for their specific non-actor voices; e.g. *-anay* marking for CV, conveyance voice, in (37a), and *-aw* for PV, patient voice, in (37c). The AV verbs are also morphologically marked by *-em-* as in (37b).[29] The AV structure can be analysed as antipassive because the patient argument of the transitive verb is demoted to non-core status, which is flagged by the OBL marker as shown in (38). Puyuma, therefore, exhibits clear syntactic asymmetry in its voice alternations, which is the hallmark of a truly ergative system. In the transitive structure, ⟨1:agent, 2:patient/theme⟩, the two core arguments are not equally selectable as syntactic SUBJ/PIVOT. That is, SUBJ/PIVOT selection is asymmetrically aligned towards the second patient core slot. Hence, when the agent has to be linked to SUBJ/PIVOT, the patient must be removed and demoted to non-core status in order to allow for the linking of the agent to SUBJ/PIVOT. Removing the patient from the core status in the a-structure results in an intransitive ⟨1:agent | 2:patient/theme⟩ structure.

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[29] Note that in Teng's (2005, 2008) descriptions, the AV affix *-em-* is glossed as intransitive (INTR) because the AV structure is syntactically intransitive.

(38) Puyuma (Teng 2008: 72, 187)

a. T⟨em⟩engedr=ta dra unan i, ...
⟨AV⟩kill=1PL.NOM INDF.OBL snake TOPIC, ...
'We killed a snake, ...'

b. K⟨em⟩asu=ta dra eraw, dra irupan.
⟨AV⟩bring=1PL.NOM INDF.OBL wine INDF.OBL dishes
'We brought some wine and some dishes.'

However, in many other AN languages with robust voice morphology, the antipassive analysis of AV is controversial because the evidence for the demotion of the underlying patient to OBL is often unclear and debatable. In Tagalog, for example, the patient argument of the AV sentence is flagged by the core phrase marker *ng* in (23a). Thus, the AV sentence in Tagalog is distinct from Puyuma in that it is syntactically transitive. Conversely, under an ergative analysis, the AV is analyzed as antipassive on the basis that P is understood as indefinite, which is a typical semantic property of the antipassive patient (Hopper & Thompson 1980). Yet, this semantic criterion for the core status of AV patient is disputable, as shown in the Paiwan (Formosan) examples in (39) below. While an OBL patient may be indefinite, as in (39a), the reverse does not hold since an oblique-marked patient can have a definite reading, as seen in (39b) (cf. DOM in Puyuma in Section 4.3). This suggests that in many Philippine-type languages, the coreness status of the non-SUBJ argument in AV cannot be easily and solely specified by its semantic property due to the mismatch of semantic transitivity, syntactic transitivity and voice alternation.[30]

(39) North Paiwan (Formosan) (Chang 2006: 114, 412)

a. Ki-lakarav tua sipangetjez tua zua marekaka.
obtain.AV-flower OBL.CN gift OBL.CN that both.sibling
'(He) would pluck flowers as a gift for both sisters.'

b. Na=t⟨em⟩ekeL=anga timadju tua ʔucia.
PFV=drink⟨AV⟩=COMPL 3SG.NOM OBL.CN tea
'He has drunk the tea.'

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[30] The status of coreness must, therefore, be determined by taking into account all the relevant language-specific morphosyntactic properties. This is possible via a core index analysis (Arka 2017), for example. The core index analysis applied to the P of the AV structure in Puyuma reveals a core index of 0.44, which is classified as OBL albeit atypical. A prototypical OBL in Puyuma (e.g. LOC OBL of the AV verb) has a core index of 0.11, which is in line with the cross-linguistic tendency for prototypical OBL to have a core index of below 0.20. The degrees of coreness/obliqueness for the P of AV structures across other Philippine-type languages is a matter of future research.

Likewise, for AN languages in the regions of Sulawesi, which have been analysed as showing ergative properties, the status of the av patient is not very straightforward either. Consider the examples in (40) from Moronene (in Southeast Sulawesi). Moronene shows DOM whereby a definite obj NP receives object indexing. Conversely, an indefinite or a non-specific obj NP receives no such indexing. The av sentence with av morphology (*moN-*) has been analysed as antipassive (Andersen & Andersen 2005) based on the patient NP being indefinite or non-specific.

(40) Moronene (WMP, Indonesia) (Andersen & Andersen 2005: 246, 252)

a. Yo laku ari **kea'-o** manu.
art civet already bite-3sg.abs chicken
'The civet bit the chickens.' [laku11]

b. Da-hoo nta **mong-kea** miano.
be-3sg.abs fut av.nf-bite person
'It will bite someone.' [col85] [AuAbmV]

While it is true that the av structure shows a lower degree of transitivity in terms of parameters described by Hopper & Thompson (1980), it is not syntactically antipassive in the analysis where the a-structure consists of two core arguments; that is, the patient NP in (40) is obj, not obl. Additional evidence for this comes from its expression in bare NPs and the fact that obl is prepositionally flagged in Moronene.

In addition to semantic properties, other syntactic evidence in complex constructions such as control properties has been used to argue for an accusative and/or a split ergativity analysis (i.e. acc case for the av patient). For instance, proponents of treating av patient as a core argument (Hsin 1996, Chang 2000) would analyse the phrasal marker *tu* in Kavalan (41) as an accusative case marker, as it phrasally marks the a-object of *pumupup* that functionally controls the subject of the second verb *matiw* 'go'. The argumentation here is that only core status can allow an argument to be the controller.

(41) Kavalan (Chang 1997: 198)
P⟨um⟩upup tina-na **tu sunis 'nay** m-atiw sa Bakung.
⟨av⟩persuade mother-3sg.gen obl child that av-go prep Bakung
'That child's mother persuaded the child to go to Bakung.'

However, the status of controller in the matrix clause may not be decided purely on syntactic grounds since it also depends on the semantic properties of the matrix verb. The control construction in (41) is analysed as the 'influential' type of control, defined by lexical semantic properties (Sag & Pollard 1991), where the controller is the influenced argument (i.e. the persuadee) regardless of its GF. In other terms, the choice of controller is based on the lexical semantics of the control verb that requires an intentional agent in an open clause complement (XCOMP). However, the control verb does not specify that the syntactic properties of the influenced argument are core or oblique.

Instead, it is the status of the controllee in the embedded clause that provides the diagnosis of termhood (Kroeger 1993: 40). Only core arguments can be the controllee, as opposed to OBL arguments. In the Kavalan example (41), the controllee is the SUBJ of a non-finite AV verb *matiw*, so the agent argument in the embedded clause fulfils both syntactic and semantic properties required by the 'influential' type of control. Likewise, in Haian Amis, the core status of the AV agent is evident by its property as the controllee (i.e. AV-SUBJ) as in (42a–b), regardless of its status as the controller (i.e. PV-SUBJ or AV-OBL) in the matrix clause. By contrast, as shown in (42c), it is not acceptable for the AV patient (i.e. *ci Akian* in 42c) in the embedded clause to be the intended controllee.[31]

(42) Haian Amis (Formosan) (Wu 2006: 378–379)

a. Ma-ucur aku ci Aki mi-to'or ci Panay-an.
PV-assign 1SG.GEN PN.ABS **Aki** AV-follow PN Panay-LOC
'I assigned Aki to follow Panay.'

b. Mi-ucur kaku ci **Aki-an** mi-to'or ci Panay-an
AV-assign 1SG.ABS PN Aki-LOC AV-follow PN Panay-LOC
'I am going to assign Aki to follow Panay.'

c. *Mi-ucur kaku ci **Aki-an** mi-to'or ci Panay
AV-assign 1SG.ABS PN Aki-LOC AV-follow PN.ABS Panay
'I am going to assign Aki to be followed by Panay.'

In comparison to other grammatical tests (e.g. 2P clitic placement, pronominal bound forms and DOM), evidence of control in complex constructions for testing the status of non-SUBJ arguments should be examined carefully. That is, using control verbs as the evidence of an accusative analysis of the AV construction necessitates a meticulous evaluation and differentiation between properties of control that have semantic roots and those that are purely syntactic in nature.

At the morphological level, pronominal forms (affixes/clitics) across AN languages show nominative and ergative alignment. In AN languages with robust

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[31] However, Haian Amis differs from Tagalog (Kroeger 1993) and Pazeh-Kaxabu (Yeh in preparation) in that the core status of a PV agent cannot be observed via properties of the controllee.

voice systems, the bound pronouns typically consist of two sets. The first set is often labelled GEN, or ERG under an ergative analysis. This pronominal form is linked to the transitive agent argument in non-AV structures, such as *ku=* and *tu=* in Puyuma in (37), *=na* in Kavalan in (6), and *no-* in Tukang Besi in (32). The second set is the SUBJ/PIVOT form and is typically labelled NOM in the AN literature. This is the thematically unrestricted form that is linkable to any semantic role of a core argument, including the patient core argument of a transitive verb and the intransitive subject. This justifies the labelling of this set as the ABS(olutive) form in an ergative analysis, as exemplified by *-(ho)o* in Moronene in example (40) above. Note that in descriptive works, such as Teng's (2008) description of Puyuma, the second set is also (confusingly) called the NOM(inative) set even though the language shows an ergative alignment property. Morphology and syntax in LFG are separate modules in grammar with case (marking) being dealt with at the morphology-syntax interface (see Bresnan & Mchombo 1987). It is captured through the CASE feature constraint, which is associated with GF linking. Thus, in a language like Puyuma and Pazeh-Kaxabu where there is empirical evidence for ergative alignment (both morphologically and syntactically), a pronominal affix/clitic can be specified as having a CASE feature in its entry: (↑ CASE)=ABS. The grammar of the language can be globally specified as having a conditional if-then constraint: (↑ SUBJ) ⇒ (↑ SUBJ CASE)=ABS. Because this constraint applies to verbs broadly, one way to handle it is by incorporating it into the rule that introduces the clausal c-structure that comes with the SUBJ annotation. This constraint means that if the argument is selected as SUBJ then it must have ABS case. Other pronominal clitics can be specified as having (↑ CASE)=ERG in their entries for languages like Puyuma, and specifically for the agent a-subject argument of a transitive predicate. However, for other languages that show a SUBJ fixed linking with NOM-ACC alignment, as in Kambera (Klamer 1998: 73), a different specification must be given for the pronominal clitic linked to the transitive agent argument, namely (↑ CASE)=NOM.

For non-pronominal forms, the semantic and syntactic information throughout the system can be specified in the entry for phrasal markers.[32] This applies to the differential OBJ and OBL marking, noting that we extend DOM to include OBL marking as well). For simplicity, only one marker of DOM is exemplified below

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[32] The term 'phrasal markers' finds frequent usage in AN linguistics, especially when characterizing Philippine-type AN languages. These markers, like *na* and *kana*, which mark SUBJ and definite OBL relations in Puyuma (as seen in example (37a)), tend to manifest in diverse forms across various AN languages. They are often labelled differently by different authors depending on their analysis, such as clitics, case markers, non-/personal markers, or prepositions (Himmelmann 2005: 144–149).

in (43). DOM across languages commonly draws on different semantic properties. In LFG, these semantic features can be specified together with the semantic case value without affecting the syntactic status of the argument (Butt & King 1991, 2003, Dalrymple & Nikolaeva 2011).

In Pazeh-Kaxabu, DOM encodes the differential information related to the topicality and specificity/definiteness of P (Yeh in preparation). For example, in the AV structure in (43a), P is realised as OBL due to the ergative system and is flagged by *u* because the referent is definite and topical (reading [i]) or specific indefinite (reading [ii]). The non-specific indefinite P (cf. example 10b) is realised by an unmarked bare NP.

Extending from the classic, integrated i- and f-structure (cf. Bresnan & Mchombo 1987) we represent the simplified lexical entry of the phrase marker *u* in (43b). It specifies a constraint that the noun phrase flagged by *u* must be OBL whose CASE is LOC. In addition, it imposes a disjunctive specification with two options capturing the two readings in (43a). The first option in reading (i) reflects sharing of the values of OBL argument and TOPIC. This is shown in the partial f-structure in (44a) where the reference is definite and specific (cf. Enç 1991; see also von Heusinger 2002 for the distinction and interaction of definiteness and specificity). The (partial) f-structure for reading (ii) is given in (44). It captures the crucial difference in that there is no sharing as the OBL is indefinite and not TOPIC. The empirical fact about having in-/definite readings in the OBL argument (cf. also the Paiwan example in (39) above) is elegantly shown without assuming syntactic status to be determined by semantic property.

(43) Pazeh-Kaxabu (Li & Tsuchida 2002: 169)

a. … babaxa u kia'aren a arim.
AV.give LOC pretty LNK peach
(i) '… gave the pretty peach(es).' or
(ii) '… gave certain pretty peaches.'

b. *u* (OBL ↑)
(↑ CASE)=LOC
{(TOPIC ↑) (↑ DEF)=+ (↑ SPEC)=+
| (↑ DEF)=− (↑ SPEC)=+ }

(44)

a. $$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{give}\langle\ldots\ \textsc{obl}\rangle\text{’} \\ \textsc{topic} & \\ \textsc{obl} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{peach}\text{’} \\ \textsc{adjunct} & \left\{\left[\textsc{pred}\ \text{‘}\textsc{pretty}\text{’}\right]\right\} \\ \textsc{def} & + \\ \textsc{spec} & + \end{array}\right] \end{array}\right]$$

b. $$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{give}\langle\ldots\ \textsc{obl}\rangle\text{’} \\ \textsc{obl} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{peach}\text{’} \\ \textsc{adjunct} & \left\{\left[\textsc{pred}\ \text{‘}\textsc{pretty}\text{’}\right]\right\} \\ \textsc{def} & - \\ \textsc{spec} & + \end{array}\right] \end{array}\right]$$

There are AN languages showing properties of split intransitivity or split-S. The split can be reflected in the argument pronominal marking, as in Acehnese (Durie 1987), or the morphological marking on verbs, which correlates with the properties of semantic roles as well as lexical-aspectual properties. Acehnese, for example, is an AN language with systematic clitic sets that cross-reference A(ctor) versus U(ndergoer) roles (Durie 1987). It has a split/fluid S or active system, as seen in examples (45)-(46) below. subj in Achenese is, therefore, semantically very transparent and not a neutralised or syntactic subj/pivot as seen in Philippine/Indonesian types. It is not uniquely picked up by a set of morphosyntactic behavioural properties, such as ‘control’ (see Section 5.1). LFG is well-equipped to handle such kinds of split transitivity (cf. Zaenen 1993; Arka 2003a). For example, the A and U clitics must have a linking constraint specified in their lexical entries, as shown in (45c) and (46c), respectively. The sigma metavariable ($\uparrow_\sigma$) in the entries ensures the correct mapping or correspondence between semantic a-structure and f-structure, so the constraint represented as ($\uparrow_\sigma$ a) in (45c) states that semantically *geu* must be Actor). In addition, the specification (↑ subj) for *geu* also ensures that it is associated with subj. However, the undergoer or P clitic, *geuh*, must have a disjunctive specification to capture the fact that a sole argument (S, or subj) of an intransitive verb has the same form as the undergoer (P, or obj) in a transitive clause (i.e. S_P/P pattern of the split).

(45) Cross-reference Actor (Acehnese, WMP, Indonesia) (Durie 1987: 366)

a. Gopnyan **geu**=mat lôn.
3 3a=hold 1sg
‘S/he holds me.’

b. **Geu**=jak gopnyan.
3A=go 3
'S/he goes.'

c. *geu* CL (↑ PRED)='PRO'
(↑ PERS)=3
(↑ NUM)=SG
(↑ SUBJ)$_\sigma$= (↑$_\sigma$ A)

(46) Cross-reference Undergoer (Acehnese) (Durie 1987: 369)

a. Gopnyan ka lôn=ngieng=(**geuh**).
3 IN 1SG.A=see(=3P)
'I saw him/her.'

b. Gopnyan rhët(=**geuh**).
3 fall(=3)
'S/he falls.'

c. *geuh* CL (↑ PRED)= 'PRO'
(↑ PERS) = 3
(↑ NUM) = SG
(↑ {SUBJ|OBJ})$_\sigma$ = (↑$_\sigma$ P)

This section has demonstrated how AN languages differ in their development of the voice system, and how they also show variation in the realisation of grammatical functions and DOM patterns. The theoretical advances in LFG studies —such as the inventory of GFs, the syntacticised a-structure, the overlay function PIVOT, and the specifications of case, information status and referential semantics—have shown advantages in capturing some patterns in AN languages that have long been controversial.

5 Complex constructions

Following the discussion of word order and the basic notions of how AN morphosyntax is represented in LFG, we now move on to some complex constructions. In this section, we highlight two salient features of complex structures in AN languages which are of long-standing theoretical and typological interest: complementation that involves argument gapping or control in the embedded clause, and complex predication with a particular focus on SVCs.

5.1 Complementation and control

Complement clauses are object-like clausal arguments which, for certain matrix verbs, may be syntactically peripheral or oblique-like. Formally, and in LFG terms, they are realised as comps (finite clauses) and xcomps (non-finite clauses with syntactic subj-control). The distinction between comp and xcomp and their core status may not always be easy to identify. In what follows, we outline clear cases of (x)comps and their syntactic status.

Languages with robust voice morphology provide a diagnostic tool to determine the core status of (x)comp. For example, in Indonesian-type languages, only a core argument can be selected as subj/pivot, and a peripheral oblique/adjunct-like argument must be promoted to become a core argument in order to be realized as subj. This is the case with the Balinese verb *edot* 'want'. It is a two-place intransitive verb with the second argument being either a simple oblique argument appearing as a PP, like in (47a) below, or an xcomp (without P-flagging) as in (47b). In both cases, the applicative *-ang* cannot be used. However, when an embedded clause is fronted and given the discourse function focus-c (i.e. made the pivot/subj), as in (47c), the applicative *-ang* is obligatory; the verb *edot=a* is unacceptable. Note, however, that the matrix verb must be in uv since the av form *ng-edot-ang* 'av-want-appl' is unacceptable. That is, the clausal argument is treated as a non-Actor core argument. The obligatory applicativisation serves as evidence that the second clausal (comp) argument with *edot* is syntactically oblique-like in (47b), but a core argument in (47c).

(47) Balinese (Arka 2003b: 135)

a. Ia edot / *edot-ang [teken poh]$_{\text{OBL}}$.
   3 want want-appl to mango
   '(S)he wants a mango.'

b. Ia edot / ?*edot-ang [__ ngae umah luung]$_{\text{XCOMP}}$.
   3 want want-appl subj av.build house good
   '(S)he wants build a good house.'

c. [__ Ngae umah luung]$_{\text{PIVOT}}$ (ane)
   subj av.build house good foc
   edot-ang=a/*edot=a/*ng-edot-ang.
   uv.want-appl=3
   'Building a good house is what s/he wants.'

However, xcomp can also be a core argument. This is the case with the xcomp of the verb *coba* 'try' in Indonesian in (48a) below. In Indonesian, like in Balinese, an OBL cannot alternate with SUBJ/PIVOT without applicativisation. The XCOMP of the verb *coba* can, however, alternate to become SUBJ/PIVOT without applicativisation, as seen in (48b). Note that *coba* 'try' allows different patterns of control, including the so-called double (backward/forward) control given in (48c). This double control structure shows two gaps—left-headed and right-headed arrows indicate backward and forward control types, respectively (see Arka 2000 and Arka 2014a for details).

(48) Indonesian (Arka 2014a: 31 and own knowledge)

a. Aku sudah mencoba [__ menjual mobil itu]$_{\text{XCOMP}}$.
1SG PFV AV.try AV.sell car that
'I have tried to sell the car.'

b. [__ Menjual mobil itu]$_{\text{PIVOT}}$ yang sudah ku=coba.
AV.sell car that FOC PFV 1SG=UV.try
'Selling the car is what I have tried (to do).'

c. [Mobil itu]$_{\text{PIVOT}}$ (yang) sudah __ coba [__ ku=jual]$_{\text{XCOMP}}$.
car that FOC PFV (A) UV.try (P) 1SG=UV.sell
'That car (is the one that) I have tried to sell.'

The clausal argument of a raising verb can also have an XCOMP with the raised argument being obligatorily SUBJ. The following shows the (unusual) SUBJ raising to matrix OBL in Puyuma. In (49a) below, the clausal complement of the verb 'know' is COMP. It is syntactically non-core since it is flagged by *dra* (i.e. the indefinite OBL phrase marker; glossed as a complementiser for clarity here). The patient NP 'the fish' (indicated in bold) is selected by the PV *-aw* on the verb as SUBJ, and present in the embedded clause. In (49b), however, the SUBJ is raised and appears as OBL in the matrix clause, flagged by *kana*. Note that raising in (49b) is not possible with an embedded verb containing the voice suffix, *-anay*, since this selects an instrumental argument instead.

(49) Puyuma (Teng 2008: 153-154)

a. Ma-ladram=ku [dra tu=lriputr-**aw** **na** **kuraw**
INTR-know=1SG.NOM COMP 3GEN=wrap-PV DEF.NOM fish
dra bira']$_{\text{COMP}}$.
INDF.OBL leaf
'I know that the fish was wrapped in a leaf.'

b. Ma-ladram=ku **kana** **kuraw** [dra tu=lriputr-**aw**/
intr-know=1sg.nom def.obl fish comp 3gen=wrap-pv/
*tu=lriputr-**anay** dra bira']$_{\text{XCOMP}}$
3gen=wrap-iv indf.obl leaf
'I know that the fish was wrapped in a leaf.'

In the indexing AN languages of eastern Indonesia and Oceania, the subj (bound) pronoun is typically part of the verbal morphology and cannot be gapped. subj is not a syntactic pivot for clause combining purposes in these languages. There is, therefore, no syntactic control or raising. Clausal arguments are consistently comps with no xcomp alternative. This is the case in Taba in (50), and Mangap-Mbula in (51):

(50) Taba (CEMP, Eastern Indonesia) (Bowden 2001: 391)
Nculak wangsi de lmul akle.
n=sul-ak wang=si de l=mul ak-le
3sg=order-appl child=pl res(so.that) 3pl=return all-land
'He told the children to go home.'

(51) Mangap-Mbula (Oceanic) (Bugenhagen 1995: 272)
Ti-maŋmaŋ yo [be aŋ-kam pizin].
subj:3pl-urge obj:1sg comp subj:1sg-do dat.3pl
'They urged me to give it to them.'

Despite their rarity, some Oceanic languages with indexing systems, such as Hoava (Davis 2003), Longgu (Hill 2002), and Kokota (Palmer 1999), have syntactic subj/pivot. In Hoava, the index on the verb is only for obj. This language shows comp, as in (52a), as well as xcomp like in (52b). Complement-taking predicates in Hoava come with an invariant obj index *-a* which signals that there is an embedded complement clause in the structure.

(52) Hoava (Oceanic) (Davis 2003: 288)

a. Hiva-ni-a ria [de pule mae sa qeto]$_{\text{COMP}}$.
want-appl-obj:3sg 3pl comp return come art:sg war.party
'They wanted the war party to come back.'

b. Haku=haku-ni-a ria [de naqali-a]$_{\text{XCOMP}}$.
redup=be.tired.of-appl-obj:3sg 3pl comp carry.tr-obj:3sg
'They were tired of carrying it.'

5.2 Serial Verb Constructions

SVCs are the hallmarks of AN languages of the isolating type and are observed in the languages of eastern Indonesia, such as Rongga (Arka 2016), and also in Oceanic languages, as discussed below. Some SVCs are also encountered in the agglutinating Philippine/Indonesian-type languages, including Balinese (Indrawati 2014) and Puyuma (Teng 2008).

Unlike complementation, SVCs syntactically express complex (sub)events in monoclausal structures (Crowley 2002, Haspelmath 2016). Semantically, the relations between subevents typically convey adverbial modification with meanings such as comitative, benefactive and instrumental. However, they may also express other tightly integrated meanings often discussed under the rubric of complex predicates (see Arka & Simpson 2008). For example, the SVC expresses the desiderative 'want' (i.e. 'feel-say') in Ambae in (53), and the causative and resultative meaning in Rongga in (54) and Mwotlap in (55).

(53) Ambae (Oceanic) (Hyslop 2001: 387)
No=mo rongo vo na=ni qalo.
SUBJ:1SG=REAL feel say SUBJ:1SG=IRR fight
'I want to fight.'

(54) Rongga (Arka 2016: 227)
Selu tau mata manu ndau.
Selu make die chicken that
'Selus killed the chicken.'

(55) Mwotlap (Oceanic) (François 2006: 232)
Ne-lēn mi-yip hal-yak na-kat.
ART-wind PRF-blow fly-away ART-cards
'The wind blew the cards away.'

SVCs can be analysed in LFG in the same way as complex predicates through predicate composition (Andrews & Manning 1999). The exact c-structure varies according to the language considered, but it is typically a compound-like nested structure: $[\mathrm{V(P)}_1\ \mathrm{V(P)}_2]_{\mathrm{V(P)}}$. That is, there is a higher VP consisting of lower VPs in the c-structure. The crucial idea of the analysis is to capture the empirical fact that the SVC is monoclausal; that is, the V(P) component(s) share the same SUBJ, and possibly another argument, depending on the transitivity of V_1 and V_2 verb components.

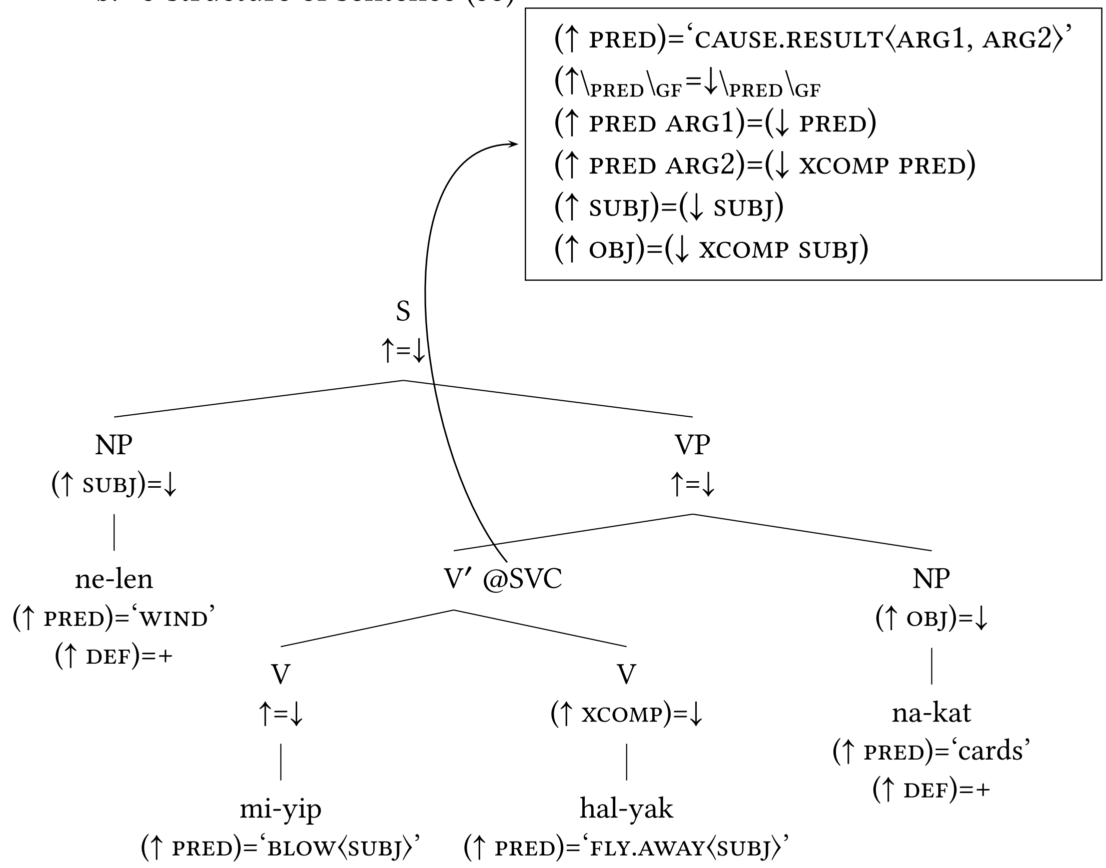
SVCs also reveal an intriguing and important property of the construction, exemplified by the Mwotlap example in (55). The causative-resultative meaning is constructed at the level of SVC because neither V_1 nor V_2 carry a causative-resultative meaning lexically. That is, the syntactic transitivity is constructional because neither V_1 nor V_2 is transitive. In LFG, such resultative constructions, as in example (55), can be captured by lexical-constructional a-structure, indicated by the SVC template, @SVC, annotated to V′ of the VP in (56b). The template consists of complex equations given in the box showing the constructional predicate of ‘cause.result⟨arg1, arg2⟩’ (where arg1 is the causing event and arg2 is the resulting event). The restriction operator expressed by $\uparrow\backslash_{\text{PRED}}\backslash_{\text{GF}}=\downarrow\backslash_{\text{PRED}}\backslash_{\text{GF}}$ (Kaplan & Wedekind 1993) regulates the predicate composition involved in the SVC; see Butt et al. (2003) for the application of the restriction operator in Urdu/Hindi and other languages. This restriction operator and the other constraints associated with @SVC result in an f-structure with the subcategorisation frame shown in (56a).

Note that, in the resultative SVC of (56b), the obj annotation is specified at the NP of the higher VP, sister of V′, of the c-structure since it is the obj argument of the constructed causative-resultative predicate; neither V1 nor V2 has obj. The @SVC template (with detailed specifications provided in the box) specifies that the SVC's obj has the same value as the lower V2's subj, and the SVC's subj has the same value as the subj of V1. This sharing of values for subj and obj is indicated through tags [1] and [2] in (56a).

(56) a. f-structure of sentence (55)

$$\left[\begin{array}{ll} \text{PRED} & \text{‘CAUSE.RESULT}\langle\text{SUBJ}[1]:\text{‘BLOW}\langle[1]\rangle\text{’},\ \text{OBJ}[2]:\text{‘FLY.AWAY}\langle[2]\rangle\text{’}\ \rangle\text{’} \\ \text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘WIND’} \\ \text{DEF} & + \end{array}\right] \\ \text{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘CARDS’} \\ \text{DEF} & + \end{array}\right] \end{array}\right]$$

b. c-structure of sentence (55)



However, the distinction between mono-clausal SVCs and bi-clausal subordination is not always clear. A typical diagnostic test for SVCs is negation: since SVCs are monoclausal, the criterion of single negatability applies (Durie 1997). There are also other language-specific criteria that distinguish SVCs from multi-verb constructions in coordinate and subordinate clauses. In Balinese, for example, the presence/absence of voice morphology serves as a diagnostic criterion. The second verb in an SVC may optionally contain an AV prefix, indicated by putting the AV prefix in brackets in (57a): *(ng)ajak*. The absence of the AV prefix (i.e. *ajak*) gives rise to a comitative reading only, as shown by reading (i) in (57a); this is a comitative SVC in Balinese. In contrast, the presence of the AV prefix, *ngajak*, leads to an ordinary coordination, which requires a syntactic PIVOT, as in reading (ii) in (57a). The presence of the clausal negator, *tan* ‘not’, in (57b) forces the coordination structure, which requires SUBJ PIVOT marking. Hence, the presence of an AV prefix on the verb in the second clause is obligatory, as seen in (57b).

(57) Balinese (Shiohara & Arka 2023)

a. Tiang [mlajah kelompok (ng-)ajak timpal-timpal-e]$_{\text{SVC}}$.
   1sg mid.study group (av-)invite friend.redup-def
   (i) 'I studied in a group together with friends.' (with *ajak*)
   (ii) 'I studied in a group and invited friends to join.' (with *ngajak*)

b. Tiang [mlajah kelompok], [tan ngajak/*ajak Ketut].
   1sg mid.study group neg av.invite/invite Ketut
   'I studied in a group, (but) I didn't invite Ketut (to join).'

In addition, the prosody is different: the SVC in (57a) with the bare verb, *ajak*, has one intonational contour (i.e. without a break), while the coordination in (57b) has a break indicated by a comma after the first VP (cf. prosodic properties of mono-/bi-clausality in Aikhenvald 2006: 7, Dixon 2006: 339, Haspelmath 2016: 308) Likewise, sentence (57a) in its non-SVC or bi-clausal reading (ii) is also accompanied by a prosodic break before the av verb.

6 Discourse information structure: Contrastive focus and nominalisation

In this final section, we consider the interface between information structure and morphosyntax in AN languages. Recall from Section 3 that contrastive discourse functions are a crucial factor that motivate syntactic variation for fronting. Fronting is of special interest since it involves clefting, which is closely bound with the subj-only restriction on extraction in many AN languages with robust voice systems (cf. Section 4.2.2).

In this section, we look thoroughly at the connection between contrastive dfs and the syntactic structure of clefts from a comparative perspective and demonstrate how cross-linguistic variation can be captured in LFG. We begin by introducing the basic notions of discourse features in information structure (Zaenen 2023 [this volume]) with a primary focus on focus-c because in many AN languages, focus-c is the most common discourse function associated with clefting. Then, we move on to show how focus-c expressions via clefting are structured differently across languages.

The pragmatic uses of clefting in expressing contrastive focus (focus-c) emerge as a motivating factor in the extension of bi-clausal structure across AN languages, as discussed below. In symmetrical-voice languages, bi-clausal clefting is used in combining nominal predicates and headless relative clauses, while indexing-type languages use mono-clausal clefts without relative constructions. The major difference lies in the gradual erosion of clausal nominalisation. We will see that both types of cleft-structures for expressing focus-c (with/without nominalisation) can be elegantly captured in an LFG analysis to reflect the language-specific variation.

6.1 Information structure: focus-c, fronting and cleft

Topic and focus have long been recognized as discourse functions within information structure. However, this traditional dichotomy view falls short of encompassing all the information structure nuances (Zaenen 2023 [this volume]). Decomposing i-structure features is generally adopted in LFG studies. In our analysis, marked dfs (focus-c/topic-c) are represented by three distinct decomposed features, as demonstrated by Arka & Sedeng (2018) and references therein: contrast, salience, and givenness. The [+contrast] feature is central for focus and is exemplified in (58) below. The [+salient] and [+given] features are typically topic-related, encompassing communicatively important properties, such as the particular frame/entity by which new information should be understood (i.e. the ‘aboutness’ of the topic), and the degree of importance/prominence of one piece of information relative to other bits of information in a given context. The [+salient] feature reflects the speaker’s subjective choice of highlighting one element and making it stand out for communicative purposes. While often closely linked, salience and givenness are distinct: for example, new information, [−given], can be [+salient] (see Riesberg et al. 2018 on information structure across AN languages).

focus-c is a marked focus and is typically characterised by overt marking of the conception of alternatives in the contrastive set it is associated with (cf. Krifka 2008). Clefting is a typical ‘marked’ strategy to express focus-c as seen in the English example of (58a): John is a person in the set of referents associated with the subj (i.e. John, not somebody else). The equivalent structure in Indonesian is given in (58b) below:

(58) Indonesian (Arka, own knowledge)
a. It is [John]$_{\text{focus-c}}$ [who killed the robber]$_{\text{vp:comment|given}}$.
b. [(Adalah) John]$_{\text{pred/focus-c}}$ [yang membunuh perampok itu]$_{\text{subj}}$.
be John rel av-kill robber that
‘It’s John who killed the robber.’

Note that English and Indonesian show structural parallelism in their relativisation of the second part of cleft structures, and contrastive focus fronting. Also, they both show clear evidence of biclausal structures with each part having its own predicate. However, Indonesian *adalah* 'be' is optionally present. English requires the empty SUBJ *it*, while Indonesian has no such SUBJ. The fronted NP (*John*) is the predicate, and the (headless) relative with *yang* is actually a (clausal) SUBJ.

6.2 Cross-linguistic variation in fronted FOCUS-C

Fronted content questions in other AN languages of Indonesia also typically employ the same clefting strategy that involves relativisation, including in Indonesian, Sundanese and Sasak as in examples (59)-(61) below. These sentences are biclausal. Note that these languages also allow in-situ mono-clausal content questions with no relativisation required (cf. (59) and (62a) where SUBJ is questioned).

(59) Indonesian (Arka, own knowledge)
[Siapa]$_{\text{PRED/FOCUS-C}}$ [yang membunuh perampok itu]$_{\text{SUBJ}}$?
who REL AV-kill robber that
'Who killed the robber?' (Lit. 'Who is the one who killed the robber?')

(60) Sundanese (Hanafi 1997: 3)
[Sahaʔ]$_{\text{PRED/FOCUS-C}}$ [nu meuliʔ mobil]$_{\text{SUBJ}}$?
who REL AV.buy car
'Who bought a car?'

(61) Menó-Mené Sasak (Arka, fieldwork data)
[Ape]$_{\text{PRED/FOCUS-C}}$ [*(saq) Amir paling wiq]$_{\text{SUBJ}}$?
what REL Amir steal yesterday
'What did Amir steal yesterday?'

(62) Indonesian (Arka, own knowledge)

a. [Siapa]$_{\text{SUBJ}}$ mem-bunuh perampok itu?
who AV-kill robber that
'Who killed the robber?'

b. Orang itu membunuh [siapa]$_{\text{OBJ}}$?
person that AV-kill who
'Who did the person kill?'

c. *Siapa orang itu membunuh __?

Variation in the above clefting strategies reveals the effect of the subj-only constraint on extraction of focus-c and a change in the constraint in some languages. Philippine/Indonesian type languages with robust grammatical voice cannot front the obj q NP in av (mono)clauses (Arka 2003a: 27, Kroeger 1993: 50, 208). This is exemplified by the ungrammaticality of (62c) above, in contrast to the acceptable in-situ question (62b). A voice alternation is obligatory in order for obj q NP fronting to be acceptable because it maps the patient onto the subj, and also allows possible clefting of the type seen in (59).

However, in languages where grammatical voice is in decline or has disappeared (as often observed with the erosion of AV verbal morphology), the strict adherence to the subj-only constraint might be eased. This relaxation could allow for the fronting of the obj q NP. However, this can only occur under the condition that the fronted obj q NP necessitates relativization within a bi-clausal structure. Such a phenomenon is evident in Sasak, as demonstrated in (61). Notably, when obj q is fronted, the relativizer *saq* cannot be omitted.

It should be noted that even when the AN verbal voice is completely lost, syntactic voice is not always lost as well. The languages of western and central Flores, such as highly isolating Manggarai and Rongga, exhibit a syntactic passive or undergoer voice without verbal voice morphology (see Arka & Kosmas 2005 for details). The canonical clausal word order in these languages is SVO, and the fronted q NP also makes use of clefting via relativisation, as seen in Manggarai in (63a) below. In this instance, the fronted q NP is the actor subj. Despite the absence of av verbal morphology, the syntactic structure follows the Actor Voice (av) pattern. Conversely, when the fronted q NP takes on the role of the undergoer, as depicted in (63b), the structure undergoes an alteration to become Undergoer Voice (uv). Here, the actor is expressed in genitive form, which is characteristic of actor realization in the uv voice within AN languages. Note that the verb form in (63a) is identical to that in (63b). However, they are assigned distinct voice glosses (av/uv) to signify that they are part of different voice constructions.

(63) Kempo Manggarai (CEMP, Indonesia)

a. [Cai]$_{\text{pred/focus-c}}$ [ata tengo hau]$_{\text{subj}}$?
who rel av.hit you
'Who hit you? (Lit. 'who is the one hitting you?') (Semiun 1993: 63)

b. [Cai]$_{\text{pred/focus-c}}$ [ata tengo gau]?
who rel uv.hit 2gen
'Who did you hit?' (Semiun 1993: 64)

The above discussion has shown how the different morpho-syntactic systems in AN languages are structurally connected in a bi-clausal structure with relativisation. Unlike Philippine/Indonesian type languages, a relaxed constraint on extraction is witnessed in the loss of voice morphology in languages like Manggarai, Flores. In the latter, fronting of a non-SUBJ argument is possible without the need for voice alternation.

The obligatory relativisation in fronted question NPs discussed so far brings us to the important interconnection between FOCUS-C, relativisation, voice and nominalisation. This interconnection is evident in that the AN relative clause used for fronted FOCUS-C is transparently nominal in its structure. Typically, and formally, the relativiser is a nominal phrase marker and thus, the marker is multifunctional. In Tagalog, for instance, the relativiser is the NOM marker for an ordinary NP (see (23)), but also for a verb when its SUBJ is in FOCUS-C in the content question (see (64)). Likewise, marked FOCUS-C in declarative sentences —as seen in Indonesian-type languages like Old Javanese in (65)—also use the same nominalisation strategy through relativisation. The same form *ikang* in (65) is also used as a definite determiner in Old Javanese. The NP flagged by *ang* in Tagalog also receives a definite interpretation. Based on these functional correspondences, we contend that Tagalog *ang*, Old Javanese *ikang*, and the Indonesian pronominal relativiser *yang* are clearly cognates (Kähler 1974: 266–267; Blust 2015: 465; Kaufman 2018: 228–229).

(64) Tagalog (Kaufman 2018: 219)
[Sino]$_{\text{PRED}}$ [ang d⟨um⟩ating]$_{\text{SUBJ}}$?
who NOM ⟨AV⟩arrive
'Who arrived?' (Lit. 'the coming one is who?')

(65) Old Javanese (WMP, Indonesia) (Erawati 2014: 150)
Ikang naga Taksaka [ikang s-um-ahut wwang atuha-nira].
DEF dragon Taksaka REL ⟨AV⟩bite person old-3SG.POSS
'The Taksaka dragon is the one who bit his parent.'

The same pattern of nominalisation involving a fronted FOCUS-C is observed across Philippine-type languages as shown in Table 1. These languages also use the same nominalisation strategy through relativisation. Crucially, there are two morphosyntactic properties worth noting. First, only SUBJ can be fronted as FOCUS-C. Thus, when the transitive patient is in FOCUS-C, the PV must be used, as seen in Table 1. Second, the agent argument of the PV verb is expressed in the genitive, which is the realisation of the possessor in the nominal structure.

Table 1: SUBJ FOCUS-C across the Philippine-type languages (Kaufman 2018: 220)

Tagalog	*maŋga*	*aŋ*	*kina:ʔin*	*naŋ*	*ba:taʔ*
Bikolano	*maŋga*	*aŋ*	*kinakan*	*kan*	*a:kiʔ*
Cebuano	*maŋga*	*aŋ*	*ginka:ʔun*	*han*	*bataʔ*
Hiligaynon	*pahuʔ*	*aŋ*	*kinaʔun*	*saŋ*	*ba:ta*
Tausug	*mampallam*	*in*	*kyaʔun*	*sin*	*bataʔ*
Ilokano	*maŋga*	*ti*	*kinnan*	*dyay*	*ubiŋ*
Ibanag	*maŋga*	*ik*	*kinan*	*na*	*abbiŋ*
Pangasinan	*maŋga*	*su*	*kina*	*=y*	*ugaw*
Kapampangan	*maŋga*	*iŋ*	*pe:ŋa=na*	*niŋ*	*anak*
	[mango]$_{focus\text{-}c}$	*[NOM*	*eat.PV.PFV*	*GEN*	*child]*$_{SUBJ}$

‘It was the mango that the child ate.’
(Lit. ‘the mango was the one eaten by the child.’)

The pattern showing the genitive agent in the fronted FOCUS-C with relativisation is also observed in the languages of western Flores, such as Manggarai (Semiun 1993). Recall that Manggarai is highly isolating, but it has a genitive clitic set usable in fronted FOCUS-C questions. Note that the Q *cai* in (66) below is associated with the transitive patient; questioning the agent SUBJ requires no genitive clitic (cf. Kambera example (21) above with (67a) below).

(66) Kempo Manggarai (Semiun 1993)
Cai (ata) tengo gau?
who REL hit 2SG.GEN
‘Who did you hit? (Lit. ‘who is your hitting?’)

In AN languages of the indexing type, the resources for FOCUS-C may also be parasitic to nominalisation/relativisation coding whereby the focused argument ends up being fronted sentence-initially. For example, the Kambera example in (67a) is a content question (FOCUS-C) with equational structure: the verb is affixed with the subject relativiser *ma-* and the verb appears within a nominal (headless) relative clause structure. The nominal article *na* flags the structure as an NP. The same pattern is observed in (67b), where the patient argument is FOCUS-C. Like in Manggarai and Philippine-type languages, the agent in Kambera in (67b) appears as a genitive too, which is the same case as used for the possessor of an NP.

(67) Kambera (Klamer 1998: 132, 318)

a. Ngga [na ma-palewa-kai] hi mài lai nai?
who art relS-send-2pl.acc cnj come loc dem
‘Who was the one that send you so that you’d come here?’

b. [Da kalembi-da]$_k$ [na pa-pa.marihak-na$_j$ nyuna$_j$]$_{\text{subj}k}$.
art shirt-3pl.poss art relO-caus.be.dirty-3sg he
‘Their shirts$_k$ were (the ones) made dirty by him$_j$.’

In the languages of Sulawesi, such as Makassarese, where unmarked structures are predicate-initial (like in Philippine-type languages), focus-c formation also requires fronting (Jukes 2006: 341–345). However, while relativisation uses a nominalisation strategy by means of the definite clitic *=a* as seen in (68a), the focus-c formation requires no nominalisation as seen in (68b–c). Makassarese exhibits systematic pronominal indexing, but it still shows the AN voice system. Thus, when agent subj is in focus-c, it requires the homorganic nasal substitution av prefix on the verb (*aN-* realised as *am-*) as in (68d). Crucially, the sentences with fronted focus-c NPs in (68b–d) are monoclausal.

(68) Makassarese (WMP, Indonesia) (Jukes 2006: 238, 343, 353)

a. [tau [na=buno=a sorodadu]$_{\text{RC}}$]$_{\text{NP}}$
person 3=kill=def soldier
‘the person killed by a soldier’

b. Miong=a na=buno kongkong=a.
cat=def 3=kill dog=def
‘The dog killed the cat (not something else).’/ ‘It’s the cat that the dog killed.’

c. Inai na$_i$=ba’ji [i Ali]$_i$?
who 3=hit pn Ali
‘Who did Ali hit?’

d. Inai am-ba’ji=i i Udin?
who av-hit=3 pn Udin
‘Who hit Udin?’

6.3 Representing information structure in LFG

LFG is well equipped to capture the language-specific variation in fronted focus-c discussed here. There are two kinds of analysis: the (earlier) integrated f-structure analysis (Bresnan & Mchombo 1987, King 1995, among others) and the more recent independent i-structure analysis (Butt & King 1996, Dalrymple & Nikolaeva 2011, among others). In the first analysis, dfs are part of the f-structure and share their values (fully or partially) with argument gfs in the f-structure due to the extended coherence condition (Zaenen 1980) or their anaphoric relation. This analysis is straightforward for cases involving focus-c with no requirement for nominalisation, as in the Makassar examples of (68b–d). Here, the sentences are mono-clausal, and the fronted argument is functionally not the head predicate. For the analysis to work, the sentence-initial XP is identified as focus-c and is licensed by the phrase structure rule shown in (69a) below:

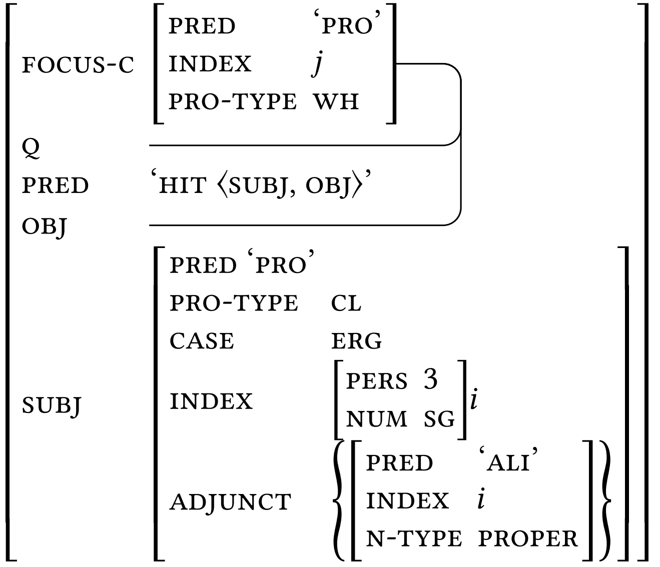
(69) a. CP ⟶ XP C′
$(\uparrow \textsc{focus-c}) = \downarrow$
$(\uparrow \textsc{focus-c}) = (\uparrow \textsc{gf})$

b. Makassarese Voice Marking:
  i) av, *aN*-: $(\uparrow \textsc{focus-c}) = (\uparrow \textsc{subj})_\sigma = (\uparrow_\sigma \text{ 1:agent})$
  ii) pv, Clitic_A=: $(\uparrow \textsc{focus-c}) = (\uparrow \textsc{obj})_\sigma = (\uparrow_\sigma \text{ 2:patient})$

The two lines of annotation in (69a) impose a sharing between focus-c and any gf, including adjunct. However, there are also other independent language-specific voice selection constraints given in (69b) to regulate how a core argument is selected as subj/obj in Makassarese, particularly when this core argument is also assigned focus-c. Therefore, in light of the rule given in (69b.ii), the example in (68c) (cf. the same example in (70) below) will have the focus-c selected as obj. The f-structure is shown in (71) below. We analyse the free NP, which cross-references the agent proclitic, as an adjunct that provides specific information about the agent.

(70) Makassarese (Jukes 2006: 353)
inai$_j$ na$_i$=ba'ji [i Ali]$_i$?
who 3=hit pn Ali
'Who did Ali hit?'

(71) f-structure of sentence (70)



The integrated f-structure analysis just outlined for Makassarese faces an issue when it is applied to fronted focus-c involving bi-clausal or relative clause nominalisation as in Indonesian, as illustrated in (58b), reproduced as (72) below. This is because the focus-c unit is the predicate (cf. the Russian examples discussed by King 1997). One way of resolving this issue is to separate f-structure from i-structure in order to focus on the pred value only and not its gfs.[33] Since space precludes a full discussion of a separate i-structure analysis in this chapter, we instead demonstrate an integrated f-structure analysis of the fronted q in Indonesian in (72) below, through the double-tier predlink analysis. This analysis is typically used for the non-verbal predicate with the copula ‘be’ (Butt et al. 1999, Dalrymple et al. 2004). The (simplified) f-structure in (73) for example (58), repeated in (72), shows that the fronted q is the focus-c predlink.

(72) Indonesian
[(Adalah) John]$_{\text{PRED/FOCUS-C}}$ [yang membunuh perampok itu]$_{\text{SUBJ}}$.
be John rel av-kill robber that
‘It’s John who killed the robber.’

---

[33] The independent i-structure with a set df value also allows more than one element in focus. This analysis requires a different df annotation in the PS rule. The independent i-structure analysis also adopts more sophisticated i-structure conceptions (e.g. with fine-grained distinctions of internal units, such as topic/focus types and background/given. See King 1997, Dalrymple & Nikolaeva 2011, Butt 2014).

(73) f-structure of sentence (72).

$$\left[\begin{array}{ll}
\text{PRED} & \text{‘BE}\langle\text{SUBJ, PREDLINK}\rangle\text{’} \\
\text{SUBJ} & \left[\begin{array}{ll}
\text{PRED} & [1]\,\text{‘PRO’}\\
\text{INDEX} & i \\
\text{ADJUNCT} & \left\{\left[\begin{array}{ll}
\text{PIVOT} & \left[\begin{array}{ll}\text{PRED} & [1]\\ \text{INDEX} & i\end{array}\right]\\
\text{PRED} & \text{‘KILL}\langle\text{SUBJ OBJ}\rangle\text{’}\\
\text{SUBJ} & \rule{6em}{0.4pt}\\
\text{OBJ} & \left[\text{PRED ‘THE ROBBER’}\right]\\
\text{CL-TYPE} & \text{REL}
\end{array}\right]\right\}
\end{array}\right]\\
\text{PREDLINK} & \left[\begin{array}{ll}\text{PRED} & \text{‘JOHN’}\\ \text{INDEX} & i\end{array}\right]\\
\text{FOCUS-C} & \rule{6em}{0.4pt}
\end{array}\right]$$

In this analysis, John in (72) is part of the (fronted) PREDLINK (Butt et al. 1999), which is introduced by the copular verb *adalah*.[34] In the absence of *adalah*, the analysis specifies the existence of an unpronounced copular verb in the c-structure. The FOCUS-C in the c-structure is occupied by the fronted PREDLINK and so PREDLINK and FOCUS-C share the same value. This connection is signified by the curved lines in (73). Note that the subject is a headless RC marked by *yang*. The headless RC contains [PRED ‘PRO’] (tag [1]) supplied by the pronominal relativiser *yang*.[35] It is coreferential with the SUBJ/FOCUS-C (i.e. PIVOT) of the RC, and the fronted complement predicate, John (indexed i).

The difference between two types of FOCUS-C fronting in indexing-type and symmetrical-voice type languages is captured in LFG by the distinct f-structures in (71) and (73). The f-structure of the indexing type (e.g. Makassarese) in (71) shows a single functional clausal PRED head (i.e. syntactically monoclausal). The Q, *inai* ‘who’, functions as the question (Q) operator, also identified as FOCUS-C and OBJ (i.e. sharing the same value). In contrast, the f-structure of the Indonesian cleft in (73), which represents the symmetrical-voice type, shows a bi-clausal structure in which the matrix PRED is the copula ‘BE’ and the embedded relative clause’s functional head is ‘KILL⟨SUBJ, OBJ⟩’. Its SUBJ is identified as FOCUS-C via anaphoric relation (represented by index i).

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[34] In LFG, there is more than one way of analysing non-verbal predicates (e.g. nominal predicates) depending on language-specific properties: a single-tier or double-tier analysis. See Andrews (1982), Butt et al. (1999) and Dalrymple et al. (2004) for further discussion.

[35] [PRED ‘PRO’] should be optionally specified in the lexical entry of *yang*. It shows up in the headless RC, but it is not needed in the headed RC as the RC’s head noun supplies the PRED value.

To conclude, grammatical variation in FOCUS-C fronting in AN languages can be straightforwardly captured in LFG because of its modular design. In such a design, different dimensions of linguistic information are modelled in separate layers of structure. We have demonstrated how the separation of syntactic representation of linear order (c-structure), relational information about grammatical functions (GFS, or f-structure) and context-related Discourse Function (DF) information (i-structure) makes LFG well suited for explicit linguistic analysis to account for the complex constraints in the interface of morphosyntax and pragmatics.

7 Final remarks

In this chapter, we reviewed a broad range of empirically attested morphosyntactic properties in AN languages. We demonstrated how the parallel correspondence architecture of LFG is used to capture the typological diversity of AN languages at different levels of the grammar. Some of these features have posed descriptive and analytical challenges to traditional grammatical notions. Despite these challenges, LFG emerged as a robust and flexible framework for capturing the dynamics of AN languages' internal grammatical systems and the variation between them. This allows us to account for the AN voice system and related grammatical features in a holistic and coherent way. Further, the application of LFG in AN languages plays a crucial role in increasing the framework's potential to be a well-rounded descriptive and analytical tool for typological and theoretical discussions. Thus, additional documentation of AN languages is expected to uncover richer datasets and linguistic diversity, which will provide an ideal testing ground for LFG's grammar-representing architecture.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

2P	Second position	mid	Middle Voice
AN	Austronesian	nf	nonfinite
av	Actor Voice	PMP	Proto-Malayo-Polynesian
CEMP	Central-Eastern Malayo-Polynesian	pn	Proper Name
cn	Common Noun	predfoc	Predicate Focus
cnj	Conjunction	prep	Preposition
cv	Conveyance Voice	prt	Particle
df	Discourse Function	pv	Patient Voice
DOM	Differential Object Marking	RC	Relative Clause
dv	Dative Voice	real	Realis
focus-c	Contrastive Focus	redup	Reduplication
gen	Genitive	relO	Object relativizer
gr	Grammatical Relation	relS	Subject relativizer
in	Inchoative	svc	Serial Verb Construction
iv	Instrumental Voice	uv	Undergoer Voice
lnk	Linker	WMP	Western Malayo-Polynesian
lv	Locative Voice		

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Chapter 29

LFG and Celtic languages

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This chapter presents an overview of LFG studies on grammatical phenomena in two of the Celtic languages, Irish and Welsh. While there is less work on the Celtic languages in LFG compared to other theories, the studies we have touch on important topics in any linguistic theory or language study, such as word order, grammatical functions, agreement and verbs of existence. The chapter is structured accordingly, and discusses issues such as the presence or absence of a VP, impersonal and passive verb forms, relative clauses and unbounded dependencies, verbal agreement, and the syntax of the Irish copula verb. The Celtic languages are minority languages, and the chapter is framed by reflections on the challenges inherent in studying languages in that situation.

1 Introduction

1.1 The Celtic languages

Historically the Celtic languages are divided into Continental Celtic and Insular Celtic. For the Continental Celtic languages such as Gaulish and Celtiberian, very little is attested. Insular Celtic is normally divided into two branches, the Gaelic or Goidelic group containing Irish, Scottish-Gaelic and Manx, and the British or Brythonic group consisting of Welsh, Breton and Cornish. The Goidelic and Brythonic languages are sometimes referred to as Q Celtic and P Celtic respectively, reflecting the development of Indo-European */k^w/ into /k/ in the Goidelic languages and /p/ in the Brythonic languages (Schmidt 2002: 68).

All the modern-day Celtic languages are minority languages influenced by the strong presence of either English or French as the majority language. While there

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are movements to revive Cornish and Manx, these languages have no known traditional native speakers alive.

In minority languages like these, with potentially more speakers who are second language learners than there are native speakers, it is important for a researcher in any linguistic field to be aware of which variety of the language she is working with. For example, Irish is estimated to have 141,000 L1 users and 1,030,000 L2 users (Eberhard et al. 2019). This means that there are for all intents and purposes two Irish language communities, the rural communities of the official Irish-speaking areas called the *Gaeltacht* (plural *Gaeltachtaí*), and urban communities of second-language learners who go on to raise their children in what seems to be developing into new varieties of the language. McCloskey (2003) describes some of the issues involved in working with Irish in this situation. As McCloskey points out, even the question of which variety to study for the purpose of theoretical syntax is fraught with the potential to be felt painfully by the speakers in question. Kennard's (non-LFG) studies on Breton word order (Kennard 2014), and on an impersonal construction and initial mutation[1] in Breton (Kennard 2019), are other excellent examples of some of the complexities involved in studying minority languages like these.

Another issue to be aware of is the differences between the spoken and literary varieties in these languages, a distinction which is particularly prominent in Welsh, but also relevant for Irish. Areas where different varieties come into play in this chapter are among others Irish verbal agreement (dialect, register and diachronic development, Section 4.2) and Irish numerals ("school" language vs. spoken language, Section 4.3).

1.2 On the selection of topics in this chapter

Relatively little work has been done on the Celtic languages in LFG compared to in other theories, and the studies we have cover very different topics. It has been my goal to write an overview chapter that shows some of this breadth. This means that there has not been sufficient room to present all the relevant theory or all the relevant language structures in detail. References to theoretical and grammatical resources are provided, including to other chapters in this Handbook. I encourage the reader to consult the referenced works.

Often the works presented in this chapter are single studies on a single grammatical phenomenon in a single language. What do these studies contribute to our understanding of LFG and of the Celtic languages? What is the theoretical context of the study? I highlight where there remains work to be done in

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[1] See Section 1.2.

LFG through comparisons with studies on the Celtic languages in other frameworks, and through introducing relevant grammatical phenomena in the Celtic languages that are still unaccounted for in LFG. It is my hope that this may be useful for researchers down the road who want to help fill the gaps in our LFG-theoretical understanding of the Celtic language family, or otherwise study the Celtic languages within the framework of LFG.

The system of initial mutation is a striking example of a central phenomenon in the Celtic languages that has received little attention in LFG. All the Celtic languages have a system of initial mutation in which phonological changes to the initial segment of words are triggered by lexical, morphosyntactic or syntactic conditions. Taking Irish as an example, there are two initial mutations in the language, called lenition and eclipsis. Some examples of how these mutations affect consonants are provided below. In these examples the acute accent denotes a palatalised as opposed to a velarised consonant, called "slender" and "broad" respectively in traditional grammars.

(1) Some initial mutations in Irish, spelling and pronunciation (Mac Eoin 2002: 109)

Radical		Lenited		Eclipsed	
c	/k/, /k′/	ch	/x/, /ç/	gc	/g/, /g′/
d	/d/, /d′/	dh	/ɣ/, /j/	nd	/N/, /N′/
f	/f/, /f′/	fh	(silent)	bhf	/w/, /v′/
s	/s/, /s′/	sh	/h/, /ç/	N/A	

Initial mutation is perhaps one of the most studied Celtic phenomena in general (see Harlow 1989, Ball & Müller 1992, Tallerman 2006 among many others). This might be one reason why it is hard to find LFG studies on this topic beyond computational approaches such as Mittendorf & Sadler's (2006) analysis of Welsh initial mutation using the XLE grammar development environment and the associated finite state and tokenisation tools. However, initial mutation is frequently mentioned when it interacts with the grammatical phenomenon under discussion, such as the Irish relative sentences discussed in Section 3.4.

2 Word order

2.1 Introduction

The Celtic languages show basic VSO word order. As pointed out for example by Fife (2002: 16), the Celtic languages are VSO not only in terms of basic word order

– they also show the features proposed by Joseph Greenberg to be implications of basic VSO word order: they are prepositional; they can be said to show SVO as an alternate order through fronting of non-verbal constituents, possibly more correctly described as XVO; they have initial interrogative particles, pre-verbal *wh*-words and the main verb after the auxiliary; and as a main rule, they show post-head modifications.

This section is centered on an LFG analysis of basic VSO word order at the clausal level, with the main issue being the presence of a VP in the Celtic languages. As will be seen, Sadler (1997) and Bresnan (2001) analyse the VSO word order of Welsh in order to develop and illustrate some very central concepts of LFG.

2.2 Is there a VP or not?

A central theoretical discussion concerning the Celtic languages has been the presence or absence of a VP. Early work on this question in other theories than LFG include Sproat (1985) for Welsh, McCloskey (1983) for Irish and Anderson & Chung (1977) for Breton.

As previously mentioned, the Celtic languages show various surface word orders in addition to VSO in different types of clauses. Tallerman (1998: 22–23) distinguishes between what she calls "two major word order patterns in finite clauses in Celtic". The first pattern has the finite lexical verb in initial position followed by the subject, object and any optional material – in other words, the standard VSOX order, as illustrated in (2) for Welsh and (3) for Irish.

(2) Welsh (Tallerman 1998: 23)
Rhoddais i afal i'r bachgen ddoe.
give.PST.1SG I apple to.DEF boy yesterday
'I gave an apple to the boy yesterday.'

(3) Irish (Ó Siadhail 1989: 205)
Labhrann Mícheál Gaeilge le Cáit go minic.
speak.PRS Mícheál Irish to Cáit often
'Mícheal often speaks Irish to Cáit.'

The other unmarked word order referred to by Tallerman (1998: 22–23) is a periphrastic construction with an initial finite auxiliary verb, followed by the subject and a non-finite verb and its complement, followed by any optional material. Examples are provided in (4) for Welsh and (5) for Irish, both of which illustrate the progressive construction.

(4) Welsh (Tallerman 1998: 23)
Mae o'n adeiladu tai ym Mangor.
be.PRS he.PROG build houses in Bangor
'He's building houses in Bangor.'

(5) Irish (Mac Eoin 2002: 131)
Tá mé ag baint fhéir.
be.PRS I PROG cut grass.GEN
'I am cutting grass.'

It is possible to front the non-finite verb and its complement in this construction using the cleft construction, illustrated in (6) for Welsh.

As we will see, this is taken as one indication of the presence of a VP in Welsh.

(6) Welsh (Bresnan 2001: 128)
Adeiladu tai ym Mangor a wnaeth o.
build houses in Bangor REL do.PST.3SG he
'He built houses in Bangor.' (VP focus)

(6) shows the periphrastic construction with the finite auxiliary verb 'do'; the non-finite verb 'build' and its complement is fronted. Similar fronting is found in Irish, as shown with the periphrastic construction in (7):

(7) Irish (from McCloskey 1983, quoted in Carnie 2005: 14):
Má's ag cuartughadh leanbh do dhearbhrathra a tá tú …
if.COP PROG seek child your brother REL be.PRS you …
'If it's seeking your brother's child that you are …'

Another argument frequently posited in favour of a VP in VSO languages is the presence of structure-dependent subject/object asymmetries such as anaphoric binding (Carnie & Guilfoyle 2000: 5–6 and references therein). The examples in (8) illustrate anaphoric asymmetries for Welsh:

(8) Welsh (Borsley 2006: 476)
   a. Welodd Gwyn ei hun.
      see.PRS.3SG Gwyn 3SG.M self
      'Gwyn saw himself.'
   b. *Welodd ei hun Megan.
      see.PRS.3SG 3SG.F[2] self Megan
      Intended: 'Megan saw herself.'

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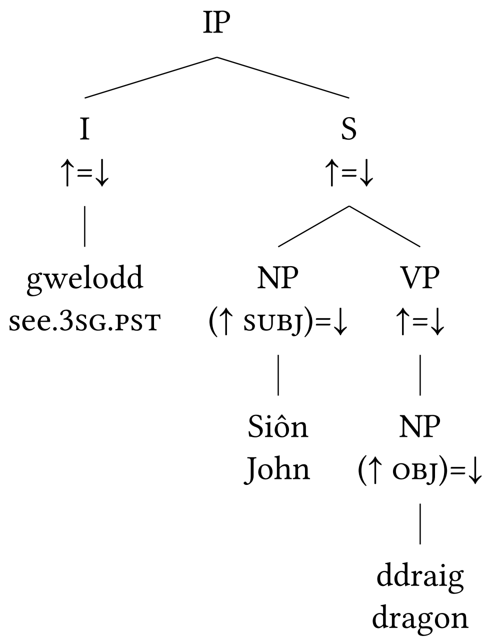
[2] This is glossed 'M' in Borsley (2006: 476).

If, as in LFG, binding constraints are taken to be a matter for f-structure (Rákosi 2023 [this volume]), examples such as the above are, however, not an argument in favour of a VP in VSO languages.

Based on examples such as (6) and (7) above, Bresnan (2001: 126–131), in line with Sadler (1997), argues in favour of a VP for Welsh as shown in the trees in (9).[3] For Bresnan (2001: 126ff), this argument is a matter of showing an example of what she calls "the noncompositionality of f-structures in c-structures", or more specifically for Welsh and the other Celtic languages that a finite VP can be discontinuous and with a head appearing external to the rest of the phrase. Crucially, this places the analysis of the word order of the Celtic languages in the context of central LFG concepts and analyses such as structure-function mapping and endocentricity and extended heads (see Belyaev 2023 [this volume]).

(9) Welsh word order

a. 'John saw a dragon.' (Broadwell 2005: 2)



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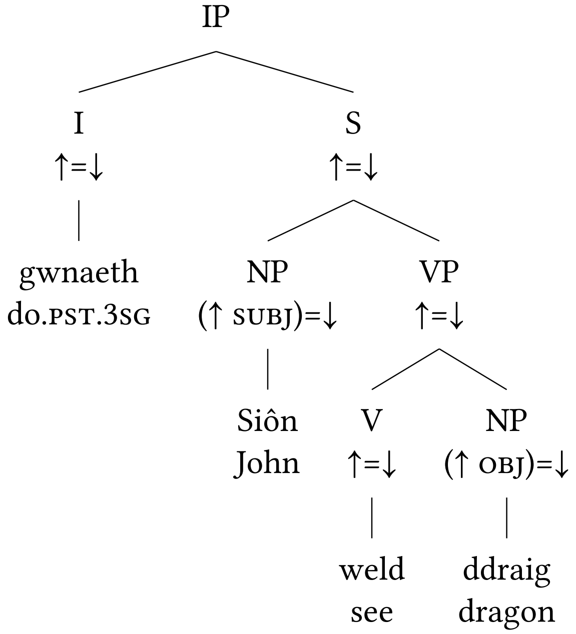
[3] See Carnie (2005) for a discussion of Irish copula clauses as a possible counter-argument to this type of analysis of VSO languages.

b. ‘John saw a dragon.’ (Bresnan 2001: 128)



In this analysis the V in the I(nfl) position is the extended head of the VP. The tree in (9)a illustrates standard VSO order, whereas (9)b shows a Welsh periphrastic construction with the finite auxiliary verb ‘do’ in the initial position followed by the subject, a non-finite verb and its complement.

More broadly this analysis deals with several very central questions in any linguistic theory: what is the status of the VP? Is it desirable to maintain a unified analysis of different constructions in a language? Compare for example Borsley (2006), who argues against a head-raising account/discontinuous VP for finite, non-periphrastic clauses in Welsh. Borsley acknowledges the possibility of a VP in periphrastic constructions, but argues that it does not follow that there is a VP in finite, non-periphrastic clauses.

There is much more work to be done on the word order of the Celtic languages, both in general and in LFG, for example in light of Breton apparently showing verb-second effects (Schafer 1995, Tallerman 1998: 22, Stephens 2002: 400) and the development of SVO vs. V2 structure in modern Breton (Timm 1989, Kennard 2014, etc.). See also Sadler (2006: 1779–1783) for a discussion of Welsh constituent structure.

2.3 Some other patterns of word order

Within LFG there are so far relatively few studies of Celtic word order beyond clausal VSO structure. One important exception is Sadler’s (1998) article “Welsh

NPs without head movement”, on the structure of Welsh noun phrases. Her starting point is the similarity between nominal and clausal structure in Welsh, which has led to head movement type of analyses of Celtic noun phrases in which the head N raises to a functional category position, parallel to the extended head analyses described for VSO clauses. Sadler argues against this type of analysis for Welsh noun phrases for both conceptual and empirical reasons. She proposes instead an analysis in which Welsh nouns lack complements, and that what appears to be complements of the noun, are instead adjuncts. This removes the need for a head raising account for this data.

These similarities between NPs and VPs in the Celtic languages are another area that would benefit from further study. The issues raised are broader than the Celtic languages: as Sadler (1998: 2) points out, the head raising account of Celtic noun phrases is modelled on analyses of Semitic noun phrases, which show similarities with the Celtic structures.

In the introduction to this section, I mentioned some salient typological features of the Celtic languages that correspond to a VSO word order. One of these is fronting, or clefting. The Celtic pattern of fronting (see Tallerman 1998: 31–34, etc.) is illustrated below using Irish and Welsh. The basic structure of the Irish cleft construction is copula + clefted phrase + relative particle + the remainder of the sentence. This is illustrated in (10) through (a) a standard VSO sentence, (b) fronting of the subject, and (c) fronting of an adverb:

(10) Irish (Sulger 2009: 571):

a. Léigh an múinteoir leabhar inné.
read.pst def teacher book yesterday
‘The teacher read a book yesterday.’

b. Is é an múinteoir a léigh an leabhar inné.
cop agr def teacher rel read.pst def book yesterday
‘It is the teacher who read a book yesterday.’

c. Is inné a léigh an múinteoir an leabhar.
cop yesterday rel read.pst def teacher def book
‘It is yesterday that the teacher read a book.’

In Welsh, the corresponding construction does not have a copula, leaving the relative particle as the only marker of clefting (Watkins 2002: 336–337):

(11) Welsh (Watkins 2002: 337)
y bachgen a welodd y dyn
def boy rel see.pst.3sg def man
‘It was the boy who saw the man.’

The cleft construction in the Celtic languages has received relatively little attention in LFG, but see Sulger (2009) for an analysis that builds on analyses of the Irish copula.[4]

3 Arguments

3.1 Introduction

This section starts with an analysis of the Modern Irish so-called "autonomous" verb form and its diachronic development from a passive verb, which is then contrasted briefly with the Welsh impersonal verb form. These analyses deal with a crucial topic in any grammatical theory, namely mapping between verbal semantics and syntactic functions. The autonomous verb is followed by a description of a pattern in Welsh in which an adjective phrase is said to select for an object. The authors in question argue that this analysis raises wider issues about how best to understand grammatical functions in areas outside of verbal subcategorisation. Finally, there is a brief discussion of Irish relative clauses in the context of LFG analyses of unbounded dependencies.

3.2 Passives and impersonals

All the Celtic languages contain a verb form in their paradigm called "autonomous" or "impersonal" (Fife 2002: 14). There are two PhD theses dealing with this verb form within the framework of LFG, Graver (2010) for the Irish autonomous verb and Arman (2015) for the Welsh "impersonal passive" as well as another type of Welsh passive called the GET-passive. Both make use of Lexical Mapping Theory (LMT) as revised by Kibort (2007, 2014) (see Findlay et al. 2023 [this volume]).

Some classic studies of the Modern Irish autonomous verb are Stenson (1989) and McCloskey (2007). Their main conclusion is that the Modern Irish autonomous verb is an active verb with an impersonal subject comparable in semantics to French *on*, etc. In Irish, this subject is phonologically null. Drawing on this conclusion, Graver (2010, 2011) presents an LFG analysis of the Modern Irish autonomous verb and its diachronic development.

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[4] Compare also Borsley (2020), a comparative analysis in HPSG of *wh*-interrogatives, free relatives and cleft sentences. Borsley suggests that the Welsh cleft construction involves identity predication. As mentioned, the copula does not appear in Welsh cleft sentences today. This leads Borsley to suggest that the identity predication is associated with the construction in Modern Welsh, whereas in Middle Welsh, where the copula did appear, the identity predication of the cleft sentence was associated with the copula.

Examples of the Modern Irish autonomous verb are provided in (12):

(12) Irish

a. Tugadh an corp chun na reilige agus cuireadh é.
bring.PST.AUT DEF corpse to DEF graveyard and put.PST.AUT it
'The corpse was brought to the graveyard and it was buried.' (Graver 2010: 4)

b. Deir siad go gcuirfear ar ath-chúirt é.
say.PRS they that put.FUT.AUT on re-court it
'They say that it will be appealed.' (Graver 2010: 9)

As will be shown in Section 4.2, the Modern Irish verbal paradigm contains a mixture of so-called synthetic forms, which express person and number, and analytic forms, which are used with separate pronouns. The autonomous form can thus be interpreted as a synthetic form expressing a subject with impersonal meaning, similar to a third person singular subject, etc.

The agent phrase is ungrammatical with the autonomous verb. This is an argument in favour of an active, impersonal analysis instead of a passive analysis. Assuming an analysis of the agent phrase as an oblique rather than an adjunct, this ungrammaticality is predicted by analysing the autonomous verb as an active, synthetic form, since the first argument of the verb is mapped to the impersonal subject and is thus unavailable for mapping to the agent phrase.[5] The ungrammaticality of the agent phrase with an autonomous verb is illustrated in (13).

(13) Irish (Stenson 1989: 382)
*buaileadh Ciarraí {ag, le} Gaillimh
beat.PST.AUT Kerry by, with Galway
Intended: 'Kerry was beaten by Galway.' [in a hurling match or similar]

Another argument in support of the same conclusion is object marking on the patient argument (*é* 'it' in (13)). Stenson illustrates this as follows, showing the ungrammaticality of the subject pronoun *siad* 'they' instead of the object pronoun *iad*:

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[5] See Graver (2010: 60–61 and references therein) for arguments in favour of analysing the agent phrase as an oblique as opposed to an adjunct.

(14) Irish (Stenson (1989: 384)
buaileadh arís iad/*siad
beat.PST.AUT again them/*they
'They were beaten again.'

What is more, the autonomous verb may be used with more or less all verbs including intransitive and unaccusative verbs. I refer to the abovementioned references for additional data in favour of an active impersonal analysis.

Kibort (2007) reformulates the principles for mapping between arguments and grammatical functions compared to classic LMT, and suggests the following mapping principle.

(15) Mapping principle (Kibort 2007: 16)
The ordered arguments are mapped onto the highest (i.e. *least* marked) compatible function on the markedness hierarchy. [emphasis original]

The markedness hierarchy referred to in (15) is the classic hierarchy provided in (16), which again is based on the feature decomposition of f-structure functions shown in (17):

(16) Partial ordering of syntactic functions in terms of markedness (Bresnan (2001: 309)

$$\mathrm{SUBJ} < \mathrm{OBJ}, \mathrm{OBL}_{\theta} < \mathrm{OBJ}_{\theta}$$

(17) Feature decomposition of f-structure functions (Bresnan 2001: 308)

	[−*r*]	[+*r*]
[−*o*]	SUBJ	OBL_{θ}
[+*o*]	OBJ	OBJ_{θ}

Thus, the mapping between a- and f-structure will simply look as follows for a transitive autonomous verb, where *impers* is shorthand for "impersonal" – this mapping is similar to a regular active, transitive verb with any kind of subject.

(18) Mapping, transitive autonomous verb (Graver 2010: 62)

verb [aut.trans.]	⟨	arg1	arg2	⟩
		[−*o*]	[−*r*]	
		[−*r*]	[+*o*]	
		SUBJ *impers*	OBJ	

Three different morphosyntactic operations can be formulated to account for passivisation with and without an agent phrase, and with the second argument mapped to either the subject function (canonical passive) or the object function (impersonal passive). All of these operations result in passive verbs, the mapping of which is incompatible with the analysis of the autonomous verb as active with an impersonal subject as shown in (18).

When the agent phrase is not present in a passive sentence, arg1 undergoes mapping to zero/∅ (Bresnan 2001: 310). When the agent phrase is present, it undergoes mapping to OBL$_\theta$ (Kibort 2007: 17–19). In a canonical passive, arg2 maps to SUBJ as the least marked compatible function. In an impersonal passive, an operation called object preservation applies to map arg2 to OBJ, which entails an increase in the markedness of the mapping.

Where these mapping relations really turn out to be of use according to Graver (2010, 2011) is in the analysis of the diachronic development of the Modern Irish autonomous verb. In Old Irish, the properties of the autonomous verb appear contradictory in terms of the above mappings. Graver (2010: 179) sums this up as follows:

(19) Properties of the Old Irish autonomous verb:
   a. It is found included in the paradigm for practically any verb in every category of tense/aspect/mood, including intransitive and unaccusative verbs such as the substantive verb (Section 5.1) and verbs of inherently directed motion. (See Graver (2010: 62–63 and references therein) on passivisation and unaccusativity in LFG in the context of the Irish autonomous verb.)
   b. A third person patient is marked as subject, by nominative case on nouns, agreement in number with the verb and by the verb itself if the patient is a pronoun.
   c. There is object marking on first and second person patients, with infixed pronouns.
   d. The agent phrase is possible with transitive verbs.

The development from the above situation to the Modern Irish active impersonal can be summarised in terms of the markedness inherent in Kibort's (2007) theory: due to general changes in the morphological system of the Irish language, the patient of the Old Irish "passive" verb is reanalysed as the object rather than the subject of the verb. The resulting impersonal passive is predicted by the theory to be more marked than the original canonical passive, since an additional morphosyntactic operation/increase in markedness, object preservation, has applied.

The resulting subjectless, impersonal passive can be considered an unstable category, and for example Blevins (2003: 480–481 and references therein) suggests that subjectless impersonal passives tend to have an indefinite human agent interpretation, and that a subjectless impersonal passive thus would be practically indistinguishable from an active impersonal and consequently susceptible to reanalysis. When the autonomous verb in Irish is reanalysed as containing an impersonal active subject, there is no longer any need for the morphosyntactic increase in markedness – but see Graver (2010: 200–203) for a discussion of the difficulties of pinpointing the exact causes of such a diachronic change.

In other words, the status of the Old Irish autonomous verb could be termed contradictory or unclear in terms of the morphosyntactic operations illustrated above and the resulting impersonal and passive constructions. A comparable situation appears to apply in Modern Welsh: for example, the Welsh impersonal verb form can occur both with an agent phrase and unaccusative verbs. This phenomenon is analysed in terms of LFG by Arman (2015). Arman does not conclude whether the Welsh "impersonal" verb is in fact passive or active, but suggests that LFG, and particularly the revised mapping theory, is flexible enough to account for the Welsh data (Arman 2015: paragraph 7.3). The strength of Arman's approach is the large amount of data, the comparisons with other passives in the language and, in particular, the detailed analysis of the interaction of the impersonal verb form with different semantic verb classes (chapter 6). A similar LFG analysis of the autonomous verb in Old Irish would be highly interesting.

3.3 A Welsh adjectival construction

Mittendorf & Sadler (2008) analyse a Welsh adjective phrase construction containing a noun phrase as a constituent. They call this the *in-respect-of* construction, illustrated in (20), where the adjectives *byr* 'short' and *trwm* 'heavy', respectively, are followed by noun phrases containing a possessive clitic pronoun, here *ei* 'her':

(20) Welsh (Mittendorf & Sadler 2008: 2)

a. byr ei thymer
short her temper
'short-tempered'

b. trwm ei chlyw
heavy her hearing
‘hard of hearing’

Mittendorf & Sadler (2008: 19–20) suggest that the main theoretical contribution of their analysis of this Welsh construction is a call for more specific descriptions of the grammatical functions of LFG, particularly outside of the area of verbal subcategorisation.

Mittendorf & Sadler show that the construction occurs in similar environments to adjective phrases, as shown in (21) for attributive and predicative use respectively.

(21) Welsh (Mittendorf & Sadler 2008: 9)
a. merch fyr ei thymer
girl short her temper
‘a short-tempered girl’
b. Mae’r ferch yn fyr ei thymer.
be.PRS.DEF girl PRED short her temper
‘The girl is short-tempered.’

They go on to provide evidence, following apparently unpublished work by Jones (2002), in favour of analysing the adjective-NP sequence as one constituent, which is headed by the adjective. Phenomena in favour of this analysis include coordination – the NP in the sequence can be coordinated, which indicates that it is a subconstituent (Mittendorf & Sadler 2008: 3) – and the way that the adjective in the sequence can be modified as expected by regular adverbials and other types of intensifiers.

Initial mutation occurs in Welsh on an adjective modifying a feminine singular noun. The *in-respect-of* construction behaves as expected for an adjective when it modifies a singular feminine noun, as illustrated in (22), where the adjective *mawr* ‘big’ is lenited and becomes *fawr* following the feminine singular noun *athrawes* ‘(female) teacher’:

(22) Welsh (Mittendorf & Sadler 2008: 6)
athrawes fawr ei pharch
teacher big her respect
‘a highly-respected (female) teacher’

Having established that the adjective-noun sequence is a constituent headed by the adjective, Mittendorf & Sadler's main question is: what is the correct f-structure analysis of the noun phrase contained in the adjective phrase? What is its grammatical function? They review and reject analyses in which the noun phrase is a subj and adjunct, and tentatively conclude that the noun phrase is an obj.

They provide the f-structures in (23) for attributive and predicative use of the construction (Mittendorf & Sadler 2008: 12):

(23) F-structures, the *in-respect-of* construction (Mittendorf & Sadler 2008: 12)

a. attributive use:

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{girl}\text{'}_i \\ \textsc{adj} & \left\{ \begin{bmatrix} \textsc{pred} & \text{`}\textsc{short}\langle\textsc{obj}\rangle\text{'} \\ \textsc{obj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{temper}\langle\textsc{poss}\rangle\text{'} \\ \textsc{poss} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{pro}\text{'}_i \end{bmatrix} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}$$

b. predicative use:

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{short}\langle\textsc{subj, obj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{girl}\text{'}_i \end{bmatrix} \\ \textsc{obj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{temper}\langle\textsc{poss}\rangle\text{'} \\ \textsc{poss} & \begin{bmatrix} \textsc{pred} & \textsc{pro}_i \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Mittendorf & Sadler suggest that it might sound surprising that an adjective selects for an object, but propose that this is a reasonable analysis given the resources of the theoretic arsenal of LFG, as well as some cross-linguistic support from Swedish among other languages (Mittendorf & Sadler 2008: 18). However, their main argument in support of an obj analysis of the noun in this construction is a comparison with a very similar Welsh *tough* construction and the mandatory presence of the noun. See Kaplan 2023: Section 6 [this volume] on the *tough* construction in English in the context of long-distance dependencies. The *tough* construction in Welsh is illustrated below, with a verbal noun as the comp of the adjective *treulio*, verbal noun of 'to digest' in the example below, and the mandatory presence of the noun, which argues against an adjunct analysis.

(24) Welsh *tough*-construction (Mittendorf & Sadler 2008: 14)
bwyd anodd ei dreulio
food difficult its digest
'food difficult to digest'

3.4 Unbounded dependencies – the Irish relative clause

What happens when an argument of the verb is taken out of its normal position through relativisation? Irish has two relativisation strategies that conform with the Accessibility Hierarchy (Keenan & Comrie 1977). One of the earliest descriptions of these facts is McCloskey (1979). For an analysis of the more complicated Welsh data, see for example Tallerman (1990) and Borsley (2013).

In traditional grammar (such as The Christian Brothers 2002), the two Irish relativisation strategies are called the direct and the indirect relative. The direct relative is a gap strategy, whereas the indirect relative uses a resumptive pronoun.

The direct relative is used when the relative constituent is the subject or the object. It uses a relative particle that lenites.[6]

(25) Irish: the direct relative (McCloskey 1979: 5–6)

a. Relativised subject
an fear a dhíol an domhan
DEF man REL$^{\text{L}}$ sell.PST DEF world
'the man who sold the world'

b. Relativised object
an scríbhneoir a mholann na mic léinn
DEF writer REL$^{\text{L}}$ praise.PRS DEF students
'the writer whom the students praise'

The direct relative is obligatory with a relativised subject and the most common with a relativised object (McCloskey 1979: 6). However, since the VSO word order gives rise to potential ambiguity in examples like (25)b, the indirect relative with a resumptive pronoun is possible in these cases:

(26) Irish: indirect relative with a relativised object (McCloskey 1979: 6)
an scríbhneoir a molann na mic léinn é
DEF writer REL$^{\text{N}}$ praise.PRS DEF students him
'the writer whom the students praise'

Going further down the Accessibility Hierarchy, the Indirect Relative is obligatory with objects of prepositions and possessors:

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[6] Lenition and eclipsis are the two initial mutations in Irish, as explained in Section 1.2. They are glossed L for lenition and N for nasalisation, the latter a traditional – but imprecise – term for eclipsis.

(27) Irish: the indirect relative (McCloskey 1979: 6)

a. Relativised prepositional object
an fear a dtabharann tú an t-airgead dó
DEF man REL^{N} give.PRS you DEF money to.him
'the man to whom you give the money'

b. Relativised possessor
an fear a bhfuil a mháthair san otharlann
DEF man REL^{N} be.PRS his mother in.DEF hospital
'the man whose mother is in the hospital'

These core Irish facts, as well as some more peripheral patterns described by McCloskey (2002), are analysed in detail by Asudeh in his book *The Logic of Pronominal Resumption* (Asudeh 2012: chapter 7). The chapter on long distance dependencies in this volume (Kaplan 2023 [this volume]) provides a brief description of Asudeh's analysis in the context of the development of LFG analyses of the explicit marking of f-structures in the domain of a long distance dependency – though it should be noted that Kaplan restricts himself to examples with the direct relative, in comparison with sentences with the Irish complementiser *go*^{N} 'that' – which introduces complements that are not in the domain of a long distance dependency.

4 Agreement

4.1 Introduction

There are many agreement issues in the Celtic languages that remain untouched within the LFG framework. In this section I present analyses of Irish verbal conjugation and a Welsh conjunct agreement pattern, before moving on to agreement between cardinal numbers and numerals in Welsh and Irish respectively. There are clear similarities in these areas between the two languages discussed, but also interesting differences that lack thorough analyses.

4.2 Various issues of verbal agreement

Table 1 shows parts of the standard conjugation of the Irish verb *mol* 'to praise'.[7] There is variation between analytic forms, which take a separate pronoun (or

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[7] Welsh is quite different from Irish in this respect (see Borsley et al. 2007: 9–10). Welsh shows complete paradigms of synthetic verbal morphology. Literary Welsh permits null subjects; colloquial Welsh does not.

noun) subject, and synthetic forms (marked in bold) which are conjugated for person and number.

Table 1: Irish conjugations (The Christian Brothers 2002: 95, emphasis added)

	Present tense	Past tense	Imperfect
1sg	**molaim**	mhol mé	**mholainn**
2sg	molann tú	mhol tú	**mholtá**
3sg	molann sé/sí	mhol sé/sí	mholadh sé/sí
1pl	**molaimid**	**mholamar**	**mholaimis**
2pl	molann sibh	mhol sibh	mholadh sibh
3pl	molann siad	mhol siad	**mholaidís**

There has been a general development in Irish towards more analytic forms, but as e.g. Ó Siadhail (1989: 182–185) points out, there is a mixture of synthetic and analytic forms in all the dialects, with a tendency for the most synthetic forms in the south and the fewest in the north of the country.

There are two important descriptive generalisations associated with Irish verbal agreement. First, as a general rule, the synthetic forms are incompatible with a pronoun or noun subject, as shown in (28).

(28) *molaim mé
praise.PRS.1SG I

Second, when the paradigm contains a synthetic form, the analytic form is unavailable (though see below for a potential exception).

Irish data such as these are used by Andrews (1990) as a basis for formulating the Morphological Blocking Principle. The main intuition behind this principle is that if there is a highly specified form in the Lexicon, a less highly specified one cannot be used (Andrews 1990: 508).

Andrews (1990) shows first of all that it follows from general LFG architecture that a synthetic verb form cannot occur together with a noun phrase or pronoun. Synthetic verb forms are taken to specify the value of the PRED of the subject as ‘PRO’. A subject NP would contribute a different PRED value than that to the subject, and this is ruled out by the Uniqueness Condition (see Belyaev 2023: Section 3.4.1 [this volume]).

However, as Andrews (1990: 516) points out, the Uniqueness Condition is not sufficient to rule out the presence of a pronoun with a synthetic verb form, since the specification of the PRED value of the subject as 'PRO' from both the verb form and the pronoun would not appear to be contradictory. To solve this, Andrews refers to the principle of Predicate Indexing, which he suggests "causes each PRED-value introduced in a lexical item to receive a unique index, which distinguishes it from all other PRED-values in the structure" (Andrews 1990: 516). This principle makes a synthetic verb form and a pronoun subject mutually exclusive, since the 'PRO' values contributed by a synthetic verb form and a subject pronoun respectively would carry separate indices, which in its turn would violate the Uniqueness Condition.

Finally, to account for the ungrammaticality of an analytic verb form with a pronominal subject when there is a synthetic form available, Andrews (1990) formulates the Morphological Blocking Principle:

> Suppose the structure S has a preterminal node P occupied by a lexical item l_1, and there is another lexical item l_2 such that the f-structure determined by the lexical entry of l_1 properly subsumes that determined by the lexical entry of l_2, and that of l_2 subsumes the f-structure associated with P in S (the complete structure, after all unifications have been carried out). Then S is blocked. (Andrews 1990: 519)

Building on this, Sulger (2010) offers a computational LFG analysis of Irish verbal agreement facts. As a part of his analysis, Sulger (2010: 169–170) criticises the Morphological Blocking Principle in computational terms, suggesting that this principle has the consequence that the lexicon needs to be checked for a corresponding synthetic form every time an analytic form occurs. If there is a synthetic form, the analytic form is blocked. Sulger (2010: 170) argues, from a computational grammar viewpoint, that this approach is inefficient and that it is questionable whether it is adequate for larger-scale grammars.

McCloskey & Hale (1984: 491–492 and §6) point out that there is greater variation in the Irish paradigms than described above (see also Ó Siadhail 1989: 182–185), and that in certain cases the same person-number combination can be expressed both by a synthetic and an analytic form. Some of their examples are included in (29):

(29) Irish (McCloskey & Hale 1984: 491)

a. chuirfidís
   put.COND.3PL

b. chuirfeadh siad
   put.COND they

This matter seems to involve both dialect and register variation as well as historical developments, and is so far an understudied topic within the framework of LFG. McCloskey & Hale (1984: 531) indicate morphological blocking as potentially the most fruitful line of enquiry going forward.

Sadler (1999) discusses another agreement phenomenon in Welsh, a single conjunct agreement pattern illustrated in (30):

(30) Welsh (Sadler 1999: 2)

a. Daeth Siôn a minnau.
come.PST.3SG Siôn and 1SG
'Siôn and I came.'

b. Daethost ti a minnau/Siôn.
come.PST.2SG 2SG and 1SG/Siôn
'You and I/Siôn came.'

c. Roedd Mair a fi i briodi.
be.PST.3SG Mair and 1SG to marry
'Mair and I were to marry.'

d. Roeddwn i a Mair i briodi.
be.PST.1SG 1SG and Mair to marry
'I and Mair were to marry.'

All these examples have a plural coordinate subject.[8] When the first conjunct is a pronoun, the verb agrees with the pronoun in person and number. When the first conjunct is non-pronominal, the verb is in the unmarked third singular form. An identical asymmetrical agreement pattern shows up both in nominal structures containing possessor phrases and with objects of prepositions.

Sadler (1999: 3–4) suggests that a similar agreement pattern is found in Irish, based on data from McCloskey (1986). Some of McCloskey's examples are provided in (31):

(31) Irish (McCloskey 1986: 248)

a. Bhíos féin agus Tomás ag caint le chéile.
be.PST.1SG self and Tomás PROG talk with each.other
'Tomás and I were talking to one another.'

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[8] See Sadler (2006) for a discussion of other coordination patterns in Welsh within the framework of LFG.

b. Bhíos -sa agus Pádraig Ó Guithín le pósadh.
be.PST.1SG -CONTR and Pádraig Ó Guithín to marry
'Pádraig Ó Guithín and I were to marry.'

Note the elements *féin* and *-sa* here; these are emphatic/contrastive elements that are mandatory in the above coordination pattern.[9]

Andrews (1990: 522–523) mentions this Irish pattern of agreement. He suggests that it presents significant difficulties for an LFG analysis and chooses to leave them aside in the context of his paper on morphological blocking. This type of pattern is also not restricted to the Celtic languages; it appears to be found in for example Czech, Latin and Palestinian Arabic (Sadler 1999: 4 and references therein).

The interesting difficulty with the Welsh data is, as Sadler (1999: 15) puts it, that "morphosyntactic and semantic agreement come apart under coordination": the only difference between the structure illustrated above and other coordinate structures is the agreement between the first, pronominal conjunct and the verb. On the other hand, data such as predicate agreement seem to indicate that semantic feature resolution appears to operate on coordinate structures in Welsh independent of whether the coordinate structure includes pronouns or not.

Sadler (1999) describes two main features of the classic LFG view of agreement: agreement features such as person, number, gender and case are an f-structure phenomenon, and agreement is a matter of constraints on the same structure rather than matching between features on different structures (see Haug 2023 [this volume] on agreement). The crucial question then is this: can this view of agreement be reconciled with the single conjunct agreement pattern illustrated above? Sadler (1999) argues that these data show that it is difficult to maintain a simple and homogenous view of what agreement is.

4.3 Noun phrase agreement: numerals

Fife (2002: 21) lists as "a common feature of Celtic nominal syntax" the use of singular forms (and/or special forms) following cardinal numerals. Mittendorf & Sadler (2005) make use of the INDEX/CONCORD distinction (referencing Wechsler & Zlatić's (2000) HPSG analysis and King & Dalrymple (2004) in LFG) to account for the resulting agreement mismatch in Welsh noun phrases.

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[9] See McCloskey & Hale 1984: 493–496 for a thorough discussion of these and other elements and arguments why they are not pronouns.

The INDEX/CONCORD distinction describes two sets of nominal agreement features: CONCORD features relate to agreement between the noun and any determiners or adjectives, whereas INDEX features are related to the semantics of the noun and agreement between the noun phrase and a bound pronoun and often also verb agreement (see Haug 2023: Section 3 [this volume] for further details).

In Welsh, numerals require the singular form of the noun, as shown below in the examples 'five dogs' and 'three cats', where the noun in both cases is in the singular form:

(32) Welsh (Mittendorf & Sadler 2005: 6)

a. pum ci
five dog.M.SG
'five dogs'

b. tair cath
three.F cat.F.SG
'three cats'

What is more, if the noun is modified by an adjective with a distinct plural form, the singular form is used. In (33), the adjective *arall* 'other' is used in the plural form *eraill* in the phrase 'other dogs', but in the singular form *arall* when a numeral is added:

(33) Welsh (Mittendorf & Sadler 2005: 6)

a. cŵn eraill
dog.M.PL other.PL
'other dogs'

b. pum ci arall
five dog.M.SG other.SG
'five other dogs'

Demonstratives on the other hand are always plural when a noun with a plural premodifier is involved. In the below examples, the singular (feminine) form *hon* 'this' is used in the phrase 'this cat', whereas the plural form *hyn* is used in 'these three cats':

(34) Welsh (Mittendorf & Sadler 2005: 6)

a. y gath hon
DEF cat.F.SG this.F.SG
'this cat'

b. y tair cath hyn
DEF three cat.F.SG this.PL
‘these three cats’

At the same time, the noun phrase behaves overall as plural, as shown in (35), where the noun phrase ‘the five men’ controls a pronominal anaphor:

(35) Welsh (Mittendorf & Sadler 2005: 7)
Roedd y pum dyn yn gweld eu hunain yn y drych.
be.IPFV.3S DEF five man.M.SG PROG see 3PL self.PL in DEF mirror
‘The five men saw/were seeing themselves in the mirror.’

Mittendorf & Sadler (2005) suggest that these distinctions can be most usefully described as an INDEX/CONCORD mismatch: specifically, the numeral contributes the INDEX NUM feature, which will be plural. This accounts for the example in (35), where the noun phrase ‘the five men’ controls a plural anaphor. What is more, it accounts for the plural demonstrative *hyn* if Welsh demonstratives show INDEX agreement. On the other hand, the singular noun following the numeral will contribute a singular CONCORD NUM feature. This accounts for the requirement that adjectives modifying the noun be in the singular form, since adjectives are taken to show CONCORD agreement.

The f-structure for the noun phrase *tri dyn* ‘three men’ is shown in (36) to illustrate:

(36) Welsh (Mittendorf & Sadler 2005: 11)
tri dyn
three.M man.M.SG
‘three men’

$$\begin{bmatrix} \text{PRED} & \text{‘MAN’} \\ \text{INDEX} & \begin{bmatrix} \text{NUM} & \text{PL} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \\ \text{ADJ} & \left\{ \begin{bmatrix} \text{PRED} & \text{‘THREE’} \end{bmatrix} \right\} \end{bmatrix}$$

Irish numerals show agreement patterns of the same type as Welsh, in that numerals, as a main rule with certain exceptions described below, are followed by a noun in the singular. How this system interacts with adjective agreement lacks analysis in LFG for Irish.

Describing what he calls the “traditional” system, Ó Siadhail (1982) shows that the main rule also in Irish is that the unmarked, singular form of the noun is used after cardinal numerals:

(37) Irish

a. trí chnoc
three hill.M.SG
‘three hills’ (Ó Siadhail 1982: 99)

b. dhá chnoc d(h)éag[10]
two hill.M.SG ten
‘twelve hills’ (Ó Siadhail 1982: 100)

c. trí chnoc fhichead
three hill.M.SG twenty.GEN
‘twenty-three hills’ (Ó Siadhail 1982: 101)

The “traditional” system referred to above is a system based on multiples of twenty:

(38) Irish

a. deich lá fichead
ten day twenty.GEN
‘thirty days’ (Ó Siadhail 1982: 101)

b. naoi lá dhéag is fiche
nine day ten and twenty
‘thirty-nine days’ (Ó Siadhail 1982: 101)

c. lá is dá fhichead
day and two twenty.GEN
‘forty-one days’ (Ó Siadhail 1982: 102)

However, as Ó Siadhail (1982: 101) points out, what he calls the “school system” has introduced numerals in a decimal system, such as *tríocha* ‘thirty’, *ceathracha* ‘forty’, etc.[11] This latter system is considered standard today, and is illustrated in

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[10] Whether the form has undergone mutation or not (*déag* vs. *dhéag*) is a matter of dialectal variation (see Ó Siadhail 1989: 100).

[11] The terms used by Ó Siadhail when he makes the distinction between “traditional” and “school” system, highlight the need for linguists to be aware of the sociolinguistic nuances of the language under study, in order to be certain of which linguistic system we are describing and analysing at a given time. Mac Eoin (2002: 118–119) suggests that the decimal system is in fact a survivor from the literary language, whereas the vigesimal system has prevailed in the spoken language. He goes on to state that “[t]he promotion of the decimal system in the schools during the last seventy years has not diminished the popularity of the vigesimal system in ordinary speech” (Mac Eoin 2002: 119).

(39) with examples from the school grammar book *New Irish Grammar* by the Christian Brothers:

(39) Irish (The Christian Brothers 2002: 76)

a. trí chapall is tríocha
three horse and thirty
'thirty-three horses'

b. seacht gcapall is caoga
seven horse and fifty
'fifty-seven horses'

The numerals three to ten are however used with certain nouns in the plural. This holds for both number systems. As illustrated in the examples above, the '-teen' part of the numeral phrase – whether the abovementioned multiples of twenty or the school system numerals – is placed after the modified noun while the numbers 1–10 are placed before the noun. Consequently, the exception to the singular rule is relevant for the number system in general and not just when counting to ten.

Nouns used in the plural with numerals can be divided into different groups, including nouns that express a unit of measure (Ó Siadhail 1982: 102–104) and "words inherent to the counting system" such as *ceann* 'head/one' vs. *trí cinn* 'three' (literally 'three heads') (Ó Siadhail 1989: 167)

There is in other words significant variation in the Irish numeral system, depending on whether you are dealing with the traditional or standard written language or the traditional spoken language with its many dialects. We may perhaps also expect to see that the use of the singular form of nouns following numerals is on the way out in the urban varieties of Irish, on the pattern of English.

5 The copula

5.1 Introduction

All the Celtic languages show or have shown a distinction between two 'be' verbs, usually labelled the substantive verb (Irish: *bí*) and the copula (Irish: *is*) (Fife 2002: 19–20, etc.). In LFG it is mainly the Irish copula that has been studied, and thus Irish will be the focus here.[12] This means that Irish copula predication has not

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[12] Welsh has one copula verb *bod*, which appears to share properties with both the Irish copula and the Irish substantive verb (see Borsley 2019). A comparative LFG analysis of the Irish and Welsh copula systems would be interesting.

been studied in its entirety in LFG. In theoretical terms, the Irish copula and the Irish substantive verb are both copulas, but I will use the traditional labels.

For the Irish copula, it is customary in traditional grammar to distinguish between two types of copula sentences, classificatory and identificatory (e.g. Ó Siadhail 1989: 224). Some examples are provided below, as context for the following theoretical discussion:

(40) Irish (Ó Siadhail 1989: 224)

a. Is scoláire mé.
cop scholar I
'I am a scholar.'

b. Is múinteoir í Cáit.
cop teacher agr.3sg.f Cáit
'Cáit is a teacher.'

(41) Irish (Ó Siadhail 1989: 227)

a. Is mé an múinteoir.
cop I def teacher
'I am the teacher.'

b. Is é Seán an múinteoir.
cop agr.3sg.m Seán def teacher
'Seán is the teacher.'

In classificatory sentences such as those in (40), the subjects *mé* 'I' and *Cáit* are said to belong to the class of scholar/teacher. The identificatory sentences in (41) express identity between the subjects, *mé* 'I' and *Seán*, and 'the teacher'.

In this section I first discuss the syntax of the Irish copula. There are two main types of analysis proposed in the LFG literature for copula constructions, a single-tier analysis where the pred of the sentence is the non-verbal predicate, and a double-tier analysis with two varieties depending on the choice of argument function for the non-verbal predicate. It is shown that while LFG works on the Irish copula tend towards a double-tier, predlink analysis, there is philological work on older stages of the language that suggest a single-tier analysis as more appropriate to the Irish data. I go on to show how the Irish copula behaves in terms of the distinction between stage level and individual level.

5.2 Syntax of the Irish copula

In the LFG literature (Dalrymple et al. 2004 and references therein), there are three types of analyses suggested for different types of copula constructions across languages, as shown in Figure 1.

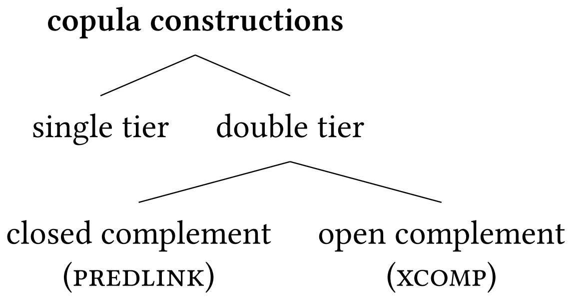

Figure 1: Types of copula constructions (adapted from Sulger 2009: 564)

Dalrymple et al. (2004) suggest that different f-structure analyses are appropriate for different copula constructions not only between languages but also within in a single language. Attia (2008) on the other hand argues in favour of a unified, general analysis of copula constructions on the f-structure level, and suggests that the variations in morphological agreement, presence or absence of the copula, etc., used as arguments in favour of different analyses by Dalrymple et al., do not warrant functional variation.

Sulger (2009) mostly follows Attia (2008) and argues that a PREDLINK analysis is universally applicable to copula constructions, thus also for Irish. In the following I show how the Irish data have been situated in the context of this discussion. I will briefly sketch the three types of copula analyses as context for Sulger's (2009) analysis, before providing his main arguments in favour of a double-tier, PREDLINK analysis for the Irish copula.

A single-tier analysis is one where the copula verb is not required or not permitted, and the copula predicate is taken to select for a subject. This is illustrated in the f-structure in (42) for the translation of a Japanese sentence meaning 'the book is red', from Dalrymple et al. (2004: 191). The copula verb, if present, may contribute tense, as seen in Japanese (Dalrymple et al. 2004).

(42) Single-tier analysis (Dalrymple et al. 2004: 191)

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{red}\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{book}\text{'} \end{bmatrix} \end{bmatrix}$$

In a double-tier analysis, the copula provides the main predicate of the clause, and selects for either an open xcomp function, or the closed predlink function ("closed" meaning here that predlink does not allow functional control).[13]

(43) Double-tier analyses (Dalrymple et al. 2004: 189)

a. Open complement

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{be}\langle\textsc{xcomp}\rangle\textsc{subj}\text{'} \\ \textsc{subj} & [\;] \\ \textsc{xcomp} & \begin{bmatrix} \textsc{pred} & \text{`}\ldots\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \end{bmatrix} \end{bmatrix}$$

b. Closed complement

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{be}\langle\textsc{subj}, \textsc{predlink}\rangle\text{'} \\ \textsc{subj} & [\;] \\ \textsc{predlink} & \begin{bmatrix} \textsc{pred} & \text{`}\ldots\text{'} \end{bmatrix} \end{bmatrix}$$

Sulger's (2009) argument in favour of a double-tier, closed complement analysis of the Irish copula is twofold, and has to do with the presence or absence of the copula, and the presence or absence of agreement between the copula predicate and subject.

Sulger (2009: 570) refers to the discussion between Dalrymple et al. (2004) and Attia (2008) on what to take away from the presence or absence of the copula. Ó Siadhail (1989: 244) formulates the general rule for the Irish copula as follows: "(…) the copula may not normally be deleted when marked for mood, tense, negation, interrogation or when embedded in a sentence." This is illustrated in (44):

(44) Irish (Ó Siadhail 1989: 244)

a.

Múinteoir	é	an	fear	sin.
teacher	agr.3sg.m	def	man	that

'That man is a teacher.'

b.

Ba	mhúinteoir	é.
cop.pst	teacher	he

'He was a teacher.'

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[13] A reviewer provided examples from Welsh where the copula occurs with an expletive subject said to be required by the complement. The examples appear to involve modal semantics. More work is needed on how this fact should be analysed in light of the above discussion on the different analyses of the syntax of the copula. Irish has periphrastic modal predicates with the copula, and for Irish my intuition would be that these would need to be treated separately from regular copula predication as discussed in this chapter. See Graver (2010: 86–94) for an overview of Irish modal verbs with references for further reading.

c. Deir siad gur duine deas é.
say.PRS they that.COP person nice he
'They say that he is a nice person.'

On the basis of these facts, Sulger (2009: 570) argues that the absence of the copula, in the contexts where it may be dropped, is a matter of stylistic variation, and that the presence or absence of the copula does not lead to semantic differences.

Sulger suggests that his argument runs counter to Dalrymple et al. (2004). Dalrymple et al. (2004: 190–191) show how the Japanese copula may be dropped with adjectival predicates but is mandatory with nominal predicates. They argue on the basis of syntactic criteria that the category of the predicate may affect whether it can license a subject and propose a single-tier analysis for Japanese copula sentences with adjectival predicates whether or not the copula is present. For Japanese copula clauses with nominal predicates, they suggest a double-tier analysis of some kind. Sulger on the other hand argues on the basis of Attia (2008) that the predication is the same independent of the presence or absence of the copula, and for this reason that a unified analysis is desirable.

For a language like Russian, where the occurrence of copula is governed by tense, Dalrymple et al. (2004: 191–193) suggest that a unified analysis is desirable, independent of the presence or absence of the copula. The point in this case is that there should not be any evidence of syntactic or semantic differences between clauses with the copula and clauses without. This is likely the case in Irish. Such a unified analysis would take two forms, either a single-tier analysis like Japanese, with the copula contributing features of tense, or a double-tier analysis with the copula as the main PRED of the clause selecting for either an XCOMP or a PREDLINK.

Sulger goes on to note that agreement between the copula predicate and the subject has been given by Dalrymple et al. (2004) as an argument in favour of an XCOMP analysis, because they view "agreement as a strong indication for a control relation between the subject and the predicate" (Sulger 2009: 566). There is no agreement between the copula predicate and the subject in Irish (see Mac Eoin 2002: 115 on the use of adjective predicates with the copula; for nouns compare (45) with (44) above).[14] Consequently, Sulger (2009: 567) argues, agreement is not an argument in favour of an XCOMP analysis in Irish.

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[14] The pronominal element glossed AGR in some of these examples is inserted to agree with the subject, and cannot be taken to involve agreement between the subject and the predicate. See Carnie (1997: 61) and Ó Siadhail (1989: 224).

(45) Irish (Ó Siadhail 1989: 224)

Is	múinteoir	í	Cáit
COP	teacher	AGR.3SG.F	Cáit

'Cáit is a teacher.'

Not all the linguistic literature on the Celtic languages in other theories agrees with this analysis. For example, Carnie & Harley (1994) provide a Principles and Parameters analysis of certain facts of the two Irish 'be' verbs where they view the copula as a complementiser particle providing features of aspect and tense (see Doherty 1996: 9–10 for arguments in favour of such an analysis based on how the copula behaves in sentences with interrogation, negation and subordination particles, and Asudeh (2002) for a general analysis of Irish pre-verbal particles). In LFG terms, this might imply a single-tier analysis.

There are hints in the philological studies and grammars of Old Irish that a single-tier analysis might be appropriate for the older stages of Irish and Scottish-Gaelic, and perhaps also for earlier stages of Welsh. For example, Ahlqvist (1971–1972: 271) calls the copula a "verb-making particle", and Thurneysen (1998: 24–25) and McCone (1996: 211) discuss the similarities between the Old Irish copula and proclitic elements like pre-verbs and articles. Fife, in his introduction to the edited volume *The Celtic Languages*, writes as follows (Fife 2002: 20): "[f]ormerly, in both Irish and Welsh, the copula and its predicate formed a constituent, with the subject moved rightward to the end of the clause." Another point to note is the fact that Old Irish showed agreement between the subject and an adjective predicate in copula clauses. There is in other words much more Irish material to study when it comes to copula clauses.

5.3 Stage level and individual level predication

Sulger (2011) provides an analysis of copula constructions that express possession in Irish and Hindi/Urdu. For Irish he shows how the copula and the substantive verb behave in terms of the distinction between stage level and individual level predication. He argues that this contrast is expressed through lexical information. Specifically, he suggests that the substantive verb may supply a situation argument (based on Kratzer 1995) when it expresses stage level predication. The situation argument serves to embed the property expressed by the predication in some situation.

Sulger (2011: 19–20) again assumes a syntactic analysis using the PREDLINK function of the Irish copula, as mentioned in the previous section. For reasons of space he does not provide any examples of f-structures or lexical entries for his Irish data.

In the following I will use Sulger's (2011) data as a starting point for illustrating how the copula and the substantive verb behave in terms of the stage and individual level distinction.

Sulger (2011: 12) notes that the linguistic literature on Irish generally assumes that the copula expresses individual level predication and the substantive verb stage level predication (see e.g. Doherty 1996: 40). "Stage level" in this sense refers to properties that hold of an individual at some stage of their lives, whereas "individual level" refers to properties that holds of an individual at all stages. The contrast between the copula and individual level predication, and the substantive verb and stage level predication, is nicely illustrated by Mac Eoin:

(46) Irish (Mac Eoin 2002: 136)

a. Is dochtúir mise
COP doctor I.EMPH
'I am a doctor.'

b. Tá mise i mo dhocthúir
be.PRS I.EMPH in my doctor
'I am a doctor.'

(46)a is a sentence with the copula verb is. (46)b on the other hand contains the substantive verb *tá*, with a subject 'I' and a prepositional phrase with the preposition 'in' together with a possessive particle 'my'. Mac Eoin (2002: 136) describes the differences between these examples as follows: "[...] *Is dochtúir mise* [with the copula] is an absolute statement of what I am, whereas *Tá mise i mo dhochtúir* [with the substantive verb] merely states the role in which I appear."

He goes on to contrast the above examples with the following:

(47) Irish (Mac Eoin 2002: 137)

a. Is gunna é seo
COP gun this
'This is a gun.'

b. *Tá sé seo ina ghunna
be.PRS this in.its gun
Intended: 'This is a gun.'

In the latter example above, the construction with the substantive verb + 'in' + possessive particle cannot be used with 'gun' as the subject, since 'being a gun' is an absolute property of the thing referred to.

Sulger (2011) tests the claim that the Irish copula expresses individual level predication on a certain type of copula sentence in comparison with his Hindi data. Sulger terms the construction in question the possessive copula construction, where the copula is followed by a prepositional phrase with the preposition *le* 'with' expressing the possessor and a noun expressing the possessee. Sulger then applies some of the well-known tests for stage or individual level predication (Sulger 2011: 7 and references therein). For example, stage level predicates are assumed to allow temporal adverbs while individual level predicates do not. This is illustrated in (48)a, where, according to Sulger, the copula sentence is judged as questionable by native speakers with the addition of the adverb *inniu* 'today'.

Another test described by Sulger is to change the tense of a sentence, which is thought to result in a change in the perceived lifetime of the individual(s) involved in an individual level predication, but not in a stage level predication. This is illustrated for Irish in (48)b, which now implies that either Pádraig or the car does not exist anymore.

(48) Irish (Sulger 2011: 12, 14)

a. Is le Pádraig an carr nua (?inniu).
   COP.PRS with Pádraig DEF car new today
   'Pádraig has the new car today.'

b. Ba le Pádraig an carr nua.
   COP.PST with Pádraig DEF car new
   'Pádraig had the new car.'

For the substantive verb on the other hand, Sulger (2011: 15) points out, referencing Doherty (1996), that while a change in tense in examples similar to those in (48) results in the subject being perceived as dead when the copula is used, with the substantive verb the subject might have changed profession.

Sulger (2011: 12–14) goes on to show that while the copula is restricted to individual level predication, the substantive verb may in fact express both stage and individual level predication. For example, in the following example with the substantive verb, the reading is ambiguous between ownership (individual level) and temporary possession (stage level):

(49) Irish (Sulger 2011: 12)
Tá an carr nua ag Pádraig
be.PRS DEF car new at Pádraig
'Patrick has the new car' (he may or may not own it)

6 Conclusion

I hope to have shown that the work in LFG on the Celtic languages, while not very substantial, has contributed in various ways to both the theory of LFG and to our understanding of the languages themselves. For example, the question of whether there is a VP in a VSO language like Welsh has been drawn into the discussion of endocentricity and extended heads in LFG (Section 2.2), and the autonomous verb form in Irish has been analysed in the context of general, cross-linguistically applicable categories describing relationships between thematic roles and syntactic functions (Section 3.2).

At the same time, there is a lot of material in the Celtic languages remaining to be studied for the interested researcher. Does it take some extra dedication from the non-native speaker researcher especially, given the challenges of working on minority languages, the low number of native speakers and comparative lack of teaching materials? Yes. But I would still argue that it is very much worth it.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

AUT	autonomous verb form	IMPERS	impersonal
CONTR	contrastive	PRED	predicative particle
EMPH	emphatic		

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Chapter 30

LFG and Continental West-Germanic languages

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This chapter presents an overview of LFG work on Continental West-Germanic languages. It starts out by giving a broad characterization of the languages that are part of this group, with a special focus on their clause layout, that is, the placement of verbs and arguments in a clause. After this, the different LFG approaches to modelling this layout are discussed, followed by a selection of clausal and verbal domain topics such as topicalization and left-dislocation, asymmetric coordination, cleft constructions, and argument ordering and realization. The chapter concludes by reviewing LFG analyses of topics from the nominal domain, namely determiner-adjective declension, preposition-determiner contraction, case indeterminacy and possessive doubling.

1 Introduction

This chapter is concerned with the Lexical-Functional Grammar treatment of the present-day West-Germanic languages *sans* English or Scots. This group is sometimes referred to as Continental West Germanic (Zwart 2008), as it is mostly comprised of Germanic languages[1] spoken in countries on the European mainland: from Belgium and the Netherlands, through Luxembourg and Germany, to Switzerland, the northernmost parts of Italy, and Austria; and in addition in smaller regions bordering these countries. In spite of the label ‘continental’, the

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[1] Unless it is relevant to the discussion, I will use the term *language* in a broad sense that ignores matters like the language/language variety/regiolect/dialect/etcetera’s political status, whether a language label covers a homogeneous or heterogeneous group of subvarieties, or whether it is mutually intelligible with languages that do not fall under the same label.

Gerlof Bouma. 2023. LFG and Continental West-Germanic languages. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1407–1468. Berlin: Language Science Press. DOI: 10.5281/zenodo.10186010

group of Continental West Germanic languages (henceforth: CWG) also contains languages like Yiddish (spoken in Israel, North America and elsewhere), Afrikaans (South Africa and Namibia), Dutch in the Antilles and Suriname (in terms of language politics part of the same standardization body as Belgium and the Netherlands), and German heritage variants in the Americas (Putnam 2011) and Siberia (Andersen 2016), to name but a few group members outside of continental Europe.

In terms of L1 speakers, the largest of these languages are the standard varieties of German and Dutch, with circa 75 and 25 million speakers, respectively.[2] Their status as standardized national languages in multiple countries also means they are supported by strong academic infrastructures. It is therefore not surprising that most of the work on CWG in LFG is done on these two languages. Standard German and Dutch[3] will figure prominently in this chapter. This is merely a reflection of their salience in the LFG literature, and should not be interpreted linguistically, for instance as a sign of them being more typical CWG languages than other members of the language group.

A comprehensive inventory of West-Germanic languages with demographic and linguistic information can be found in Ethnologue[4] (Eberhard et al. 2019). Bibliographic data on West-Germanic can be found in Glottolog[5] (Hammarström et al. 2019). Note that neither of these resources distinguishes a CWG branch in their taxonomies. For an overview of the syntactic traits of Continental West Germanic, I refer the reader to Zwart (2008). An accessible description of how German is syntactically different from English and from the North-Germanic languages can be found in the introductory chapters of Haider (2010), with arguments that in many cases carry over to the other CWG languages.

1.1 A general picture of Continental West Germanic, with a focus on the clause

In this subsection we will discuss some of the syntactic traits of CWG. Our focus will be on the clause/verbal domain, since this has been the main interest of the LFG literature on CWG. We will discuss the nominal domain more briefly. The purpose of this subsection is twofold. First, it gives a very general impression of CWG syntax and indicates how it differs from its North- and West-Germanic

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[2] Counts based on Eberhard et al. (2019).

[3] Unless the context requires otherwise, I will use *German* and *Dutch* without further modification to refer to the standardized, national language varieties of these two CWG languages.

[4] https://www.ethnologue.com/subgroups/west-0, consulted July 2022

[5] https://glottolog.org/resource/languoid/id/west2793, consulted July 2022

neighbours. Secondly, it introduces some of the language-particular background needed to understand the individual LFG analyses discussed in the rest of the chapter.

1.1.1 Clause layout

A prominent syntactic feature of CWG languages is the combination of *asymmetric verb second* together with *verb final* (Zwart 2008, Haider 2010). The former label characterizes a clause structure in which the finite verb in main clauses, but *not* in subordinate clauses, is preceded by exactly one constituent, which can have a wide range of grammatical functions. The latter label covers the generalization that any verbal material that is not in second position – finite verbs in subordinate clauses and non-finite verbs in general – clusters together towards the end of the clause, potentially following arguments and adjuncts. As such, CWG contrasts with Modern English, which lacks both pervasive verb second in main clauses and verb finality, and follows a more rigid subject-verb-complement order. CWG also differs from the present-day North-Germanic languages, which can be characterized as combining verb second with subject-verb-complement order.[6]

For the discussion of the layout of a CWG clause, it is helpful to make use of the so-called *topological field model* of the clause, which can be found in traditional descriptions of German and Dutch and in reference grammars like Zifonun et al. (1997) and Haeseryn (1997). In this model, the layout of a clause is described in terms of linearly ordered fields, and different word order variants associated with different clause types are obtained by assigning constituents to different fields. The field schema we use in this chapter is given in (1).

(1) lead ‖ Vorfeld | left bracket | Mittelfeld | right bracket | Nachfeld ‖ tail

In a main clause, the *left bracket* (lb) and *right bracket* (rb) are reserved for verbal material: a single, second-position finite verb is in the left bracket, and any other verbs are in the verb cluster in the right bracket. Between the brackets there is the *Mittelfeld* 'middle field' (Mf), which may contain any number of constituents.

---

[6] Two remarks are in order with respect to this characterization of CWG clause layout. First, as it can be used to demarcate CWG from English as well as from North-Germanic, it gives some linguistic substance to the pooling of CWG languages into one group, as we do in this chapter. Secondly, and somewhat weakening the first point, once we start to look closer at individual CWG languages, we find deviations from the general pattern. Modern Yiddish in particular fits the description poorly, both in terms of the verb-second pattern and the verb-final pattern. It is beyond the scope of this chapter to go into all the exceptions, but some of them will be discussed towards the end of this section and in the context of LFG analyses of these exceptions.

The *Vorfeld* ‘prefield’ (Vf) is the designated place for the single constituent preceding the finite verb, whereas the *Nachfeld* ‘postfield’ (Nf) may contain several items, and is typically reserved for heavier constituents like clausal arguments, extraposed relative clauses and adverbial prepositional phrases. The *lead* and *tail* fields[7] host material that is more loosely connected to the clause, such as vocatives and hanging topics. Note that not every field needs to contain material. Examples of different declarative main clause types are given in (2).

(2) Dutch

a. Subject-initial declarative:

Vf———		lb—	Mf———		rb———
De	draken	doen	Doris	dadelijk	duizelen.
the	dragons	make.PRS.PL	Doris	immediately	feel.dizzy.INF

‘The dragons immediately make Doris feel dizzy.’

b. Object-initial declarative:

Vf—	lb—	Mf———			rb———
Doris	doen	de	draken	dadelijk	duizelen.
Doris	make.PRS.PL	the	dragons	immediately	feel.dizzy.INF

c. Sentence adverb-initial declarative:

Vf——	lb—	Mf———			rb———
Dadelijk	doen	de	draken	Doris	duizelen.
immediately	make.PRS.PL	the	dragons	Doris	feel.dizzy.INF

The verb-second constraint is clear here: the finite verb is always in the left bracket and precedes its subject if a non-subject is in the Vorfeld (2b,c). The subject and object can appear in identical positions – contrast the OVS order in (2b) with SVO in (2a). Linear order is therefore not fully determined by grammatical function, or vice versa. The Vorfeld is also the target of long-distance dependencies, like fronting of wh-constituents out of embedded clauses (not shown here). The Mittelfeld may contain a collection of (nominal) arguments and (simple) adverbials, which are typically local to the clause. The extent to which the order of material within the Mittelfeld is fixed differs between languages (see Section 2.4.1). Grammatical-function assignment under word order variation, long-distance dependencies, and the order of elements in the Mittelfeld are all basic CWG phenomena that the LFG models discussed below must address.

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[7] The terminology around these last two fields is not as established as for the fields that are part of the clause proper. The lead is for instance also known as *Vorvorfeld* ‘pre-prefield’ or *linkes Außenfeld* ‘left outfield’, and the tail as *Nachnachfeld* ‘post-postfield’ or *rechtes Außenfeld* ‘right outfield’.

Other clause types have empty Vorfeld regions, such as the polar interrogative (3a), which is a verb-first construction, and the subordinate clause (3b), in which the left bracket is filled by the complementizer.

(3) Dutch

a. Polar interrogative:
lb—— Mf—————————— rb———
Doen de draken Doris dadelijk duizelen?
make.PRS.PL the dragons Doris immediately feel.dizzy.INF

b. Subordinate:
lb– Mf—————————— rb——————
…dat de draken Doris dadelijk doen duizelen.
COMP the dragons Doris immediately make.PRS.PL feel.dizzy.INF

Example (3b) has the finite verb in the right bracket, in the verb cluster. This shows the asymmetry of the verb-second phenomenon: unlike in a main clause, the finite verb in a subordinate clause can be preceded by any number of constituents in the Mittelfeld. The topological model accommodates the complementary distribution of the finite verb of a main clause and the complementizer of a subordinate clause by locating both in the left bracket.

The right bracket in (3b) contains two verbs: first the finite verb, then the non-finite verb. This is considered to be the default order in Standard Dutch, but there is considerable variation in this ordering, both between and within CWG languages. An extensive overview of ordering possibilities in CWG verb clusters is given in Wurmbrand (2004).

The topological schema based on the combination of verb second and verb final is widely applicable to the CWG languages, but, as with any generalization, there are cases where it does not apply. To start, we must keep separate the notion of main clause vs. subordinate clause *word order* from the notion of unembedded and embedded clause *uses*. This is because German, amongst others, allows embedded clauses to have verb second under bridge verbs in the absence of a complementizer (see Section 2.2.1); that is, it allows main clause word order for certain embedded clauses. Furthermore, the separation of non-verbal material in the Mittelfeld and verbal material in the right bracket is not always as clean as the topological model suggests, as languages may allow for material from the two fields to be mixed, blurring the border between them (see Section 2.1.2). Finally, Afrikaans and Yiddish have clause structures that deviate further. Spoken Afrikaans optionally allows the combination of a complementizer and verb second in subordinate clauses (Biberauer 2009). Modern Yiddish has verb second in main as well as in subordinate clauses, and in addition its status as a verb-final language is debated (Diesing 1997). Historical stages of Yiddish did however follow CWG's characteristic pattern more closely (Santorini 1992).

1.1.2 Clause union

The examples in (2) and (3) each contain two verbs. We have discussed the topological model as a schema of the clause, without questioning whether we are dealing with mono-clausal structures here. Since Bech (1955/1957), it is common to distinguish between *coherent* and *incoherent* verb combinations. The former describes a combination of two verbs into a single clause, *clause union*, whereas the latter results in a biclausal structure. The contrast is illustrated below. In (4a), the coherently combining *durfde* 'dared' shares the verb cluster with its embedded verb *te kopen* 'to buy', and the embedded object sits in the Mittelfeld of the clause headed by *durfde*. Example (4b) contains the incoherently combining *beloofd* 'promised', and here we see that both the embedded verb and its object appear after the matrix verb, in the Nachfeld of the matrix clause. As shown in (4c), this word order is not available for the coherently combining *durfde* 'dared'.

(4) Dutch

a.

	lb——	Mf——		rb——	
	…omdat	hij	geen auto	durfde	te kopen.
	because	he	no car	dared	buy.TEINF[8]

'…because he didn't dare to buy a car.'

b.

	lb——	Mf	rb——	Nf——	
	…omdat	hij	beloofde	geen auto	te kopen.
	because	he	promised	no car	buy.TEINF

'…because he promised not to buy a car.'

c.

*	…omdat	hij	durfde	geen auto	te kopen.
	because	he	dared	no car	buy

The second sign that we are dealing with one clause in (4a) and two in (4b) is the scope of the negation, as evident from the translations. In both examples, negation is marked on the embedded object through the negative determiner but it nevertheless scopes over the finite verb in (4a). The same negation marking in the biclausal (4b) yields a narrow scope negation.

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[8] The abbreviations TEINF and ZUINF in the glosses are used for the verb forms in Dutch and German that combine the infinitive marker (*te* in Dutch, *zu* in German) with an infinitive. Unlike corresponding forms in for instance English, these combinations are generally not separable.

A third phenomenon associated with clause union is the potential to trigger *infinitivus pro participio* (IPP; German: *Ersatzinfinitiv* ‘replacement infinitive’). IPP refers to the realization of a verb in the infinitive when a participle is expected on the basis of the selecting auxiliary. For this to occur, the clause itself must also contain a further, lower verb in the infinitive.[9] The occurrence of IPP is therefore evidence of the middle and lower verb combining coherently. Below, IPP is triggered in (5a), affecting the coherently combining *durven* ‘dare’, but not in (5b) for the incoherently combining *beloofd* ‘promised’.

(5) Dutch[10]

a. Hij heeft geen auto {durven / *gedurfd} te kopen.
he has no car dare.INF dare.PTCP buy.TEINF
‘He didn’t dare to buy a car.’

b. Hij had {beloofd / *beloven} geen auto te kopen.
he had promise.PTCP promise.INF no car buy.TEINF
‘He promised not to buy a car.’

Example (5a) additionally shows that a clause can contain more than two verbs. In principle, there is no limit to the number of verbs involved in clause union, since the same couple of coherently combining verbs can appear at multiple levels of embedding.[11]

A wide range of verbs allow for coherent combination. For instance, for Dutch, the reference grammar Haeseryn (1997) lists over 100 verbs that always combine coherently, and an additional 20 that do so optionally. In this list we find auxiliaries; evidential, modal and aspectual verbs; but also verbs with a clearer lexical contribution such as causal and perceptual verbs, and for instance verbs corresponding to *help*, *learn*, *try* or *forget*. In theoretical syntactic work, combining behaviour is commonly taken to be an underived, lexical property of the embedding verb, but see Cook (2001) for an explanation of coherence in German in terms of information structure.

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[9] Further conditions may apply, for instance on the order of the auxiliary and the middle verb.

[10] A note on the use of brackets and parentheses in examples in this chapter: I will use curly brackets to indicate choice. The choice is either between several forms in one position, such as in the current example (5), or between several positions for one form, such as in the example in (28). Square brackets delimit constituents when this is relevant, such as in (6). Parentheses indicate optionality as usual.

[11] In practice, it seems that three-verb combinations are common, but more complex clauses are rare. For instance, Coussé & Bouma (2022) report numbers for a mixed corpus of written and spoken Dutch: about 3% of coherence domains contain three verbs, but only 0.1% contain four verbs.

1.1.3 Crossing dependencies

When we have coherently combining verbs that also introduce their own object, we can end up with a clause in which a sequence of objects in the Mittelfeld is followed by a corresponding sequence of verbs in the cluster. In languages like German or West Frisian, the unmarked order of the objects is by increasing order of embedding $O_1O_2...O_n$, whereas the order of verbs is by decreasing order of embedding $V_n...V_2V_1$. This gives rise to a pattern of nested dependencies between the objects and their verbs (6).

(6) Standard German

		O_1		O_2		V_2	V_1
…dass	wir	[dem	Hans]	[das	Haus]	streichen	halfen
COMP	we	the.DAT	Hans	the.ACC	house	paint	helped

'…that we helped (V_1) Hans (O_1) paint (V_2) the house (O_2).'

In Dutch and Swiss German, however, objects and verbs can *both* be ordered by increasing level of embedding $O_1O_2...O_n$ and $V_1V_2...V_n$. This creates cross-serial dependencies between objects and verbs, as in (7).

(7) Swiss German (Shieber 1985: §2, example 1)

		O_1		O_2		V_1	V_2
…das	mer	[em	Hans]	[es	huus]	hälfed	aastriiche.
COMP	we	the.DAT	Hans	the.ACC	house	helped	paint

The phenomenon of cross-serial dependencies has received ample interest in the literature, because it requires more than context-free power to model (Bresnan et al. 1982, Pullum & Gazdar 1982, Shieber 1985).

1.1.4 In and around the nominal domain

We end the overview of CWG syntax by briefly discussing the main characteristics of the nominal domain and, even more briefly, adpositions. This is to give a general sense of what these domains look like in CWG languages. Most of what is discussed below resembles what we find in the North-Germanic languages and English.

The nominal domain in CWG generally follows a determiner–adjective–noun pattern, with further adnominal material (relative clauses, PPs, etc.) realized postnominally. This is exemplified in (8).

(8) Dutch
de mooiste plek van Europa
the beautiful.SUPERLATIVE place of Europe
'the most beautiful place in Europe'

Present-day CWG languages have at most four cases (NOM, GEN, DAT and ACC; for example Standard German), but many make fewer case distinctions (see Kasper 2014 for a compact description of the situation in German varieties and references), and several have only a subject-object form distinction remaining in the pronominal paradigm (for example, Afrikaans, Dutch, and West Frisian).[12] There are two numbers (SG, PL). Any of three genders (M, F and N; Alemannic[13], Low Saxon,[14], Standard German, West Flemish), two genders (COMMON gender and N; Dutch, West Frisian) or no distinction (Afrikaans) may occur. Gender agreement distinctions only show up in the singular. The different paradigm sizes with respect to gender are illustrated in (9). Note the form contrasts in the definite determiners.

(9) a. Alemannic
d Frau dr Maa s Chind
the.F.NOM woman the.M.NOM man the.N.NOM child
b. West Frisian
de frou de man it bern
the.COMMON woman the.COMMON man the.N child
c. Afrikaans
die vrou die man die kind
the woman the man the child

Adjectives can be associated with multiple inflectional paradigms – see Section 3.2.2 for a discussion of these *declension classes* in Standard German. Even in languages with more elaborate paradigms, there is typically a great level of syncretism between forms across inflectional dimensions for determiners, pronouns, adjectives and nouns. The consequences of syncretism for grammatical modelling are discussed in Section 3.2.4.

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[12] See taalportaal.org for linguistic descriptions of Afrikaans, Dutch, and West Frisian. Consulted September 2022.

[13] The term Alemannic (German) covers amongst others Alsace German, Swabian and Swiss German.

[14] Low Saxon is used interchangeably with Low German by some authors. Our use of the term here comprises regional languages of the north of Germany and the east/north-east of the Netherlands. Our choice for the term Low Saxon is partly driven by the fact that LFG work on this language uses this term: see Section 3.2.1.

Adpositions are overwhelmingly prepositional (10a), but the sporadic postposition (10b) and circumposition (10c) occur as well.

(10) Gronings (Low Saxon)

a. **op** de grìns
on the border
'on the border'

b. t haile joar **deur**
the whole year through
'the whole year through'

c. **om** de provìnzie **tou**
around the province around
'around the province'

1.2 Overview of the rest of the chapter

Thus far, I have talked about the geographic distribution and the syntactic characteristics of the Contintental West-Germanic languages, to define the scope of the chapter, and to give a background for what is to come below.

The remainder of this chapter is devoted to LFG analyses of different aspects of CWG syntax. In Section 2, I discuss LFG accounts of the clause and the verbal domain, and in Section 3, I discuss LFG studies of the nominal domain. These sections are structured in a parallel fashion: they start with analyses of the overall structure of their respective domains, and then continue with a discussion of more specific LFG accounts organized by topic. In the LFG literature on CWG, the clausal and verbal domains have received by far the most attention, which means that the corresponding section dominates this chapter in terms of size.

The chapter ends with concluding remarks in Section 4, in which I briefly touch upon some LFG and LFG-related work that was not included in detail here, and give pointers for further reading.

2 LFG analyses in the clausal and verbal domains

This section deals with phenomena at the level of the clause. I will start in Section 2.1 with a discussion of the variety of ways in which the overall shape of the clause has been modelled, mostly in terms of c-structure. I then look at specific topics that have been prominent in the LFG literature on CWG languages. The topics are divided into thematic sections. Phenomena at the left and right periphery are discussed in Section 2.2 and Section 2.3, respectively. Studies dealing with the ordering of dependents are discussed in Section 2.4. Finally, mapping-based analyses of areas of CWG clause syntax are presented in Section 2.5.

2.1 The overall shape of the clause

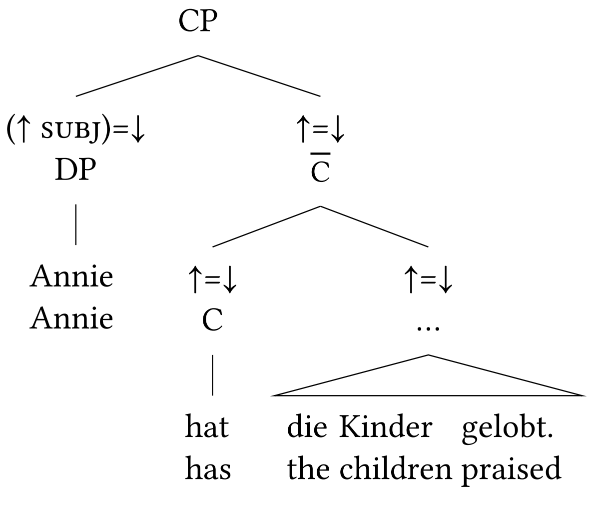
The discussion of the different LFG conceptions of the overall shape of the clause is organized according to the topological field model. I first consider the top level of the clause (directly containing the Vorfeld and left bracket) in Section 2.1.1, and then the lower level of the clause (the Mittelfeld and right bracket) in Section 2.1.2. The Nachfeld is discussed in Section 2.1.3.

2.1.1 Vorfeld and left bracket

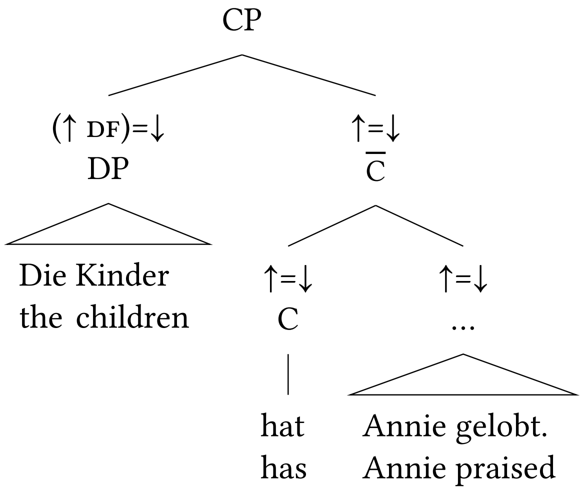
Berman & Frank (1996), Choi (1999), Berman (2003), and Frank (2006) model the German verb-second clause as a CP. The finite verb sits in C irrespective of whether the initial position is occupied by the subject of a declarative clause (11a) or by some other element, like the object in (11b). The complementary distribution between the finite verb and the complementizer in the left bracket follows as well: the complementizer can only appear in C, and when it is realized, the finite verb must occur in another, lower position (11c).

(11) German

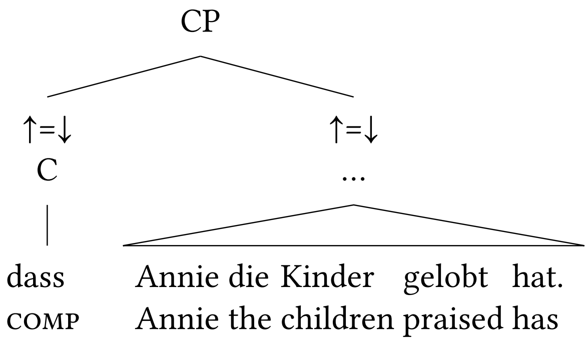
a.



b.



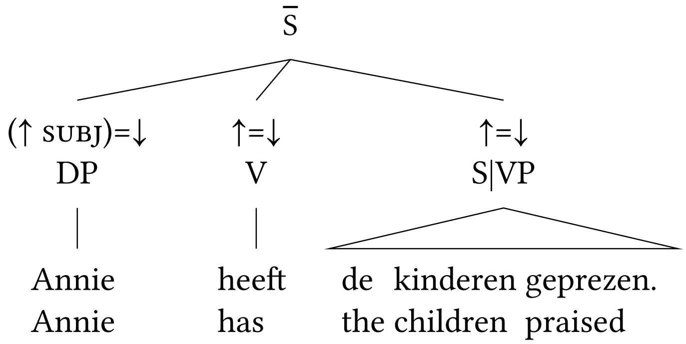
c.



The nature of Comp-CP, the node dominating the combined Mittelfeld and right bracket, differs between these authors, however, and will be discussed below. Van der Beek (2005) and Jones (2020), on Dutch, consider only main clauses, which they posit to be IPs.

Zaenen & Kaplan (1995, on Dutch; 2002 on German) prefer a slightly flatter structure, exemplified in (12). The label 'S|VP', a convention from the cited papers, is used to show that the authors do not wish to choose between these categories.

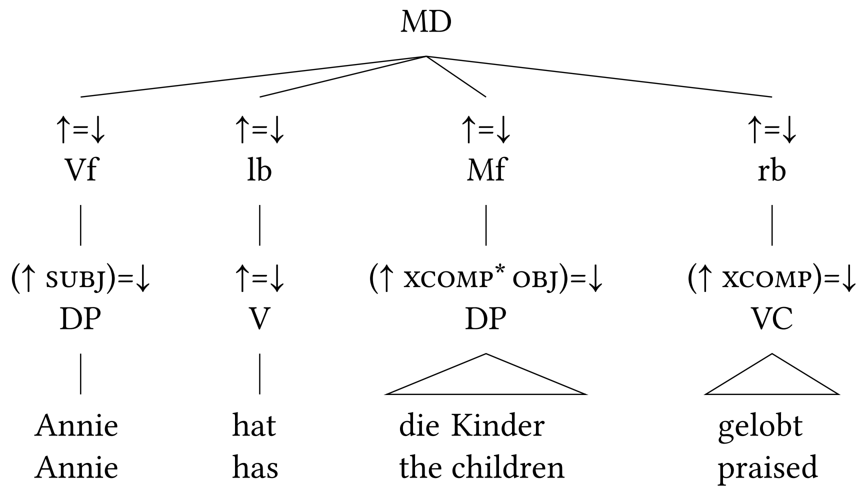
(12) Dutch



Zaenen & Kaplan's subordinate clauses are isomorphic to those in (11c), but are labelled $\overline{\text{S}}$ instead of CP.

An even flatter structure appears in the computational grammar fragment discussed in Clément et al. (2002), who model the topological field schema directly in LFG. All topological fields are c-structure nodes and direct descendants of the MD node ('main domain') that represents the whole sentence. Example (13) gives a somewhat simplified tree, using the abbreviations for the topological fields which I introduced in Section 1.1.1.

(13)



A very similar flat structure can be found in Rohrer (1996).[15]

2.1.2 Mittelfeld and right bracket

The Mittelfeld and right bracket form the lower c-structure level in the clause. This is the unlabelled Comp-CP in (11) and the S|VP node in (12). All authors agree that this part of the tree does *not* involve an IP.[16] This choice against an

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[15] Rohrer (1996), however, also writes "Diese flache Struktur läßt sich problemlos in eine binäre rechtsverzweigende Struktur umwandeln. [...] Wir behalten das flache Mittelfeld hier primär aus expositorischen Gründen bei" (p96, fn 3). [This flat structure can be converted to a binary right-branching structure without problems. We maintain the flat Mittelfeld here primarily for reasons of exposition.]

[16] In fact, in LFG, the assumption of an IP anywhere in CWG c-structure is rare. We mentioned Van der Beek (2005) and Jones (2020), on Dutch, who use it as the category at the top level, for the whole V2 declarative clause. The choice is not further motivated in these works, and moreover it is peripheral to the respective discussions. Bresnan et al. (2016) posit that Comp-CP contains an IP in one of the book's exercises on German. However, since this is a textbook, it is unclear whether the authors are theoretically committed to this choice, or whether it was made for other reasons, for instance pedagogical ones.

intermediate IP can also be found in analyses of German in the Chomskyan tradition, for instance in the line of work summarized in Haider (2010: see §2.2 therein for an overview of the arguments).

A salient question in the analysis of this part of the clause is the order of the verbs and the arguments, and the concomitant contrast between nested versus cross-serial dependencies. We will focus first on the two polar opposites: verbs ordered after increasing level of embedding (cross-serial dependencies) and verbs ordered after decreasing level of embedding (nested dependencies). The following pair, a variation on (6–7) above, illustrates the difference with three verbs in the verb cluster:

(14) a. Standard German
…dass wir [die Kinder] [dem Hans] [das Haus] streichen helfen lassen
COMP we the.ACC children the.DAT Hans the.ACC house paint help let
'…that we let the children help Hans paint the house.'

b. Swiss German (Shieber 1985: §2, example 5)
…das mer [d' Chind] [em Hans] [es huus] lönd hälfe aastriiche.
COMP we the.ACC children the.DAT Hans the.ACC house let help paint.

As mentioned in the introduction, there is considerable variation in the order of the verbal elements beyond these two opposites, and there is even variation in the extent to which the nominal material in the Mittelfeld and verbal material in the right bracket is kept separated, both between and within CWG languages. This variation will be briefly discussed at the end of this subsection.

2.1.2.1 Cross-serial dependencies

An early LFG analysis of Dutch cross-serial dependencies is found in Bresnan et al. (1982), which was a prominent demonstration of how LFG's formalism has the power needed for linguistically valid analyses of such dependencies.[17] Starting from a proposal by Evers (1975), schematically in (15a), with a flat Mittelfeld and a right-branching verb-cluster, Bresnan et al. argue that a structured Mittelfeld is to be preferred, as in (15b).

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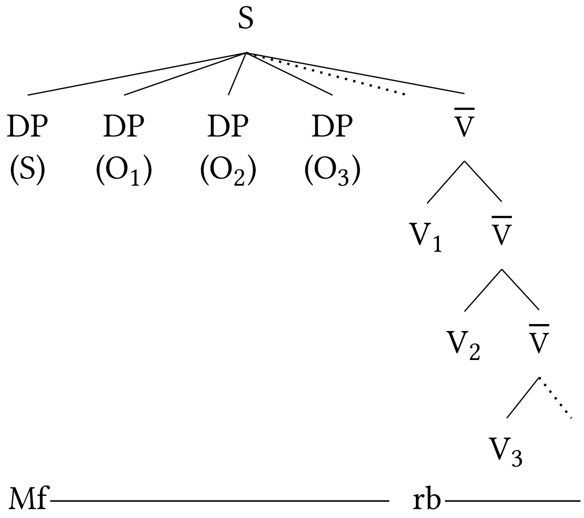
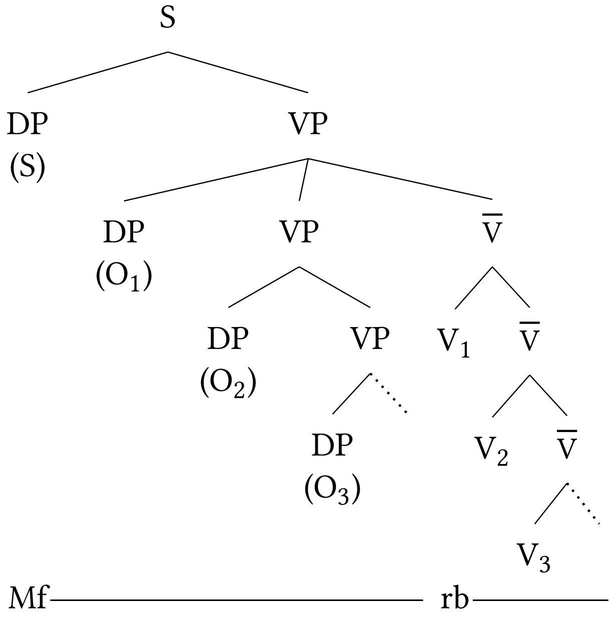
[17] The paper played a central role in the discussion of the context-freeness of natural language syntax. See e.g. Pullum & Gazdar (1982) and Shieber (1985) for more discussion of the issues involved and the kind of evidence considered.

(15) a.



b.



The tree in (15b) contains two parallel embedding structures: one for the objects in the Mittelfeld and one for the verbs in the right bracket. This is captured in the c-structure definitions in (16).

(16) a. $$\text{S} \longrightarrow \underset{(\uparrow \textsc{subj})=\downarrow}{\text{DP}} \quad \underset{\uparrow=\downarrow}{\text{VP}}$$

b. $$\text{VP} \longrightarrow \begin{pmatrix} \text{DP} \\ (\uparrow \textsc{obj})=\downarrow \end{pmatrix} \begin{pmatrix} \text{VP} \\ (\uparrow \textsc{xcomp})=\downarrow \end{pmatrix} \begin{pmatrix} \overline{\text{V}} \\ \uparrow=\downarrow \end{pmatrix}$$

c. $$\overline{\text{V}} \longrightarrow \underset{\uparrow=\downarrow}{\text{V}} \quad \begin{pmatrix} \overline{\text{V}} \\ (\uparrow \textsc{xcomp})=\downarrow \end{pmatrix}$$

For the objects, each level of VP embedding adds a level of xcomp embedding at f-structure. For the verbs, each level of $\overline{\text{V}}$ embedding does the same. A compatible stacking of xcomps is thus built up in both parts of the tree. The optionality of the object DP in (16b) allows for verbs that do not introduce their own object. It is essential that an xcomp level is introduced for these in both parts of the tree, too, to maintain the parallel structure.

The accusative with infinitive verbs involved in the cross-serial construction are analyzed as raising-to-object verbs. The inflected verb form *zag* ‘saw’, for instance, receives a lexical entry along the lines of (17).

(17) *zag* V (↑ pred)=‘see⟨subj,xcomp⟩obj’
(↑ xcomp subj)=(↑ obj)
(↑ xcomp form)=inf
(↑ subj num)=sg
(↑ tense)=pst

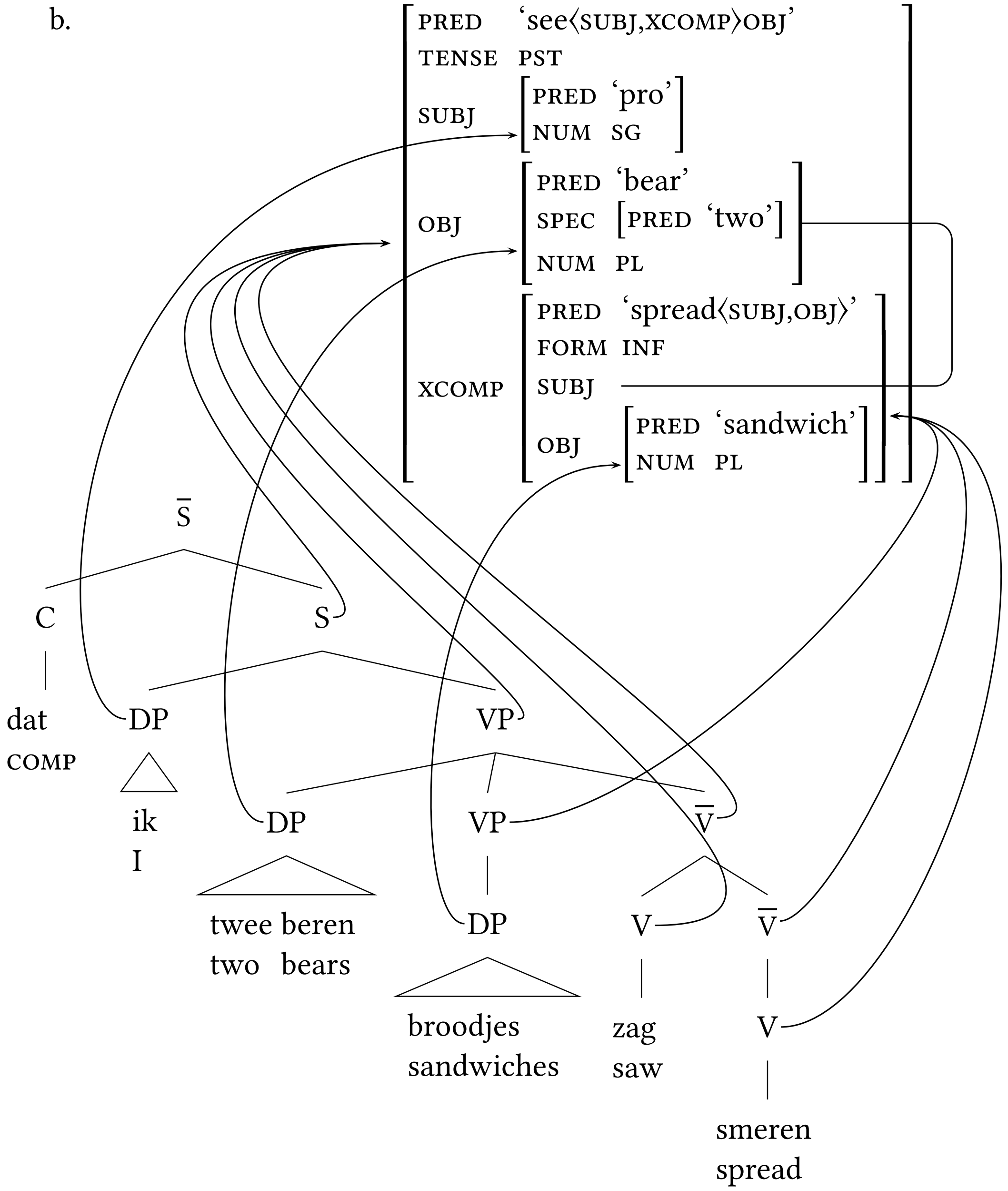
Complemented with rules for DPs and additional lexical entries, this grammar fragment gives us analyses like the one in (18).

(18) a. Dutch

	S	O_1		O_2	V_1	V_2
…dat	ik	[twee	beren]	broodjes	zag	smeren.
comp	I	two	bears	sandwiches	saw	spread

‘…that I saw (V_1) two bears (O_1) prepare (V_2) sandwiches (O_2).’

b.



However successful in capturing cross-serial dependencies, this analysis runs into descriptive problems if taken more generally as a model of the Dutch sentence. Zaenen & Kaplan (1995) give the example in (19), which involves the coordination of two V̄s that each require a different level of XCOMP embedding for the object supplied in the Mittelfeld.

(19) Dutch (Zaenen & Kaplan 1995: §2.3, example 9)

…dat	Jan	een	liedje	[[$_{\overline{\text{V}}}$ schreef]	en	[$_{\overline{\text{V}}}$ trachtte	[$_{\overline{\text{V}}}$ te verkopen]]].
comp	Jan	a	song	wrote	and	tried	sell.teinf

'…that Jan wrote and tried to sell a song.'

Since different levels of xcomp embedding of the object correspond to different c-structures in the model of Bresnan et al. (1982), example (19) cannot receive an analysis if we use the standard treatment of constituent coordination in LFG. It would require the shared material to receive two different c-structures at the same time. Zaenen & Kaplan's (1995) alternative relies on functional uncertainty to connect the objects to predicates at the required level of xcomp embedding, and on functional precedence rules to make sure that the linear order of objects reflects their level of embedding. They replace the VP and $\overline{\text{V}}$ rules of (16) with those in (20).

(20)

a. $\text{VP} \longrightarrow \underset{(\uparrow \text{XCOMP}^{*}\ \text{OBJ})=\downarrow}{\text{DP}^{*}} \quad \underset{\uparrow=\downarrow}{\overline{\text{V}}}$

b. $\overline{\text{V}} \longrightarrow \underset{\uparrow=\downarrow}{\text{V}} \left(\begin{array}{c} \overline{\text{V}} \\ (\uparrow \text{XCOMP})=\downarrow \\ \neg\big((\uparrow \text{XCOMP}^{+}\ \text{OBJ}) <_f (\uparrow \text{OBJ})\big) \end{array} \right)$

This analysis abandons the nested c-structure of the VP in favour of a flat one, which moves us back in the direction of (15a). The functional uncertainty equation on the object DP in (20a) allows connecting the object to a predicate at any depth of xcomp embedding, and the general principles of f-structure coherence and completeness make sure each object is matched to exactly one predicate. The functional precedence constraint on the $\overline{\text{V}}$ node in (20b) prevents more embedded objects from preceding less embedded ones. Together, these f-structure constraints force the same relation between Mittelfeld objects and right bracket verbs as the c-structures subtrees in Bresnan et al.'s analysis. Moreover, the interaction between functional uncertainty and the standard LFG approach to constituent coordination lets us handle sentences like (19) correctly.

Zaenen & Kaplan (1995) also apply the combined use of functional uncertainty and functional precedence to Zürich German, where cross-serial dependencies are observed as well.

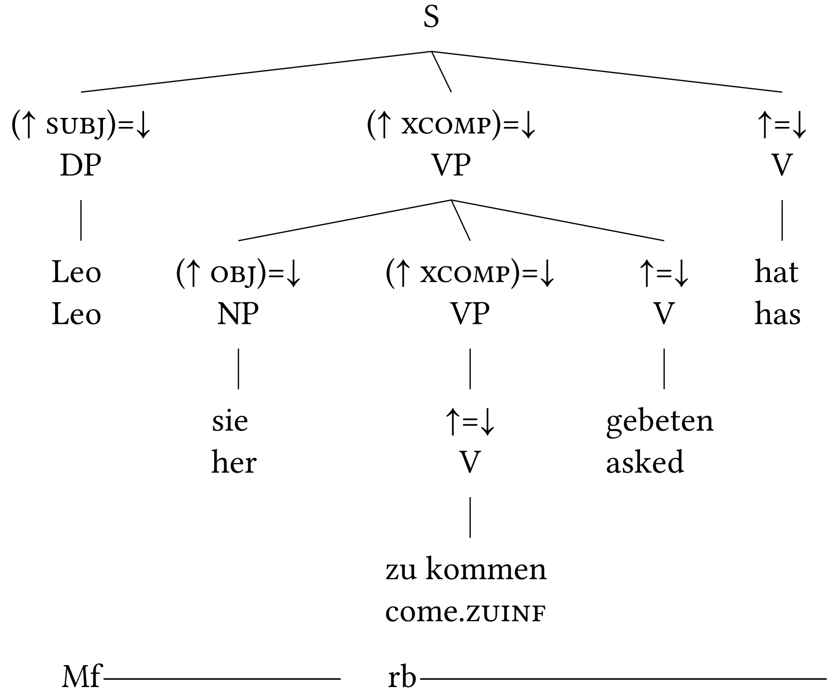
2.1.2.2 Nested dependencies

The analyses of the structures that would give rise to consistently nested dependencies all come from LFG work on Standard German. However, explicit discussion of constructions with multiple objects at different levels of embedding is rare in this part of the literature – perhaps because the modelling of these dependencies is not seen as particularly problematic. We therefore do not always fully know how the relevant nested dependencies are to be derived in these LFG models.

Some authors assume nested VPs, which rather naturally correspond to nested dependencies between objects and verbs, even when this consequence is not a central concern. One example is the grammar fragment of Netter (1988), who gives annotated c-structures like the one in (21).

(21) a. German (Netter 1988: §1, example C4)
…dass Leo sie zu kommen gebeten hat.
COMP Leo her come.ZUINF asked has
'…that Leo asked her to come.'

b.



We also find nested VPs in Choi (1999), where the combined Mittelfeld and verb cluster of the subordinate clause in (22a) would get the structure given in (22b).[18]

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[18] Choi (1999) does not provide a tree for this exact sentence, but does show a more complex example with a comparable structure. In addition, Choi (1999) never explicitly motivates the specific c-structure associated with embedded verbs in the VP. Nevertheless, we can infer the structure given here from the examples and discussion there.

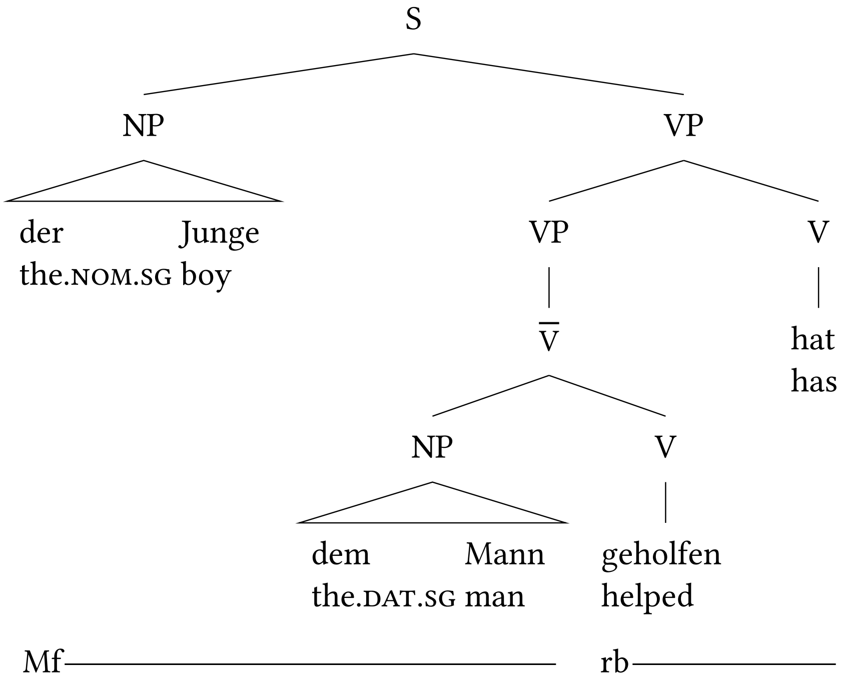
(22) German

a.

…dass	der	Junge	dem	Mann	geholfen	hat.
COMP	the.NOM.SG	boy	the.DAT.SG	man	helped	has

'…that the boy has helped the man.'

b.



In addition to a nested VP structure, the tree in (22b) shows the subject appearing in S and the object inside the VP. Any deviations from the canonical word order implied by this structure are modelled using optional adjunction of objects to higher positions. Choi (1999) motivates this partially configurational structure for German by appealing to contrasts like the following: a verb and its object can be realized together in the Vorfeld (23a), whereas – it would appear – a verb and its subject cannot (23b).

(23) German(Choi 1999: §2.1, example 12)

a.

[Dem	Mann	geholfen]	hat	der	Junge.
the.DAT.SG	man	helped	has	the.NOM.SG	boy

'Help the man, the boy did.'

b. *

[Der	Junge	geholfen]	hat	dem	Mann.
the.NOM.SG	boy	helped	has	the.DAT.SG	man

Under Choi's analysis, this contrast follows straightforwardly by assuming that a VP, unlike an S, can be put in the Vorfeld.

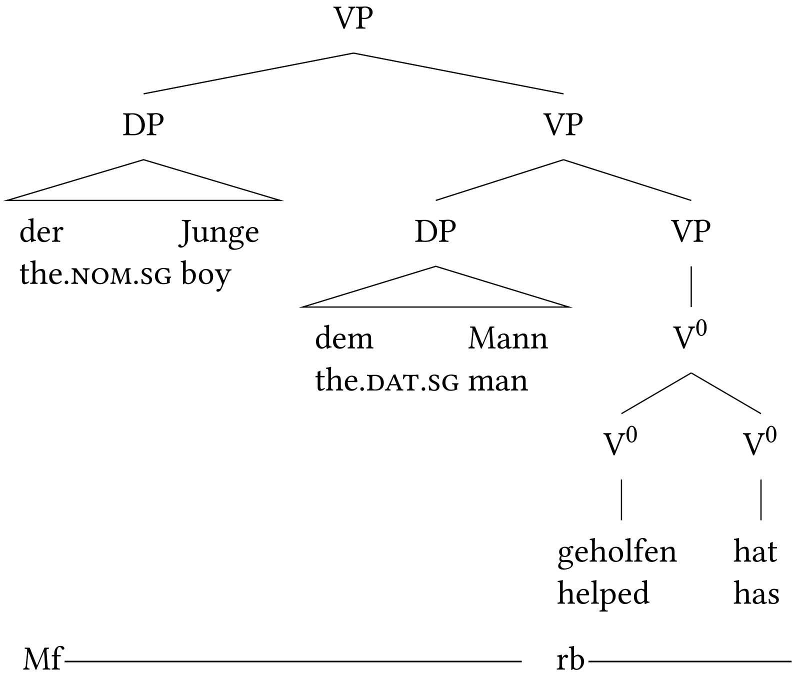
These analyses with nested VPs, which in principle could directly yield the pattern of nested dependencies we find in German, do *not* have a single node containing the whole right bracket and nothing else. Put differently, they do not include the verb cluster as such. This contrasts with the analyses we saw for the cross-serial dependency languages (Dutch, Zürich German) above, where the verb cluster exactly matched a $\overline{\mathrm{V}}$ node.

Proposals for Standard German that have a c-structure node corresponding to the verb cluster do exist in the LFG literature. One prominent such proposal is made by Berman (2003), who rejects Choi's claim that the German VP includes the object but excludes the subject, on the basis of data like (24), which, in contrast to (23b), is a successful example of Vorfeld realization of a verb with its subject.

(24) German (Berman 2003: §3.2.3.2, example 28a)
[Kinder gespielt] haben hier noch nie.
children played have here yet never
'Children have never played here.'

Instead of assuming that there are canonical positions for subjects and objects in S and VP respectively, and that only scrambled objects are adjoined, Berman does away with S completely, and always adjoins Mittelfeld arguments to VP. Furthermore, Berman posits that verbs in the verb cluster are combined by head adjunction. The structure of (23a) under this model is then (25).

(25)



Since the association of arguments with their predicates can no longer rely on positional grammatical function annotations, Berman (2003) argues that case is responsible for this association in German. This is modelled using the standard approach of conditional expressions that relate specific cases to specific functions, for instance, $(\downarrow \textsc{case})=\textsc{acc} \Rightarrow (\uparrow \textsc{obj})=\downarrow$. However, Berman does not discuss how this standard approach should be extended to allow embedded objects of coherently combined verbs in general, and it is not clear how one would correctly constrain the projection of multiple Mittelfeld objects onto f-structures that are embedded under one or more layers of xcomp without resorting to nested VPs or functional uncertainty.[19]

We have seen that the (idealized) Dutch and German patterns are mirror images in terms of the order of the verbs in the verb cluster. The approach of Zaenen & Kaplan (2002) capitalizes on this by taking the mirror image of the $\overline{\mathrm{V}}$ rule for Dutch in (20b) as the basis for their analysis of the German verb cluster (26).

(26)
$$\overline{\mathrm{V}} \quad \longrightarrow \quad \begin{pmatrix} \overline{\mathrm{V}} \\ (\uparrow \textsc{xcomp})=\downarrow \\ \neg((\uparrow \textsc{xcomp}^{+}\ \textsc{obj}) <_f (\uparrow \textsc{obj})) \end{pmatrix} \begin{matrix} \mathrm{V} \\ \uparrow=\downarrow \\ \end{matrix}$$

As before, in the proposal for Dutch, the highest $\overline{\mathrm{V}}$ node corresponds directly to the right bracket and functional uncertainty solves the relation of Mittelfeld material to embedded verbs without having to assume nested VPs.

2.1.2.3 Variation

I already mentioned at the beginning of this subsection that characterizing languages as having either cross-serial or nested dependencies is an oversimplification. For instance, both German and Dutch allow further variation in the ordering of elements in the verbal cluster. Moreover, in Zürich German – amongst other CWG languages – Mittelfeld and right bracket material can mix to some extent.

In German, *Oberfeldumstellung* (Bech 1955/1957: Vol I, §62–§66; an alternative term is auxiliary flip) can occur with three-verb combinations where V_1 is a perfect or passive auxiliary, and V_2 is itself a coherently combining verb that selects

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[19] Berman (2003) partially sidesteps the issue by (tacitly) assuming that auxiliaries add features and do not create xcomp embeddings. This means that, for instance, *lobte* 'praised' and *hat gelobt* 'has praised' both have their objects directly in the containing f-structure as objs. However, since not all coherently combining verbs can be analysed as auxiliaries and some clearly have enough lexical content to warrant their own pred values, this does not completely address the problem.

an infinitive. In this construction, the verb cluster has the order $V_1V_3V_2$, and IPP is triggered for V_2. Contrast the "regularly ordered" (27a) with the Oberfeldumstellung in (27b).[20]

(27) German (Cook 2001: §1.4, example 1.31)

a. …dass ich dich kommen gesehen habe.
COMP I you.ACC.SG come.INF seen have.PRS
'…that I have seen you come.'

b. …dass ich dich habe kommen sehen.
COMP I you.ACC.SG have.PRS come.INF see.INF

This word order variant is problematic for the nested VP models mentioned above (namely, Netter 1988, Choi 1999), since the verb cluster-initial finite verb "interrupts" the embedded VP. Models in which a c-structure node corresponds to the verb cluster (namely, Zaenen & Kaplan 2002, Berman 2003, Clément et al. 2002) have an easier time capturing such variation. An analysis of this variation can be found in Clément et al. (2002: in terms of c-structure) and in Cook (2001: in terms of the interaction between syntax and information structure). An OT-LFG analysis of verb order in Swiss German dialects is outlined in Seiler (2007).

Dutch verb clusters have so-called *participle climbing* and *particle climbing*, which refer to the realization of participles and particles to the left of the position expected from the principle of ordering by increasing embedding. Example (28) shows the different positions a particle can occupy in a three-verb cluster.

(28) Dutch
…dat Jan het liedje {mee} zal {mee} hebben {mee-}gezongen.
COMP Jan the song along will along have along-sung
'…that Jan will have sung along to the song.'

Kaplan & Zaenen (2003) adapt their earlier model of the Dutch Mittelfeld and verb-cluster to allow these and further variants, and to capture the IPP effect. Poortvliet (2015) is a further development of this model.

Zürich German has cross-serial dependencies, like Dutch, but in addition allows the nominal and verbal material to mix, as in (29).

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[20] *Oberfeldumstellung* also occurs with longer verb clusters. Furthermore, there is a (possibly regional) construction called *Zwischenstellung* that has $V_3V_1V_2$. See Cook (2001) for empirical discussion and an analysis.

(29) Zürich German
…das er sini chind wil mediziin la schtudiere.
COMP he his children wants medicine let study
‘that he wants to let his children study medicine.’

Zaenen & Kaplan (1995) use the combination of functional precedence and functional uncertainty developed for Dutch to capture these data. Another case of mixing verbal and non-verbal material can be found in Standard German, which allows a variant of Oberfeldumstellung where V_1 precedes a collocational nominal complement of V_3. An analysis of this construction can be found in Cook (2001).

2.1.3 Nachfeld

The two options for adding Nachfeld material to the different c-structures of the clause given above are 1) adjunction to any of the nodes at the right periphery and 2) inclusion of one or more optional daughters on the right-hand side of the relevant c-structure rules. Adjunction is used by Berman (2003), who assumes Nachfeld occupants (typically PPs, VPs or CPs) are right-adjoined at the VP level. Rohrer (1996), Clément et al. (2002) and Van der Beek (2005) model the Nachfeld as an optional daughter in the node covering the whole clause. Zaenen & Kaplan (1995, 2002), and Kaplan & Zaenen (2003) insert the optional daughter in the node covering the Mittelfeld/right bracket.

In Dutch and German, the non-finite complement of an incoherently combining verb appears in the Nachfeld. In Dutch, Mittelfeld placement of such a complement is ruled out (30), but in German it is allowed (see for instance Rohrer 1996 for examples).

(30) Dutch
Vf- lb– Mf———————— rb—— Nf————————
Hij had {*geen auto te kopen} beloofd {geen auto te kopen}.
he had no car buy.TEINF promised no car buy.TEINF
‘He had promised not to buy a car.’

To facilitate lexical specification of whether a verb combines coherently or not, and the formulation of placement restrictions on the non-finite verbal complement, Rohrer (1996), Zaenen & Kaplan (1995, 2002), and Kaplan & Zaenen (2003) associate coherence with selecting an XCOMP and incoherence with selecting a COMP. The relevant c-structure rule from Kaplan & Zaenen (2003) is an extension of (20a) and is given here in slightly simplified form as (31).

(31)
$$\text{VP} \longrightarrow \underset{(\uparrow\ \textsc{xcomp}^*\ (\textsc{comp})\ \textsc{obj})=\downarrow}{\text{DP}^*} \quad \underset{\uparrow=\downarrow}{\overline{\text{V}}} \quad \left(\underset{(\uparrow\ \textsc{xcomp}^*\ \textsc{comp})=\downarrow}{\text{VP}}\right)$$

The optional rightmost daughter contains a non-finite complement in the Nachfeld, assigned comp.[21]

The rule in (31) also allows for the so-called *third construction*, a marked construction in Dutch and German in which a dependent of an incoherently combined non-finite complement in the Nachfeld is realized in the Mittelfeld of the containing clause. In terms of word order, this construction therefore mixes properties of coherent and incoherent combination. An example of the third construction is presented in (32). Note that the lack of an IPP effect on *geprobeerd* 'tried' shows that we are dealing with incoherent combination.

(32) Dutch
Hij had een auto geprobeerd te kopen.
he had a car tried buy.teinf
'He had tried to buy a car.'

The c-structure rule in (31) captures the third construction by the functional uncertainty-based grammatical function assignment of DPs in the Mittelfeld: the optional comp in the path allows it to reach into an incoherently combined complement.[22] LFG analyses of the the German third construction are discussed in Rohrer (1996) and Kaplan & Zaenen (2003).

2.2 Topics related to the left periphery

2.2.1 Topicalization

In the context of the verb-second CWG languages, topicalization refers to Vorfeld placement of material, in particular material that is *not* put there by default. Roughly, then, topicalization is Vorfeld placement of anything but the local subject. The term topicalization is used irrespective of whether the Vorfeld occupant

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[21] The distinction between comp and xcomp is that of complements that supply their own subject (closed complements) and complements that do not supply their own subject (open complements). Since non-finite comps do not have an overt subject, they therefore must have an f-structure subject pred 'pro', whose interpretation is equated to one of the arguments of the selecting verbs using anaphoric control. See Dalrymple (2001: Chapter 12, §3) for a discussion of anaphoric control.

[22] Kaplan & Zaenen (2003) are not concerned with CP complements – that is, finite complement clauses – but if these are assigned comp as well, the analysis of the third construction sketched here will need to be further constrained to prevent lifting dependents from finite subordinate clauses into the Mittelfeld.

is a topic or not. In both German and Dutch, the Vorfeld may be occupied by a categorially and functionally wide range of constituents. It is also a target position for material extracted from embedded clauses and phrases.

Berman (2003: Chapter 6) formally distinguishes two different types of topicalization for German, depending on whether the Vorfeld constituent is local to the matrix clause or whether a long-distance dependency is involved. Berman introduces this distinction on the basis of observations from weak cross-over, which will be discussed in Section 2.4.2, below. In either case, the Vorfeld is Spec-CP, and its definition is part of the straightforward c-structure rule in (33).

(33)
$$\begin{array}{llcc} \text{CP} & \longrightarrow & \text{XP} & \overline{\text{C}} \\ & & (\uparrow \text{DF})=\downarrow & \uparrow=\downarrow \end{array}$$

When material local to the f-structure projected from CP is put in the Vorfeld, Berman assumes information like case and agreement drives the association with grammatical function, just as it does in the Mittelfeld – see the earlier discussion of Berman's model in Section 2.1.2, around example (25). For long-distance dependencies, Berman posits the presence of a trace at the extraction site, annotated with an inside-out functional uncertainty equation to incorporate the f-structure of the Vorfeld constituents – which by (33) is the DF of the f-structure of the whole clause – into the extraction site's f-structure.[23]

German has embedded verb-second clauses with bridge verbs, provided the complementizer is absent, as in (34a). Extraction out of such embedded clauses is also allowed, on the condition that none of the clauses involved in the long-distance dependency has material in Spec-CP (that is, no intermediate clause has a Vorfeld occupant). This is shown in the contrast (34b,c).

(34) German (b,c from Berman 2003: §6.2.4, examples 23, 24)

a. Ich glaube, (*dass) der Hans sagte gestern, (*dass) die
I believe COMP the.NOM Hans said yesterday, COMP the.NOM
Maria hat den Peter eingeladen.
Maria has the.ACC Peter invited
'I think Hans said yesterday that Maria invited Peter.'

b. Den Peter glaube ich, sagte der Hans gestern, hat
the.ACC Peter think I said the.NOM Hans yesterday has
die Maria eingeladen.
the.NOM Maria invited

---

[23] See Kaplan 2023 [this volume] for more information on modelling long-distance dependencies using inside-out functional uncertainty.

c. * Den Peter glaube ich, gestern sagte der Hans, hat
the.ACC Peter think I yesterday said the.NOM Hans has
die Maria eingeladen.
the.NOM Maria invited

Berman captures this restriction with an off-path constraint ¬(→ DF) on the functional uncertainty equation for extractions. Since only Spec-CP introduces DF in Berman's model,[24] this effectively rules out examples like (34c).[25]

In non-LFG work, Reis (1996) argues that sentences like (34b) are only apparent cases of extraction, and that they involve parenthetical constructions, instead. An LFG analysis of German parentheticals with bridge verbs is given in Fortmann (2006), although he does not consider the exact type of sentence discussed here.

German allows topicalization of VPs (as discussed above in Section 2.1.2.2, example 23) and, in the case of coherent combination, topicalization of partial VPs. For instance, in (35), the main verb and its accusative object are realized in the Vorfeld, whereas the dative object is in the Mittelfeld.

(35) German (similar to Nerbonne 1994: 3a)
Ein Märchen erzählen wird er ihr.
a fairy tale tell.INF will he her.DAT
'He will tell her a story.'

---

[24] For this to hold, we need to understand DF as not including SUBJ, since subjects can be introduced in other positions in the clause, too. Indeed, as the example shows, there is no ban on subjects occurring anywhere in the path of a long-distance dependency, as long as they do not occur in the Vorfeld. An unfortunate side effect of taking DF as not including SUBJ would be that the special Vorfeld privileges of subjects, see Section 2.2.2, remain unmodelled.

[25] However, consider the following data:

(i) a. Ich denke hier, Sie sollten etwas präziser sein.
I think here you should somewhat precise.COMPARATIVE be
'I think here(:) you should be a bit more precise.'
b. Hier denke ich, Sie sollten etwas präziser sein.

(ii) a. Ich denke, Sie sollten hier etwas präziser sein.
'I think(:) you should be a bit more precise here.'
b. Hier denke ich, sollten Sie etwas präziser sein.

Although the off-path constraint against DFs gets rid of the form (i b) as a realization of the meaning of (ii), it does not block (ii b) as a realization of the meaning of (i). In other words, the off-path constraint itself leaves unexplained why the embedded V1 of (ii b) signals that it is involved in an extraction. A possible line of defence against this criticism is to appeal to a form of Economy of Expression: the embedded V1 is a slightly more complex structure than embedded V2, a complexity that is not needed for the relational information expressed in (i).

VP topicalization can in principle be modelled using the standard mechanisms. For instance, under the assumption that coherently combined verbal complements are xcomps and if we use outside-in functional uncertainty, a c-structure rule like in (36) implements topicalization of coherently combined VPs.

(36)
$$\text{CP} \longrightarrow \begin{array}{cc} \text{VP} & \overline{\text{C}} \\ (\uparrow \textsc{topic})=\downarrow & \uparrow=\downarrow \\ (\uparrow \textsc{xcomp}^{+})=\downarrow & \end{array}$$

If the rule for VPs allows partial VPs, rule (36) says very little about which material is required to be present in the fronted VP and which material can be left to be realized in-situ. Potentially, then, this also captures partial VP topicalization. Zaenen & Kaplan (2002) problematize two aspects of such a straightforward implementation: First, in the case of partial VP topicalization, the resulting f-structure for the whole VP contains the combined topicalized and in-situ material, and therefore there is no way to see at f-structure which part of the VP was topicalized. This is problematic for approaches to information structure that associate information status with f-structures. Secondly, the approach would erroneously allow examples like (37).

(37)

* [Ihr	ein	Märchen]	wird	er	erzählen.
her.DAT	a	fairy tale	will	he	tell.INF

‘He will tell her a fairy tale.’

The preverbal material is here analysed as a headless VP, which is generally only allowed postverbally.[26]

Zaenen & Kaplan (2002) solve these problems by replacing unification with *subsumption* in the functional uncertainty annotation of Spec-CP, along the lines of (38).

(38)
$$\text{CP} \longrightarrow \begin{array}{cc} \text{VP} & \overline{\text{C}} \\ (\uparrow \textsc{topic})=\downarrow & \uparrow=\downarrow \\ \downarrow \sqsubseteq (\uparrow \textsc{xcomp}^{+}) & \end{array}$$

This directly solves the first problem, since the information in topic now no longer contains the f-structure for the whole VP, but only information projected from the material in the Vorfeld. It also solves the second problem, since, as shown in (39), the f-structure for the example in (37) under topic now no longer meets LFG’s *coherence* condition – it contains arguments but no predicate to select them.

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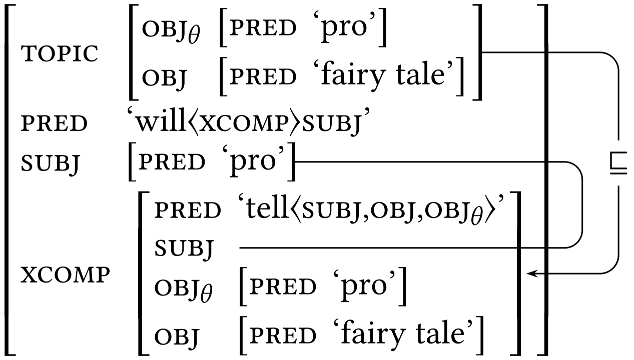
[26] I am aware that this claim is too broad. See for instance Müller et al. (2012), who use headless Vorfeld VPs in their analysis of apparent multiple fronting in German. However, a discussion of exceptions to this rule would take us too far away from the main topic here.

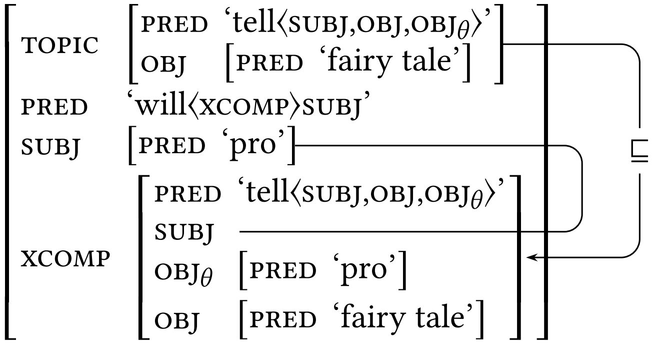
(39) F-structure for (37), which violates the coherence condition:



Finally, a reformulation of the *completeness* condition to take subsumption relations into account[27] allows the f-structures resulting from topicalizing a partial VP, as illustrated in (40).

(40) a. Ein Märchen erzählen wird er ihr.
a fairy tale tell.INF will he her.DAT
'He will tell her a story.'

b.



Berman (2003: §3.3) solves the ungrammaticality of examples structurally similar to (37) by appealing to the endocentricity principles as formulated for LFG, which include the constraint that every lexical category must have an extended head (Bresnan et al. 2016: §7.2). In (37), neither the main verb *erzählen* nor the auxiliary *wird* c-command the material in the Vorfeld VP, which leaves the fronted VP without an extended head. Note that this solution would not be compatible with Zaenen & Kaplan's conception of the German clause, as they do not assume the German VP is necessarily endocentric.[28]

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[27] "An f-structure *g* is complete if and only if each of its subsidiary f-structures is either locally complete or subsumes a subsidiary f-structure of *g* that is locally complete" (Zaenen & Kaplan 2002: [24]).

[28] As mentioned in Section 2.1, above, Zaenen & Kaplan use the label S|VP for this category.

2.2.2 The Vorfeld subject-object asymmetry

In both German and Dutch, the main clause subject is privileged when it comes to realization in the Vorfeld. In LFG work, this can be modelled directly by annotating the Vorfeld position at c-structure explicitly with (↑ subj)=↓ (Theiler & Bouma 2012), or by annotating it with (↑ df)=↓, under the assumption that the grammaticalized discourse functions include the subject (Berman 2003: §3.2.1).[29] In an OT-LFG setting, Choi (2001) posits a high-ranking constraint Subject-Left that prefers early realization of the subject, which includes realization in the Vorfeld.

One of the reflexes of this special relation between the Vorfeld and the main clause subject is a contrast like the following:

(41) German (Meinunger 2007)
Wo ist das Geld?
'Where is the money?'
a. Es liegt auf dem Tisch.
it lies on the table
'It is on the table.'
b. * Es hat Bernd auf den Tisch gelegt.
it has Bernd on the table put
'Bernd (has) put it on the table.'

Although the referent of the weak pronoun *es* has the same information status in both cases, it appears it can only occur in the Vorfeld as a subject, and not as an object. This would fit in with any of the approaches sketched above: being a subject alone is enough reason to be allowed in the Vorfeld, but – apparently – the weak pronoun *es* is incompatible with any of the other information structural functions of Vorfeld constituents.

The ban on object *es* in the Vorfeld is not categorical, however. Meinunger (2007, and references therein) gives many examples, and shows that the conditions under which object *es* can appear in the Vorfeld coincide with the conditions for the use of the homonymic Vorfeld expletive used in the presentational construction. In particular, the subject of the clause should not be topic (42).

(42) a. Es hat {jemand / *er} geklaut
it has someone he stolen
'Someone / *he has stolen it'

---

[29] I refer, however, to the comment in footnote 24, where I point out that the analysis of German embedded verb-second clauses discussed there relies on the contradicting assumption that subj is *not* part of df.

b. Es hat {jemand / *er} das Geld geklaut
expl has someone he the money stolen
'Someone / *he has stolen the money.'

Theiler & Bouma (2012) capture this behaviour by assuming that the common source of sentences with a Vorfeld object and of those with Vorfeld expletive *es* is the latter, the presentational construction. The presence of *es* in the Vorfeld signals exactly that the main clause subject is not topic. This construction is modelled using a c-structure rule that explicitly mentions the form of its first daughter.

(43)
$$\text{CP} \longrightarrow \begin{array}{cc} \text{NP} & \overline{\text{C}} \\ (\downarrow \text{FORM}) =_c \text{ES} & \uparrow=\downarrow \\ ((\uparrow \text{SUBJ})_\sigma \text{ DF}) \neq \text{TOPIC} & \\ \big((\uparrow \text{XCOMP}^{*}\text{OBJ})=\downarrow\big) & \end{array}$$

The optional assignment to object anywhere in the coherence domain of the clause is what allows object *es* to appear in the Vorfeld, under the same circumstances as the presentational construction's expletive. Expletive *es* also shows up in other situations; see Section 2.5.1 below.

2.2.3 Left dislocation

Thus far, we have not considered the *lead* field, which is positioned before the Vorfeld in the topological model given in (1) and which we characterized as reserved for material more loosely connected to the clause proper. We can distinguish several *left dislocation* phenomena that target the lead.[30] Two questions raised by this broadened view of the clause are 1) how tightly left-dislocated material is coupled to the clause, and 2) whether there are phenomena that we have treated as Vorfeld occupation that are better analysed as left dislocation with an empty Vorfeld?

The first question is central in Zaenen (1996), who studies contrastive left dislocation (44b) in Dutch and Icelandic, and asks whether this should be treated as topicalization (44a) or as a hanging topic (44c). The former counts as a well-integrated part of the clause, the latter has a looser relation to the clause.

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[30] We can likewise talk of right-dislocated material, positioned in the tail, but since we are not aware of any LFG discussions of right dislocation, we will ignore this phenomenon in this chapter.

(44) Dutch

a. Jan wil ik hier nooit meer zien.
Jan want I here never again see

b. Jan die wil ik hier nooit meer zien.
Jan DEM want I here never again see

c. Jan, ik wil hem hier nooit meer zien.
Jan I want him here never again see
'Jan, I never want to see (him) here again'

On the basis of categorial constraints on different kinds of left-dislocated material and on the basis of binding data, Zaenen concludes that contrastive left-dislocation patterns with topicalization in both languages. She proposes an analysis in which the contrastively left-dislocated material is connected to the clause using the same functional uncertainty equations we normally assume for topicalized material in the Vorfeld. The pronominal element in the Vorfeld in a contrastive left-dislocation is taken to be an (f-structure) adjunct to the left-dislocated material, and does not itself engage in the long-distance dependencies directly.

The second question underlies the discussion in Berman (2003: §7.4), which revolves around the contrast illustrated in (45).

(45) German (Berman 2003: §7.4, examples 58–61)

a. Dass die Erde rund ist, (das) hat ihn gewundert.
COMP the earth round is DEM.NOM has him.ACC surprised
'That the earth is round(, that) surprised him.'

b. Dass die Erde rund ist, (das) hat er nicht gewusst.
DEM.ACC has he not known
'That the earth is round, (that) he didn't know.'

c. Dass die Erde rund ist, *(dessen) war sie sich nicht bewusst.
DEM.GEN was she REFL not aware
'That the earth is round, of that she wasn't aware.'

d. Dass die Erde rund ist, *(darüber) hat sie sich gewundert.
about.DEM has she REFL surprised
'That the earth is round, that she was surprised about.'

In (45a,b), the fronted CP appears to alternate between being left-dislocated (with resumption) and appearing in the Vorfeld (without), whereas in (45c,d), the fronted CP must be left-dislocated. Berman gives an LFG interpretation of an existing approach in which this alternation is only apparent, and the CP is *always* left-dislocated. The difference in (45a,b) is that in German, nominative and accusative topics may be dropped from the Vorfeld. Whether the resumptive demonstrative pronoun is realized at c-structure or not, its f-structure presence is constant, and it is this which is assigned a grammatical function. The left-dislocated CP is connected anaphorically to the resumptive pronoun.

2.2.4 Split NPs

The split NP construction in German involves multiple NPs at different positions in the clause which together describe one argument. The first NP occurs in the Vorfeld of the top level clause, and a further NP occurs somewhere further down in the Mittelfeld of a possibly embedded clause. An example is (46a).

(46) German (Kuhn 2001: §1)

a. [Ein Schwimmbad] hat er sich noch [keins] gebaut.
a swimming pool has he REFL yet none built.

b. Er hat sich noch [kein Schwimmbad] gebaut.
he has REFL yet no swimming pool built
'He hasn't built a swimming pool yet.'

A striking property of the two NPs *ein Schwimmbad* and *keins* is that they both have the form of complete NPs: the first NP includes a determiner for the head count noun, the second NP involves the independent form *keins* 'none', rather than the form *kein* 'no', which is used when a nominal head is realized in the NP itself (46b).

Kuhn (2001) proposes a solution in terms of an LFG variant with linear logic-based semantics. Semantically, the clause-internal NP is a regular elliptical NP; the job of the Vorfeld NP is to supply a property as antecedent. By assuming that the form of the NP can be syntactically determined completely in terms of c-structure, treating the two NPs as c-structurally independent, but projecting to the same f-structure, the form-related characteristics of the NPs can be made to follow.

2.2.5 Asymmetric coordination

Frank (2006) gives an analysis of asymmetric coordination puzzles in German, like the *subject gap with fronted finite verb* (SGF) coordination in (47a).

(47) German (Frank 2006: §3.2)

a.

In	den	Wald	[ging	der	Jäger]	und	[fing	einen	Hasen]
in	the.ACC	forest	went	the.NOM	hunter	and	caught	a.ACC	hare

‘The hunter went into the woods and caught a hare.’

b.

* In	den	Wald	ging	der	Jäger	und	einen	Hasen	fing.
in	the.ACC	forest	went	the.NOM	hunter	and	a.ACC	hare	caught

At first sight, this looks like a run-of-the-mill symmetric $\overline{\mathrm{C}}$ coordination. However, this is not the case, since the PP in the Vorfeld is unambiguously a directional PP, which is incompatible with the verb in the second conjunct. Furthermore, what *is* shared between the two conjuncts is the subject in the Mittelfeld of the first conjunct, which is not in a c-structural position that would lead us to expect this possibility.

Frank models SGF coordination using an optional annotation on the rule for symmetric CP coordinations, which shares the (grammaticalized) discourse function of the first conjunct with the coordination as a whole, and therefore, with the second conjunct.[31]

(48)
$$\mathrm{CP} \longrightarrow \begin{array}{ccc} \mathrm{CP} & \mathrm{Coord} & \mathrm{CP} \\ \uparrow\in\downarrow & \uparrow=\downarrow & \uparrow\in\downarrow \\ \big((\uparrow \textsc{gdf}) = (\downarrow \textsc{gdf})\big) & & \end{array}$$

This extra annotation makes sure the completeness requirements in the second conjunct can be met. Frank also shows that this approach makes correct predictions with respect to the interpretation of the scope of quantified subjects in an SGF coordination. However, the formal account leaves unexplained why the second conjunct cannot have a fronted object, like the ungrammatical (47b). For this, Frank appeals to the discourse structure of SGF coordination: the second conjunct is conceptualized as part of the discourse-functional domain of the first. If the second conjunct were to have a Vorfeld TOPIC or FOCUS, this would indicate that it sets up its own discourse-functional domain.

2.3 Topics related to the right periphery

2.3.1 Clefts

The it-cleft construction in Dutch involves a neuter weak pronoun (typically *het* ‘it’), a copula, focused material, and a backgrounded finite clause in the Nachfeld.

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[31] Here, too, the grammaticalized discourse functions include the subject. In fact, in this construction, the shared material will always turn out to be the subject.

Van der Beek (2005: Chapter 2) shows that, with these ingredients, there are in fact two distinct cleft constructions: the intransitive cleft (an existential copula with extraposed complement clause, 49a) and the transitive cleft (an identificational copula with extraposed relative clause, 49b).

(49) Dutch (Van der Beek 2005: Figures 2.4 and 2.1)

a. Het is aan hem dat ze denkt.
EXPL is on him COMPL she thinks.
'It is of him that she is thinking.'

b. Het zijn jouw kinderen die huilen.
it are your children REL cry
'It is your children who are crying.'

Van der Beek shows that the two cleft types differ further in whether they involve an expletive or referential neuter pronoun, whether they tolerate pseudo-copulas like *bleken* 'seem', or only forms of the verb *zijn* 'be', and whether the neuter pronoun is obligatorily the cleft subject or not.

Van der Beek models both cleft types with dedicated c-structure rules to capture the fixed position of the backgrounded clause, and to introduce the construction-specific annotations. This ensures, for instance, that the clause must be in the Nachfeld, and cannot be realized as one constituent with the pronoun or the focused material. In the intransitive cleft, both the expletive and the complement clause project to the SUBJ's f-structure, and the focused material is linked to an adjunct or oblique position in f-structure (*aan hem* 'on him' in 49a). In the transitive cleft, the relative clause is an adjunct of the referential weak neuter pronoun, which is the construction's TOPIC, and which is subject or object depending on properties of the focused material. The top level c-structure rules for the two constructions are given in (50).

(50) a. intransitive cleft:

IP	⟶	NP (↑ SUBJ)=↓		CP (↑ SUBJ)=↓ (↓ TYPE) $=_c$ THAT (↑ FOCUS)=(↑ XCOMP* { ADJ ∈ | OBL$_\theta$})

b. transitive cleft:

IP	⟶	NP (↑ SUBJ)=↓	$\bar{\mathrm{I}}$ ↑=↓	CP ↓ ∈ (↑ TOPIC ADJ) (↑ TOPIC PRONTYPE)=COP (↓ TYPE) $=_c$ REL (↑ FOCUS)=(↑ {SUBJ|OBJ})

The TYPE feature of the CP-projected f-structures distinguishes relative clauses from complement clauses headed by *dat* 'that'. The PRONTYPE=COP restriction singles out a class of special copular pronouns which are N.3SG in form, but which show a wider range of agreement, whose existence can be argued for on independent grounds.

2.3.2 Correlative *es* and extraposed CPs

The constructions discussed in Berman et al. (1998) and Berman (2003: Chapter 8) also contain a neuter pronoun and a finite clause in the Nachfeld. In this case, the pronoun and the finite clause realize a propositional argument of the clause's main verb, and they can either appear on their own (51a,b) or together (51c), in which case the pronoun is referred to as a *correlative pronoun*.

(51) German (Berman et al. 1998: §1, examples 1 and 2)

a. Hans hat bedauert, daß er gelogen hat.
Hans has regretted that he lied has
Hans regretted that he lied.

b. Hans hat es bedauert.
Hans has it regretted
Hans regretted it.

c. Hans hat es bedauert, daß er gelogen hat.
Hans has it regretted that he lied has

The central modelling assumptions made in both analyses are that the pronoun is referential – whether it occurs on its own or as a correlative together with the finite clause – and that the pronoun and the finite clause when they appear alone (51a,b), are OBJs. In the correlative pronoun construction (51c), however, it is the pronoun that has this grammatical function. The finite clause is then either seen as supplying further semantic restrictions to the interpretation of this pronoun (Berman et al. 1998: see also Section 2.2.4 above) or as an apposition to the pronoun (Berman 2003).

Berman (2003) also goes on to show that there is a range of correlative *es* data, and that despite superficial resemblances, different syntactic analyses are called for. For instance, Berman argues that in contrast to the data above, the psych verb *stören* 'disturb' in (52) has a different argument structure for the cases with correlative *es*: it either takes the finite clause as subject when the correlative is absent, or it takes *es* as subject and the finite clause as object when the correlative is present.

(52) German (Berman 2003: §8.1, example 2d)
…weil (es) mich stört, dass sie den Hans liebt.
because EXPL me bothers COMP she the.ACC Hans loves.
'…because it bothers me that she loves Hans.'

2.4 Topics related to the ordering of dependents

2.4.1 Scrambling

Material in the Mittelfeld can be reordered to a certain extent. For instance, Dutch allows different orders of object and adverb (53).

(53) Dutch
Anna heeft {de was} gisteren {de was} gedaan.
Anna has the laundry yesterday the laundry done
'Anna did the laundry yesterday.'

In German, the order of arguments themselves is free, as well. Example (54) shows one order for the arguments of a ditransitive, but the other five possible argument orders are grammatical, too.

(54) German (Haider & Rosengren 2003: §1, example 1)
…dass [das Objekt] [dem Subjekt] [den ersten Platz]
COMP the.NOM object the.DAT subject the.ACC first place
streitig macht.
competes.for
'…that the object competes for first position with the subject.'

In general, both scrambling over adjuncts and scrambling of arguments is sensitive to information structural effects, and – related to this – things like the referential form of the material involved. Choi (1999, 2001) explains German scrambling and clause-local fronting facts using an OT-LFG model in which constraints on canonical ordering of grammatical functions conflict with constraints on information structurally induced ordering. An information structural account of clause-local word order variation and quantifier scope in German is given in Cook & Payne (2006). The explanation given by Cook (2006) for a deviating unmarked word order in a small group of ditransitives is discussed below, in Section 2.5.2.

As far as the order of arguments in the Mittelfeld is concerned, Dutch is much more restricted than German. Nevertheless there is some variation. An OT account of the Dutch dative alternation, which also covers variation in the ordering of direct object and indirect object, is presented in Van der Beek (2005). Zaenen (1989) discusses scrambling of objects over subjects with Dutch experiencer verbs and passives of ditransitives, and argues for an effect of thematic role.

The cross-serial dependency pattern comes about when objects and verbs are in separate groups and both are ordered in the same fashion according to level of embedding. The verb cluster rule given in (20) above (Zaenen & Kaplan 1995), sorts embedding verbs before embedded ones, and explicitly forces the same order on the objects with the help of an f-precedence constraint. In her work on the order of objects in Dutch, Van der Beek (2005: §3.8) argues that this constraint should be treated as a violable OT constraint. An optionally higher ranking constraint prefers early realization in the Mittelfeld of a third person, inanimate pronoun. This constraint explains examples like (55), in which the object pronoun belonging to the embedded verb precedes the object belonging to the finite verb.

(55) Ik zag$_{\text{OBJ:1}}$ 't$_2$ Jo$_1$ doen$_{\text{OBJ:2}}$.
I saw it Jo do
'I saw Jo do it.'

As with all scrambling, this type of scrambling is less constrained in German, and may also apply to full NPs, and even involve scrambling of an embedded object over the main clause subject. I am however not aware of any LFG-related work on this.[32]

2.4.2 Weak cross-over

In German, scrambling and topicalization interact with binding between arguments, which results in data like (56). Note that the grammaticality judgements are relative to the co-indexations given in the examples.

(56) German (Berman 2003, §5.2, examples 10a, 11b, 10d, 11d, 27, 31; examples a–d below originally from Choi 1995)

a. …dass jeden$_i$ seine$_i$ Mutter mag.
COMP everyone.ACC his mother likes
'…that their$_i$ mother likes everyone$_i$.'[33]

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[32] The term *embedded object shift* is van der Beek's term for this type of word order variation. In the literature on German, the phenomenon is sometimes discussed as a kind of *long(-distance) scrambling*, that is, scrambling across clause boundaries, although the view that the embedded object leaves its clause goes against the conception of coherent combining as clause union. In fact, in Lee-Schoenfeld (2007), this type of scrambling is taken as one of the hallmarks of coherence and thus of monoclausality.

[33] English seems to require the passive to achieve the intended bindings. The intended reading in (56a–d) is therefore more naturally given as *(that) everyone is liked by their own mother.*

b. Jeden$_i$ mag seine$_i$ Mutter.
everyone.ACC likes his mother
'Their$_i$ mother likes everyone$_i$.'

c. * …dass seine$_i$ Mutter jeden$_i$ mag.
COMP his mother everyone.ACC likes

d. * Seine$_i$ Mutter mag jeden$_i$.
his mother likes everyone.ACC

e. Jeden$_i$ sagte sie, habe seine$_i$ Mutter getröstet.
everyone.ACC said she has.SBJV his mother consoled
'Everyone$_i$, she said their$_i$ mother had consoled.'

f. * Jeden$_i$ sagte seine$_i$ Mutter, habe sie getröstet.
everyone.ACC said his mother has.SBJV she consoled
'Everyone$_i$, their$_i$ mother said she had consoled.'

Between dependents of the same predicate, an object may bind into the subject, provided it precedes it. It does not matter whether it precedes it in the Mittelfeld (56a) or by being moved into the Vorfeld (56b), even from an embedded clause (56e). However, as (56f) shows, an object cannot bind into an upstairs subject, even when it precedes it.

Berman (2003), using the framework of Bresnan (1998) and observations from Choi (1995), shows that the data in (56a–d) is straightforwardly explained by assuming that to bind a pronoun, an operator must either outrank it in terms of grammatical function – this isn't the case in any of these examples – or linearly precede it. The linear precedence constraint is satisfied in (56a,b), but not in (56c,d). However, example (56f) is problematic under this simple account, since the operator precedes the pronoun, but cannot bind it.

Berman therefore proposes to analyse long-distance dependencies using a trace, and to interpret the linear precedence requirement as if it includes this trace. The sentences in (56e,f) are then as in (57).[34]

(57) a. Jeden$_i$ sagte sie, habe ϵ_i seine$_i$ Mutter getröstet.
everyone.ACC said she has.SBJV his.NOM mother consoled

b. * Jeden$_i$ sagte seine$_i$ Mutter, habe ϵ_i sie getröstet.
everyone.ACC said his.NOM mother has.SBJV she consoled

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[34] Berman (2003) assumes that local arguments are adjoined to VP, in any order. This also applies to traces – the object trace may therefore appear before its clause-mate subject. In the examples in (57) we have inserted the trace as early as c-structurally possible.

In (57a), the operator's trace precedes the bound pronoun, so that the linear order requirement is met. In (57b), however, the trace follows the pronoun, which – under Berman's definition – means the operator as a whole does not precede it This results in the unavailability of the indexed reading.

Bresnan et al. (2016: §9.5) discuss the same data using a near-identical framework. Although the difference in linear order of the bound pronoun and the operator trace between (57a) and (57b) is noted, the ungrammaticality of (57b) is ultimately explained by taking the binding domain of the operator to be the f-structure for the predicate *getröstet* 'consoled', irrespective of the operator's DF role in the matrix f-structure.[35] There is therefore no need to refer to the position of the trace to explain the long-distance dependency data. Under that analysis, it would appear that weak cross-over in German alone is not a reason to assume long-distance dependencies involve traces.

Dalrymple et al. (2001)[36] give a trace-less account of the German cross-over data. Rather than considering the linear order of the binding operator and the bound pronoun, they consider f-precedence between two f-structures that are dependents of the same predicate, such that one contains the operator and the other the pronoun. In (56f), these f-structure siblings are the SUBJ (containing the pronoun) and the COMP (containing the operator) of *sagte*. Since the latter does not f-precede the former, the linear precedence requirement on binding is not met.

2.5 Topics related to mapping

2.5.1 Sentences "without a subject" in German

A recurring debate in German clausal syntax concerns the existence of true subjectless sentences. Berman (2003: Chapter 4) points out that it would appear that German has such sentences, given that 1) under her analysis, German does not have a dedicated subject position, 2) there are no oblique subjects in German (a common view, following for instance Zaenen et al. 1985, but contra the later Eythórsson & Barðdal 2005) and 3) there are sentences without nominatives, such as (58).

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[35] In contrast, Berman (2003: §5.2.6) explicitly considers the binding domain of the operator to be "extended to the matrix clause" because "it functions as a discourse function in the matrix clause" (p. 86).

[36] This paper is a response to the trace-based proposals of Bresnan (1998) and Berman (2003). The latter was also published/circulated on earlier occasions, which explains the apparent anachronism.

(58) German (Berman 2003: §4.2, examples 10a, 16b, 10d; indication of optionality of expletive mine)

a. …weil (*es) getanzt wurde.
   because EXPL danced was
   '…because people were dancing.'

b. …weil (*es) dem Mädchen geholfen wurde.
   because EXPL the.DAT girl helped was
   '…because the girl was being helped.'

c. …weil (es) mich friert.
   because EXPL me.ACC freezes
   '…because I'm cold.'

Note that each of these *can* occur without the expletive pronoun *es*, and the first two *must* occur without it.

Berman models clauses without a subject using argument structures without a SUBJ, and shows that these cases can be given an analysis in terms of Lexical Mapping Theory (LMT).[37] For the predicates involved in the examples above, we have the following LMT derivations:

(59) a. getanzt ⟨*agent*⟩ (lit. 'danced', impersonal passive)
   $[-o]$
   $\emptyset$

b. geholfen ⟨*agent*, *beneficiary*⟩ ('helped', passive, lexical case)
   $[-o]$ $[+o]$/DAT
   $\emptyset$ OBJ$_\theta$

c. frieren ⟨*experiencer*⟩ ('be cold', active intransitive, lexical case)
   $[+o]$/ACC
   OBJ$_\theta$

The question remains, then, why the expletive is not allowed in (58a,b), whereas it is in (58c). Berman adopts the analysis that German verbal agreement morphology is distinct enough to contribute subject features. Thus, the f-structures for the sentences in (58) all contain subjects. This way, German can be analysed as meeting the *Subject Condition*, which says that every f-structure with a predicate must contain a SUBJ.[38] Inserting a subject expletive would then be ruled out as a

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[37] See Findlay et al. 2023 [this volume] for more information on Lexical Mapping Theory.

[38] This Subject Condition formulation pertains to f-structure. In other contexts, for instance in Bresnan et al. (2016: §14.4), the Subject Condition is taken to be a constraint on argument structures. It is clear that under Berman's view such a constraint does not hold for German.

violation of Economy of Expression. It follows that the optional *es* in cases like (58c) is selected for: verbs like *frieren* have an alternative specification like the one in (60).

(60) *frieren* (↑ PRED) = 'be-cold⟨OBJ$_\theta$⟩SUBJ'
(↑ SUBJ FORM) $=_c$ ES_

2.5.2 Mapping explanations of variation

Zaenen (1993) is concerned with (the nature of) the unaccusative/unergative distinction in Dutch. One of the challenges in the characterization of unaccusativity in Dutch is that it not only applies to intransitives, but also to a subset of transitive experiencer verbs. Consider the examples in (61), which shows two intransitives, two transitives with the experiencer as the object, and a transitive with the experiencer as the subject. The selection of a form of *zijn* 'be' instead of *hebben* 'have' as the perfect auxiliary is given here as the reflex of unaccusativity.

(61) Dutch

a. Zij *is / heeft gewerkt.
she is has worked

b. Zij is / *heeft gestorven.
she is has died

c. Zij *zijn / hebben haar geirriteerd.
they are have her irritated

d. Zij zijn / *hebben haar bevallen.
they are have her pleased

e. Zij *is / heeft hen gevreesd.
She is has them feared.

Zaenen shows that it is possible to give semantic correlates of unaccusativity, and discusses which phenomena can be related directly to unaccusativity in Dutch (namely, auxiliary selection, prenominal attributive use of perfect participle) and which only relate indirectly (impossibility of impersonal passive). Her analysis is formalized in terms of a variant of LMT that does not rely on thematic roles to determine the intrinsic classifications of a predicate's arguments. Instead, Zaenen incorporates Dowty's (1991) proto-roles into LMT using the following simple rule: a participant that has more proto-agent than proto-patient properties is marked [−*o*], otherwise the participant is marked [−*r*]. The LMT alternative is further spelled out to allow derivation of grammatical function assignments for the data in (61): the subjects in examples (61a,c,e), with *hebben* 'have', come from intrinsic [−*o*] markings, whereas the subjects in (61b,d), with *zijn* 'be', come from intrinsic [−*r*]. The choice of auxiliary can be correctly modelled by referring to the intrinsic markings of the subject. Kordoni (2003) discusses analysing the German locative alternation in terms of Zaenen's mapping account.[39]

Another variation which is shown to be driven by lexical semantic differences that affect mapping are the so-called "high" versus "low" datives in German. Although arguments in the German Mittelfeld are readily scrambled, there is an unmarked order, which can be detected by studying information structural and quantifier scoping properties. Between objects, the unmarked order is generally DAT before ACC (62; "high dative"). However, a smaller number of verbs show ACC before DAT (63; "low dative"), and for a couple of verbs both orders appear to be unmarked. In the examples, superscript M marks the marked variant.

(62) German (Cook 2006: §1, examples 1–2)

a. Es hat ein Mann [einem Kind] [ein Buch] geschenkt.
EXPL has a.NOM man a.DAT child a.ACC book given
'A man gave a book to a child (as a present).'

b. ^{M} Es hat ein Mann [ein Buch] [einem Kind] geschenkt.

(63) a. ^{M} Es hat ein Polizist [einer Gefahr] [einen Zeugen] ausgesetzt.
EXPL has a.NOM policeman a.DAT danger a.ACC witness exposed
'A policeman has exposed a witness to a danger.'

b. Es hat ein Polizist [einen Zeugen] [einer Gefahr] ausgesetzt.

Cook (2006) demonstrates that the different unmarked orders can be related to differences in lexical semantics, which in turn give rise to thematic alternations. For the alternating verbs, it is shown that the different word orders prefer different readings in line with the general lexical semantic observations. All meanings/word orders involve an agent and a patient/theme, which under standard LMT assumptions are mapped to SUBJ and (accusative) OBJ, respectively. In addition, the DAT-ACC order is associated with a bene-/maleficiary role, which is mapped to a (dative) OBJ_θ. The ACC-DAT order, however, involves a third participant which is a goal or a location and which gets mapped to a (dative) OBL_θ. Cook argues that the unmarked order of complements in the German Mittelfeld is OBJ_θ-OBJ-OBL_θ.

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[39] It should be noted that Dowty (1991) talks about the *English* locative alternation in terms of proto-roles in depth.

The apparent word order variation is thus a fixed word order seen in the light of the unmarked order of grammatical functions. Cook extends her account to explain the compatibility of the different datives with the *kriegen*-passive, which can be used with a selection of verbs to promote the dative argument to subject.

2.5.3 Transitivity of reflexives

Lexically conditioned reflexives in German and Dutch show up in a range of situations. The simplex reflexives *sich* in German and *zich* in Dutch appear for instance in clauses with transitive verbs with co-referring arguments (64a)/(65a),[40] in anticausatives (64b)/(65b), and in inherent reflexives (64c)/(65c).

(64) a. Max rasiert sich.
Max shaves refl
'Max shaves himself.'

b. Die Tür öffnet sich.
the door opens refl
'The door opens.'

c. Max schämt sich.
Max is.ashamed refl
'Max is ashamed.'

(65) a. Max scheert zich.
Max shaves refl

b. De deur opent zich.
the door opens refl

c. Max schaamt zich.
Max is.ashamed refl

In a contrastive study of reflexivization, Sells et al. (1987) distinguish three kinds of transitivity: 1) c-structure transitivity – the reflexive is an independent constituent, 2) f-structure transitivity – the syntactic predicate selects an obj, 3) semantic transititivity – the referential identity of the arguments is accidental. Interestingly, German and Dutch simplex reflexives receive different analyses: they are both considered to be transitive in terms of c-structure, and intransitive in terms of semantics, but Sells et al. analyse the German reflexives as f-structurally

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[40] The class of grooming verbs is part of a larger class of transitive verbs that, exceptionally, allows the simplex reflexive. In general, the complex reflexive, *zichzelf* / *sich selbst* is available to realize reflexive objects with transitive verbs. This exception is what justifies treating these reflexives as being lexically specified.

intransitive, and the Dutch reflexives as f-structurally transitive. This is based upon the contrast in (66): the German reflexive can appear in an impersonal passive, whereas the non-reflexive counterpart is ruled out. The reflexive thus patterns with intransitives. The Dutch counterpart is not well-formed, which would suggest Dutch reflexives pattern with transitives.

(66) a. German (Sells et al. 1987: §2.4, example 74)
Jetzt wird {sich / *ihn} aber gewaschen!
now is REFL him however washed
'But now it is time to wash yourself!'
Not: '…to wash him!'

b. Dutch
* Nu wordt (er) {zich / hem} gewassen!
now is EXPL REFL him washed

Sells et al. (1987) model reflexives like (64a), (65a) with a lexical rule which maps a transitive verb (in all the three senses above) to a reflexive verb. For German, this involves leaving out the object slots, and marking the predicates with '[a] feature F, forcing them to combine with the reflexive element.'[41] The resulting intransitive can then serve as input for the lexical rule for the impersonal passive. For Dutch, the reflexivization rule involves moving the thematic object to a non-thematic object slot, marked to be filled by a simplex reflexive.

The analysis of Sells et al. crucially relies on the use of lexical rules to take care of mapping. Modern LFG work would rely on a variant of LMT. Data like those in (66) then also receive a different status, as LMT does not model the (impersonal) passive as a rule to be applied on the output of another rule. Alencar & Kelling (2005) propose an analysis of the whole range of data in (64a–c) in terms of LMT, and explicitly reject the importance of the contrast in (66). Instead, they offer additional data to support the conclusion that the German reflexive *is* transitive at f-structure. Their LMT analysis of the data in (64), above, is summarized in (67).

(67) a. rasieren/öffnen ⟨*agent*, *theme*⟩ ('shave'/'open', transitive)
[−*o*] [−*r*]
SUBJ OBJ

---

[41] The reflexive itself carries a constraining equation checking this feature F to make sure it is only combined with predicates that have undergone reflexivization. It is not spelled out in the article how the presence of the reflexive would be enforced technically, however. One solution is to let the verb and the reflexive be co-heads that check for the presence of each other using constraining equations.

b. (sich) rasieren ⟨*agent*$_i$, *theme*$_i$⟩ (‘shave’, reflexive of transitive)
[−*o*] [−*r*]
SUBJ$_i$ OBJ$_i$[REFL]

c. (sich) öffnen ⟨*theme*$_i$⟩ _$_i$ (‘open’, anticausative)
[−*r*] [−*r*]
SUBJ$_i$ OBJ$_i$[REFL]

d. (sich) schämen ⟨*theme*$_i$⟩ _$_i$ (‘be ashamed’, inherent reflexive)
[−*r*] [−*r*]
SUBJ$_i$ OBJ$_i$[REFL]

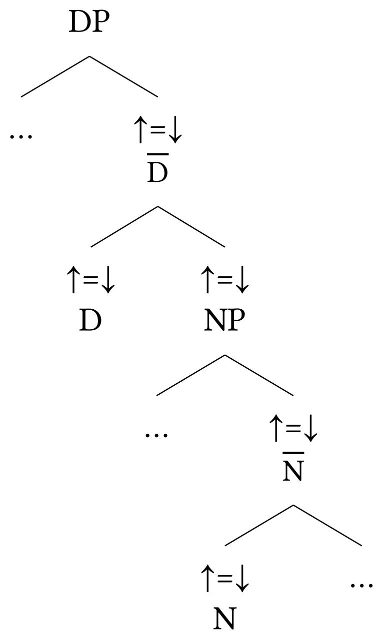
In the last two cases, the reflexive is an expletive.[42]

3 LFG analyses in the nominal domain

3.1 Overall shape of nominal constituents

The CWG nominal domain has received a lot less attention than the clausal domain in LFG. The authors that have concerned themselves with the nominal domain in more detail all assume a DP analysis (Berman & Frank 1996, Part I, Chapter 3; Dipper 2003, Chapter 7; Strunk, 2004, 2005). The general shape of the nominal constituent is characterized by the familiar representation in (68).

(68)



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[42] The notation with indices to indicate reflexivity is taken from the paper. Note that, as they are also on expletives, these indices should not be interpreted as semantic co-reference.

In Spec-DP, elements like pre-determiners (Dutch: ***al*** *die mensen* 'all those people'), prenominal genitives (that is, non-pronominal possessives; German: ***Karls*** *Auto* 'Karl's car'), and non-genitive prenominal possessors (Low Saxon: ***de'n Jung*** *sien Vadder*, lit. 'the boy his father') can occur. We refer to the discussion of possessives in Section 3.2.1 below for more elaborate examples. D holds determiners and pronouns, although Dipper (2003) assigns pronouns proper (in contrast to determiner-like pronouns) to a category Pron, which is the single daughter of $\overline{\text{D}}$.

The NP contains mostly lexical material. In Dipper (2003: Chapter 7, the theoretical discussion), the class of adjectival quantifiers (see Section 3.2.2, below) appears in Spec-NP, whereas other attributive adjectives appear as sisters to N. Berman & Frank (1996), however, assume that attributive adjectives are left-adjoined to NP (not shown in the schematic tree), whereas oblique and clausal complements are in Comp-NP, on the right.

This overall picture is slightly different in Dipper (2003: Chapter 8, the computational implementation) and Dipper (2005), which describe a flat DP/$\overline{\text{D}}$, under which predeterminers, determiners, prenominal genitives and adjectival quantifiers (that is, the material in Spec-DP, D, and Spec-NP in 68 above) all appear as sisters of NP.[43]

3.2 Topics in noun phrase syntax

3.2.1 Possessives in Low Saxon

Low Saxon has, amongst others, the range of possessive constructions illustrated in (69–71).

(69) Low Saxon (Strunk 2004: §2.2, examples 2.52 and 2.84)

a. sienen Weg
his.M.SG.ACC way
'his way'

b. jeedeen Oort kreeg [sienen], […].
every kind got his.M.SG.ACC
'Every kind got its own, […].'

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[43] This analysis has the explicit goal of "serv[ing] as the base of a robust and efficient implementation" (Dipper 2005: 101), but its status as a theoretical claim remains a bit unclear. The question of whether a deeper/different analysis would have been preferred in a more theoretically oriented analysis and whether this flat structure should mostly be seen as an operationalization of a deeper structure, is unfortunately not discussed.

(70) Low Saxon (Strunk 2004: §2.3, examples 2.112 and 2.177)

a. de'n Jung sien Vadder
the.M.SG.ACC boy his.M.SG.NOM father
'the boy's father'

b. Korl sien
Korl his.N.SG.NOM
'Korl's'

(71) Low Saxon (Strunk 2005: §6, example 61)
[Hinnerk=s Huss] iss groote den [Antje=s].
Hinnerk=POSS house is bigger than Antje=POSS
'Hinnerk's house is bigger than Antje's.'

Example (69a) contains a possessive pronoun in combination with a noun expressing the possessum. The possessor is anaphorically given as the referent of the possessive pronoun. Example (70a) is a case of *possessive doubling*: as before, we have a possessive pronoun and a noun, but now the possessive pronoun is directly preceded by a nominal in the accusative, which explicitly supplies the possessor. Finally, the first possessive expression in (71) is an instance of an *-s* marked nominal realizing the possessor, followed by the unmarked possessum. Examples (69b), (70b), and the second possessive in (71) show that the possessum can be elided in each of these constructions.

Strunk (2005)[44] models the three constructions in a unified way, crucially relying on optionally specified PRED 'pro' values to capture the differing amounts of explicitly realized referential information. He assumes entries for possessive pronouns along the lines of (72a) and the possessive clitic in (72b), as well as the top level rule for the DP in (72c).

(72) a. *sien* D ((↑ PRED) = 'pro-of⟨POSS⟩')
(↑ AGR) = M.SG
(↑ CASE) = NOM
((↑ POSS PRED) = 'pro')
(↑ POSS MARKING) = +
(↑ POSS AGR) = M.3SG
(↑ POSS CASE) = ACC

b. *=s* D ((↑ PRED)= 'pro-of⟨POSS⟩')
(↑ POSS MARKING) = +

---

[44] Strunk (2004) is an earlier version of this work, which contains a wealth of material on Low Saxon possessives.

$$\begin{array}{llcc} \text{c.}\ \ \text{DP} & \longrightarrow & \text{DP} & \overline{\text{D}} \\ & & (\uparrow \textsc{poss}){=}\downarrow & \uparrow{=}\downarrow \\ & & (\uparrow \textsc{poss marking}) =_c + & \end{array}$$

The entry for a possessive pronoun constrains two "regions", the first constraining the f-structure ↑ for the DP it heads – the possessum – and the second constraining the f-structure (↑ POSS) for the possessor. Both regions have agreement constraints, ↑ from inflectional morphology, (↑ POSS) from the choice of the pronominal root. The two regions also each have an optional equation defining PRED to be a pro-form. The four ways to satisfy these constraints correspond to the four cases in (69) and (70). Finally, Strunk (2005) analyses possessive *-s* as a clitic which also sits in D. Like the possessive pronoun this clitic can be realized with or without a possessum in NP. Unlike the pronoun it must be preceded by a DP that supplies a possessor, which explains the absence of an optional (↑ POSS PRED)='pro' in this entry.

Berman & Frank (1996) and Dipper (2003) discuss the standard German prenominal genitive possessive construction, exemplified in (73a). In contrast to the clitic-in-D analysis given above for the (perhaps only superficially) similar Low Saxon possessive *-s*, these authors put the prenominal material completely in Spec-DP. Berman & Frank (1996) also treat the colloquial German possessive doubling construction, which involves a prenominal dative,[45] found in (73b). As in the analysis proposed for the Lower Saxon counterpart above, the (now dative-marked) possessor is located in Spec-DP, and the possessive pronoun in D.

(73) German (Berman & Frank 1996: §3.1.2, example 136, 141)

a. Peters (*das) Haus
Peter's the house
'Peter's house'

b. der Frau *(ihr) Haus
the.F.SG.ACC woman her house
'the woman's house'

In the analysis put forward by Berman & Frank, the main *structural* difference between the the German prenominal genitive and prenominal dative is that the former requires D to be empty (73a), whereas the latter requires D to be filled (73b). A binary feature on head realization is used to control this.

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[45] Kasper (2014: 58–59) calls the prenominal dative possessive a "non-standard German [construction] that is completely absent from the standard but can be found in almost all regional varieties/ dialects". Berman & Frank (1996) discuss the prenominal dative together with the prenominal genitive, and note that the former "allerdings eher in der gesprochenen Sprache auftritt" [is however more likely to occur in spoken language] (p. 59).

3.2.2 Declension and the status of quantifiers

Inside the German DP, determiners, adjectives and nouns show agreement with respect to gender, number and case. *Declension* is another agreement dimension, found between determiners and adjectives. Determiners have inherent declension: they can be categorized as inflected (strong declension), uninflected or mixed. In the latter case some cells are inflected/strong and others are not. Inflected adjectives, on the other hand, have strong (more distinctive morphology) and weak (less distinctive morphology) declension paradigms. Adjective declension agrees with the inherent declension of the determiner in the following way:

(74) inflected (strong) determiner: weak adjective
uninflected or no determiner: strong adjective

This phenomenon is illustrated in (75–76). For reasons of exposition, the inflection is made explicit and we use a zero morpheme to mark the lack of inflection. Note that *ein* is a member of the mixed declension class and appears both inflected (75b) and uninflected (76b).

(75) German (data from Dipper 2005: §3.2, presentation/glosses changed)

a.

d-er	süß-e	rot-e	Wein
the-M.SG.NOM	sweet-WEAK.SG.NOM	red-WEAK.SG.NOM	wine(M)

b.

ein-em	süß-en	Wein
a-M.SG.DAT	sweet-WEAK.SG.DAT	wine(M)

(76) a.

süß-er	rot-er	Wein
sweet-STRONG.M.SG.NOM	red-STRONG.M.SG.NOM	wine(M)

b.

ein-∅	süß-er	Wein
a-M.SG.NOM	sweet-STRONG.M.SG.NOM	wine(M)

Determiners that do not inflect at all (for instance, *allerlei* 'every kind', *solcherlei* 'such') are not of the strong declension, and adjectives that do not inflect at all (*lila* 'purple', *rosa* 'pink') are ambiguous between strong/weak declension.

Dipper (2005) models the facts about declension in the following way: The f-structure projected from the DP has a feature DECL, whose value is equated with ST-DET in strong determiners and with ST-ADJ in strong adjectives. This captures the fact that these two are never seen together. Weak adjectives constrain their containing DP's f-structure by DECL $=_c$ ST-DET, and therefore only co-occur with strong determiners. Uninflected adjectives and determiners do not constrain the DECL feature at all.

As seen in (75a) and (76a), when the DP/NP contains multiple adjectives, they show identical declension. Dipper (2005) uses this fact to address the issue of the categorial status of quantifiers like *alle* 'all' and *mehrere* 'multiple', for which it is difficult to decide whether they are determiners or adjectives. By inspecting the declension of adjectival material in the presence of a quantifier, Dipper is able to clearly distinguish determiner-like and adjective-like quantifiers.

3.2.3 Preposition-determiner contractions

German has a number of lexical preposition-determiner (P-D) contractions, such as *zum* 'to the', and *vom* 'of the', shown in (77).

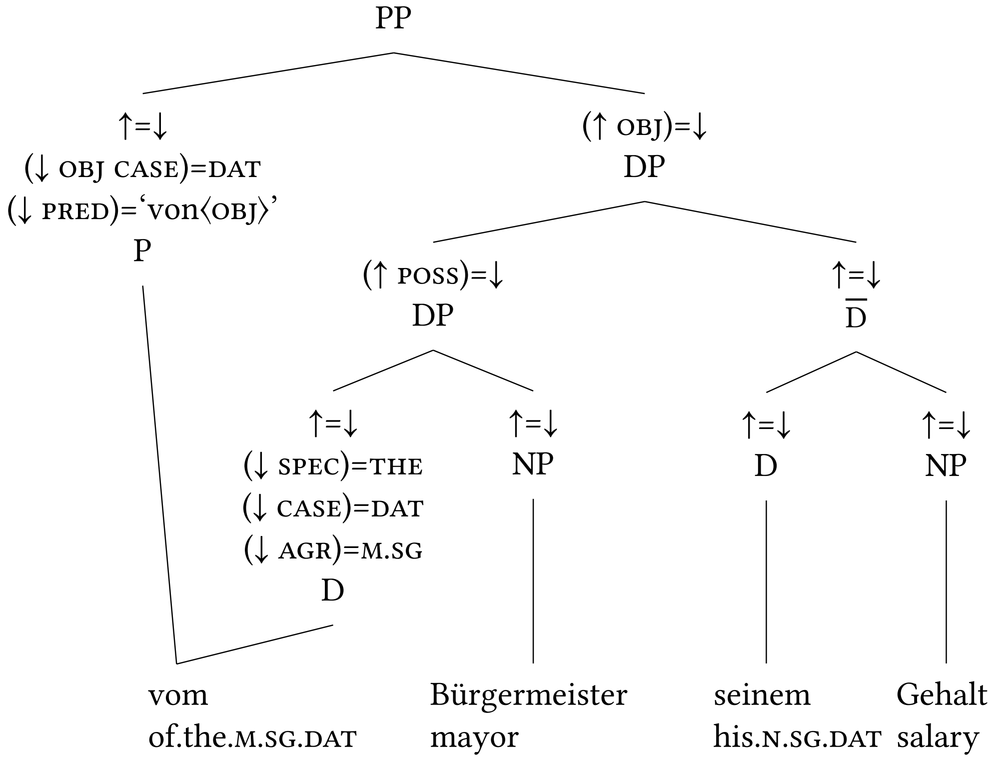
(77) a. zum König
to.the.M.SG.DAT king
'to the king'

b. vom Bürgermeister seinem Gehalt
of.the.M.SG.DAT mayor his.N.SG.DAT salary
'of the mayor's salary'

In Berman & Frank (1996), P-D contractions are treated as prepositions that not only constrain their object DP in a P-like manner – it must have a given case – but also in a D-like manner – it is marked definite and has certain agreement features. Most importantly, the object DP may not itself realize its own D. This is enforced using the binary head realization feature also used in the analysis of possessives, sketched in Section 3.2.1 above.

The example in (77b) shows that this picture is too simplistic: here, the D-like properties do not constrain the object DP, but the prenominal dative of this DP. It is inside this prenominal dative that D is left unrealized, and not in the object DP itself, which has *seinem* in D. The correct generalization about P-D contractions must therefore include that the D inherent in the contraction corresponds to a D leftmost in the object DP, and need not be the object DP's head. Wescoat (2007) gives an analysis in terms of lexical sharing that addresses exactly these points. In Wescoat's lexical sharing model, one lexical terminal can correspond to multiple adjacent preterminals. A slightly simplified analysis of (77b) is given in (78).

(78)



The fact that the preterminals projected from *vom* need to be adjacent solves the problem noted above that the generalization about P-D contractions needs to include reference to the left edge of the object DP. In the paper, Wescoat describes further constraints on the function of the projected D inside the object DP.

3.2.4 Indeterminacy of case

The German nominal inflection paradigms show pervasive syncretism. These syncretic forms can either be ambiguous or indeterminate. Ambiguous forms can be used in different contexts, but they can only be in one paradigmatic cell at a time. So *sie* in (79), which in isolation is ambiguous between plural 'they' and feminine singular 'she', can be used in either way (79a,b), but not as both at once (79c). Indeterminate forms *can* function as if they are in different cells simultaneously. For instance, *Papageien* 'parrots', which is indeterminate for case, can at the same time be selected as an accusative object and a dative object (80).

(79) a. Sie hilft Papageien.
she helps parrots

b. Sie helfen Papageien.
they help parrots

c. * Sie hilft und helfen Papageien.

(80) a. Sie hilft Papageien.
she helps parrots.DAT

b. Sie findet Papageien.
she finds parrots.ACC

c. Sie findet und hilft Papageien.

Although a simple disjunctive defining equation for a feature suffices for the ambiguous cases, this is not enough to achieve indeterminacy, since a disjunction does not change the fact that a feature can only have one value at a time. Dalrymple et al. (2009) represent indeterminate features as bundles of binary features, one for each of the values in the paradigmatic dimension. Compatibility with values is given as a disjunction of *positive* specifications, incompatibility as *negative* specifications. Two example lexical specifications are given in (81).

(81) a. *Papageien* (↑ CASE {NOM|GEN|DAT|ACC}) = +
b. *Männer* (↑ CASE {NOM|GEN|ACC}) = +
(↑ CASE DAT) = −

These specifications state that *Papageien* is completely indeterminate with respect to case (81a), whereas *Männer* is non-dative, but otherwise indeterminate with respect to case (81b).

A selecting element then expresses its case requirements in positive terms only. The entries in (82) illustrate this.

(82) a. *hilft*[46] (↑ OBJ CASE DAT) = +
b. *findet* (↑ OBJ CASE ACC) = +

Since the case feature bundles for *Papageien* defined in (81a) can satisfy both these requirements at the same time, we can capture the coordination of (80c). Dalrymple et al. show that this approach can also deal with additional material in the DP like adjectives, which further constrain the case value, and with verbs which themselves are indeterminate about their case requirements on selected arguments.

4 Concluding remarks

This chapter has presented an overview of Lexical-Functional Grammar studies of Continental West Germanic languages. The majority of the work discussed here has dealt with German clausal syntax, followed by discussions of Dutch

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[46] We follow here the presentation in the paper and gloss over the fact that *helfen* ‘help’ might be better analysed as taking an OBJ_θ rather than an OBJ, which would complicate modelling the coordination.

clausal syntax. This reflects the status of the LFG field as a whole – the nominal domain has received less attention than the clausal/verbal domain, an overview of LFG work on the former is given in Börjars & Lowe 2023 [this volume] – but it also reflects the fact that the other CWG languages – possibly, but not only, minority, regional, and/or non-standardized languages – do not feature prominently in the LFG literature. I hope that the discussion of existing work on the syntax of the two "big" CWG languages in the current chapter may inspire further application of LFG to the other members of the family.

Obviously, not every LFG study that touches upon CWG has been mentioned in this chapter. There are some larger blind-spots that I wish to mention here.

- Bögel (2015) develops an LFG model of the prosody-syntax interface. Recent papers contain applications to Swabian (Bögel & Raach 2020, Bögel 2021) and Standard German (Bögel 2020). See also Bögel 2023 [this volume] for a discussion of the syntax-prosody interface in LFG.

- A number of authors have used OT in combination with LFG, especially in the domain of word order variation and information structure. Examples are Choi (1999, 2001), Cook (2001), Cook & Payne (2006),Van der Beek (2005), and Seiler (2007). These have been mentioned in the text, but were not discussed in any detail. OT-LFG is dealt with in Kuhn 2023 [this volume], and information structure is treated in Zaenen 2023 [this volume].

- German is blessed with a wide-coverage LFG grammar, implemented in the context of the ParGram project. This grammar can be queried in the interactive XLE-WEB interface.[47] The project page for the ParGram project in Germany,[48] contains older references. The research activities in and around this project have resulted in a long list of publications. Some of that work has already been discussed above. I will here list a small selection of further papers that also have direct relevance for theoretical debates: Forst & Rohrer (2009) and Kuhn et al. (2010) discuss problems in the analysis of German VP coordination; Rehbein & van Genabith (2006) and Forst et al. (2010) deal with the implementation of particle verbs; Forst (2006) is a "grammar writer's" contribution to the COMP-debate. The desire for parallel structures in the context of ParGram is one of the forces behind the auxiliaries-as-features style of syntactic analysis in LFG. An early contribution and implementation can be found in Butt et al. (1996).

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[47] https://clarino.uib.no/iness/xle-web, consulted July 2022

[48] https://www.ims.uni-stuttgart.de/en/research/projects/pargram, consulted July 2022

> Computational work on LFG is the topic of several chapters in Part V of this volume.

Omitting these studies from the main text was a conscious choice, intended to keep the chapter accessible by not introducing too much conceptual machinery and too many problem domains. I made this choice with the knowledge that their topics would be touched upon in other chapters. At the same time, I wish to underline their importance, because exactly the fact that they span multiple domains and methods means that they are excellent demonstrations of the flexibility and precision that LFG offers.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

CWG	Continental West Germanic	OT	Optimality Theory
EXPL	expletive	rb	right bracket
IPP	infinitivus participio	TEINF	(Dutch) infinitive with marker *te*
lb	left bracket	Vf	Vorfeld
Mf	Mittelfeld	ZUINF	(German) infinitive with marker *zu*
Nf	Nachfeld		

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Chapter 31

LFG and Finno-Ugric languages

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The chapter discusses some salient, sometimes competing, LFG analyses of a variety of (morpho-)syntactic phenomena in Finno-Ugric languages, with occasional glimpses at alternative generative approaches and at some related phenomena in languages belonging to Samoyedic, the other major branch of Uralic languages. We concentrate on clausal c-structure representational issues, verbal modifiers, focused constituents, negation, copula constructions, argument realization, subject-verb agreement, differential object marking, evidentiality and a set of noun phrase phenomena related to event nominalization. It argues that LFG provides an appropriate and suitably flexible formal apparatus for a principled analysis of all the phenomena in all the Finno-Ugric languages discussed here. In addition, it shows that the analysis of some of these phenomena can also contribute to LFG-internal theorizing.

1 Introduction

1.1 General remarks on Finno-Ugric languages

Finno-Ugric is one of the two branches of Uralic, the other branch being Samoyedic. In Figure 1 we show the major branches of the Uralic family tree and those leaves (languages) that are discussed, or at least mentioned, in this chapter. This figure is in accordance with the general remarks in the introductory chapter of Miestamo et al. (2015) on the representation of the Finno-Ugric branch.[1] We use

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[1] We are thankful to Anne Tamm for helpful discussions of certain family tree issues.

Tibor Laczkó. 2023. LFG and Finno-Ugric languages. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1469–1532. Berlin: Language Science Press. DOI: 10.5281/zenodo.10186012

the names of the individual languages as they appear in that volume.[2] The authors point out that, although there are several alternative approaches to this branch, most of them share the view that the following language groups are valid genealogical units: Samoyedic, Ugric, Permic, Mari, Mordvin, Saamic and Finnic. However, the details of the relationships among certain languages are subject to variation across these competing approaches.[3]

For the sake of a complete picture, we have included the Samoyedic branch as well. In the Northern branch there are two major sub-branches: Enets-Nenets and Nganasan. From the Enets-Nenets sub-branch Tundra Nenets will be discussed and compared with some Finno-Ugric languages in Section 7.1.2 with respect to differential object marking. The only living representative of the Southern branch is Selkup, also mentioned in Section 7.1.2. Saamic languages also have a variety of sub-branches. From these languages Inari Saami will be discussed in Section 5.2 on copula constructions and in Section 7.1.1 on subject-verb agreement.

As regards the geographical distribution of the languages indicated in Figure 1, Estonian is primarily spoken in Estonia, Hungarian is spoken in Hungary, Finnish and Inari Saami are spoken in Finland, and all the other languages are spoken in Russia.

Several languages belonging to the Finno-Ugric branch of Uralic languages have a considerable number of properties that have contributed to linguistic research in LFG. On the one hand, these phenomena provide empirical or typological evidence for theoretical generalizations. On the other hand, they exhibit cases in which LFG is well-suited for the development of principled analyses. Such phenomena include, but are not limited to, discourse-functionality, negation, *wh*-questions, copular clauses, particle-verb constructions, event nominalization, possessive constructions, the nature and inventory of grammatical functions, evidentiality, rich inflectional morphology, partitives, duals and complex agreement patterns.

In this chapter we can only concentrate on those phenomena in Finno-Ugric languages that have been analyzed in an LFG framework in such a way that the summary of the given analysis within the limitations of space serves the purposes

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[2] Several languages in this figure are also referred to by alternative names in some other works, e.g. Khanty = Ostyak, Mansi = Vogul, Udmurt = Votyak, Mari = Cheremis; see the discussion of Dalrymple & Nikolaeva (2011) in Section 7.1.2, for instance. When we cite authors, we keep the version of the name of a language that they use.

[3] For a recent, fundamentally similar Uralic family tree representation indicating all the languages (including those that are extinct by now), see Maticsák (2020).

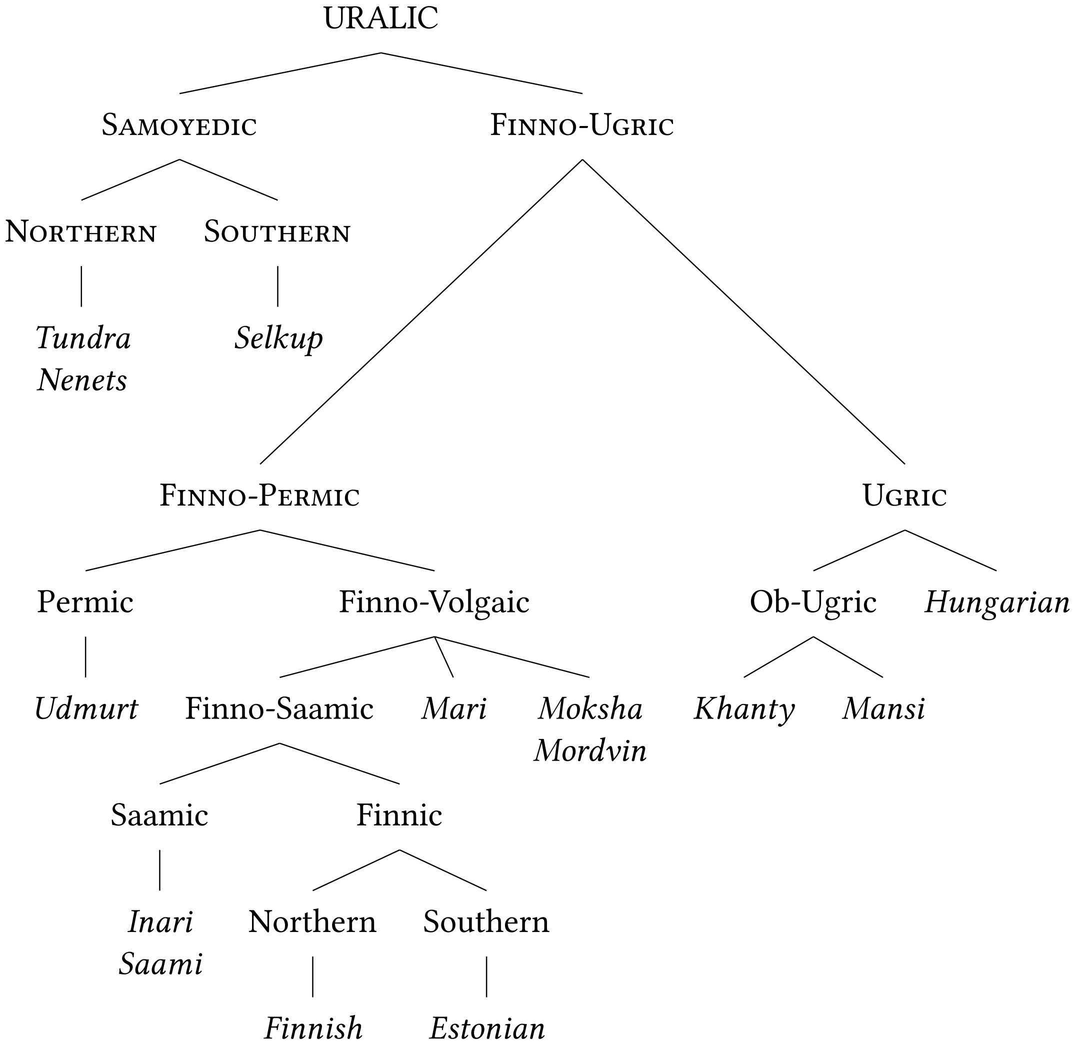

Figure 1: The (simplified) family tree of Uralic languages

of the chapter, as outlined in the foregoing paragraph. Consequently, this determines which languages appear in the chapter. Given that Hungarian is the most intensively and extensively researched Finno-Ugric language in LFG,[4] the discussions of LFG analyses of Hungarian phenomena outnumber the discussions of phenomena in other Finno-Ugric languages. For further information on related and additional phenomena and other Uralic or Finno-Ugric languages, the interested reader is referred to the following comprehensive sources: Abondolo (1998),

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[4] For introductions to LFG in Hungarian, see Laczkó (1989) and Komlósy (2001). The following works also have introductory sections to LFG: Szabó (2017) in Hungarian and Tamm (2004a) in Estonian.

Dryer & Haspelmath (2013), Miestamo et al. (2015) and de Groot (2017).[5] The online journal *Finno-Ugric Languages and Linguistics* (http://full.btk.ppke.hu) regularly contains generative papers on Finno-Ugric languages.[6] In addition, Tamm & Vainikka (2018) present an overview of generative works on Finnish and Estonian syntax.[7]

As regards comprehensive analyses of several phenomena in Hungarian, Laczkó 2021 offers a synthesis of his earlier LFG(-XLE)[8] accounts of the following phenomena in Hungarian finite clauses: sentence structure, verbal modifiers, operators, negation and copula constructions. He posits all this in the context of a critical overview of alternative Chomskyan and lexicalist approaches to these phenomena. Tamm (2004c) develops a comprehensive LFG approach to the relations between Estonian aspect, verbs and case.

The following databases on Uralic languages are useful resources about their syntactic properties: the Uralic language typological data set at bedlan.net/data/uralic-language-typological-data-set the Selkup and Kamas corpora at www.slm.uni-hamburg.de/inel, and the typological database of Ugric languages at en.utdb.nullpoint.info.

1.2 The structure of the chapter

In accordance with the scopes of LFG works on Finno-Ugric languages, the significantly larger part of this chapter (Section 2-Section 7) concentrates on the investigation of clausal phenomena, and this is followed by the discussion of salient LFG analyses of some noun phrase phenomena (Section 8). In Section 2 we discuss clausal c-structure representational issues by focusing on a variety of

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[5] In Section 9 we make brief references to additional works on Uralic languages in general and Finno-Ugric languages in particular that we cannot discuss here for limitations of space.

[6] See, for instance, Brattico (2019) on Finnish word order, É. Kiss (2020) on pronominal objects in Ob-Ugric, and Asztalos (2020) on focus in Udmurt.

[7] In her review, Anne Tamm has kindly provided the following information about the history of syntactic research on Estonian. "For a long while since the mid-20th century, there was more work on Estonian syntax than on Finnish syntax. Keeping abreast with western mainstream linguistics in the 60s, 70s and early 80s resulted in numerous formal syntactic works and a tradition of understanding syntax that is, in spirit, rather similar to LFG approaches. Rätsep (1978), for instance, is a lexicalist analysis of patterns of argument structures and their alternations; this work has certainly been influential in the context Uralic syntax. Tamm (2012c) provides an overview of the treatment of verb classes in this and related works, these early generative-style lexicalist works are available in Estonian only [...]. Almost all LFG work on Estonian expands that work in some way."

[8] In his XLE work he further develops Laczkó & Rákosi's (2008–2019) implemented Hungarian grammar.

LFG approaches to Hungarian. In Section 3 we concentrate on verbal modifiers in Hungarian and Estonian in general and on their radically different relations to focus in these languages in particular. In Section 4 we offer a brief overview of an LFG-XLE analysis of negation in Hungarian by also pointing out its potential contribution to the treatment of negation phenomena cross-linguistically. In Section 5 we discuss LFG accounts of copula constructions in Hungarian, Inari Saami and Finnish. In Section 6 we deal with LFG treatments of some aspects of argument realization in Finnish and Estonian. In Section 7 we concentrate on a selection of morphosemantic phenomena: (i) subject-verb agreement in Inari-Saami and Finnish; (ii) differential object marking in Uralic with particular attention to Finno-Ugric languages; (iii) the grammaticalized expression of evidentiality in Udmurt and Estonian. In Section 8 we present a summary of a variety of LFG approaches to noun phrase phenomena in Hungarian: (i) c-structure issues; (ii) event nominalization, and we add a short section on the morpho-syntax of possessive noun phrases in Finnish and Hungarian. In Section 9 we make brief references to additional relevant LFG(-related) works on Finno-Ugric languages that space limitations have prevented us from discussing. In Section 10 we conclude.

2 C-structure representation in clauses

de Groot (2017) presents a very useful tabular comparison of the major word order properties of 21 Uralic languages. In Table 1 we present the parts of his table that are relevant for our current purposes.

As the table shows, in these languages word order is predominantly free (except for Enets and Nenets). The two major patterns are SVO and SOV with roughly the same frequency. In seven languages there is a designated preverbal focus position (and in one of them, Komi, there is an additional postverbal Foc position). In three languages the Foc position is clause final. This is the general word order picture. Below we fundamentally concentrate on Hungarian because several alternative LFG c-structure analyses have been proposed for this language. In addition, we make some comparative remarks on Finnish and Estonian.

Table 1: Word order properties of 21 Uralic languages (part of Table 11, de Groot 2017: 548)

Language	word order	major pattern	focus position
Finnish	free	SVO	
Estonian	free	SVO	clause final
Votic	free	SVO	
Ingrian	free	SVO	clause final
Veps	free	SVO	clause final
Karelian	free	SVO	
South Saami	free	SOV/SVO	
North Saami	free	SVO	
Skolt Saami	free	SVO	
Erzya	free	SVO	
Mari	free	SOV	Foc V
Komi	free	SOV/SVO	Foc V / V Foc
Udmurt	free	SOV	Foc V
Hungarian	free	SOV/SVO	Foc V
Khanty	free	SOV	Foc V
Mansi	free	SOV	
Nenets	not free	strict SOV	Foc V
Enets	not free	strict SOV	Foc V
Nganasan	free	SOV	
Selkup	free	SOV	
Kamas	free		

Hungarian is a classic example of a discourse configurational language: see É. Kiss (1995), for instance.[9] The crucial empirical generalizations about Hungarian sentence structure are as follows. The fundamental sentence articulation

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[9] On sentence structure and discourse-functionality in Finnish in non-LFG frameworks, see Vilkuna (1995) and Brattico (2019), for instance. According to Vilkuna (1995), there is a preverbal K (contrast) and also a T (topic) position in Finnish. While fundamentally these two positions are also available in Estonian, on the basis of their experimental and corpus investigation, Sahkai & Tamm (2018b, 2019) claim that other types of constituents can also occur in the preverbal domain. While Hungarian exhibits strong discourse-configurationality, Estonian is only weakly discourse-configurational: see Sahkai & Tamm (2018b: 416–417). Hiietam (2003) argues that topic is to be defined semantically and not configurationally in this language. In addition, Estonian is the only Uralic language with V2, and its V2 is prosodic: see Sahkai & Tamm (2018a). Tael (1988) claims that the focus position is at the end of the clause in Estonian.

is topic-predicate (also called topic-comment in a variety of approaches). In the topic field, the order of topics and sentence adverbs is free. In the preverbal domain, quantifiers follow the topic field. In neutral sentences[10] there is a designated immediately preverbal position for a special constituent type: 'verbal modifier' (VM). This is a conventionally used cover term for a range of radically different categories sharing the syntactic property of occupying this designated preverbal position. Preverbs (also known as verbal particles or coverbs),[11] bare nouns, designated XP arguments, etc. are all assumed to be VMs. Basically, the word order of postverbal elements is also free. In a non-neutral sentence the (heavily stressed) focused constituent occupies the immediately preverbal position, and, as a consequence, the VM has to occur postverbally, i.e. the VM and the focus are in complementary distribution. How to capture this complementarity is a crucial cross-theoretical issue. The two salient solutions are as follows. (i) There is only a single designated preverbal position for which focused constituents and VMs compete. (ii) There are two distinct positions for the two elements: focus and VM. In this approach it needs to be explained why these two elements cannot co-occur.

Börjars et al. (1999) offer some general considerations against functional projections like TopP and FocP (*à la* Government and Binding Theory and the Minimalist Program) for languages like Hungarian and some hints at a possible LFG alternative with an extended verbal projection in which word order regularities are capturable by dint of Optimality Theoretic (OT) style constraints. They claim that the assumption that discourse functions are not necessarily associated with the specifier positions of functional projections allows an analysis of Hungarian in which quantifier phrases and topics are positioned within an extended verbal projection, avoiding the postulation of functional projections without heads. They propose that Hungarian sentences are VP projections, as in (1),[12] and they suggest that the immediately preverbal occurrence of the focused constituent should be captured in terms of OT constraints. In this work, there is no discussion of VMs and their complementarity with focused phrases.

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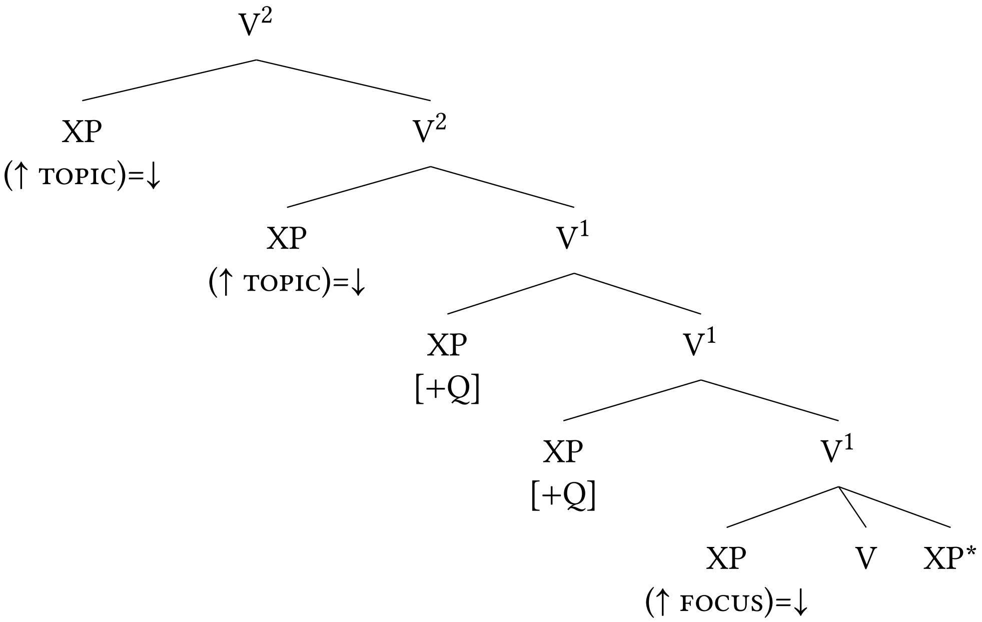
[10] The standard description of a neutral sentence is that it does not contain negation or focus, it is not a *wh*-question, and it has level prosody.

[11] Other Ob-Ugric languages have developed verbal particles to a lesser extent, see Zsirai (1933). For more information on Uralic (aspectual) verbal prefixation and verbal particles, see Kiefer & Honti (2003). For an analysis of Estonian sentence-final particles with focus, see Tamm (2004c: 224–242), discussed in Section 3.2.

[12] The superscripts in V^1 and V^2 indicate bar-levels.

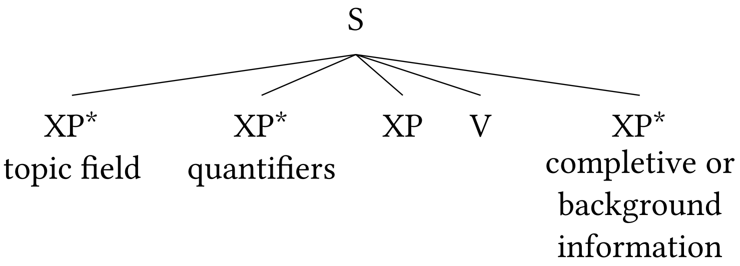
(1)



Adopting the basic representational assumptions and ideas of Börjars et al. (1999), in their OT-LFG framework, Payne & Chisarik (2000) develop an analysis of Hungarian preverbal syntactic phenomena: the complementarity of constituent question expressions, focused constituents, the negative marker and verbal modifiers.

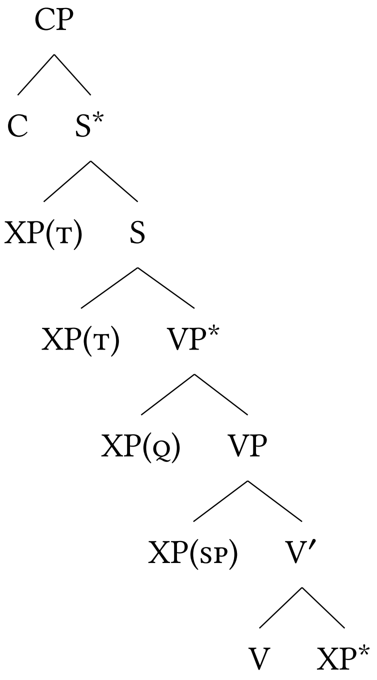
Gazdik (2012), capitalizing on Gazdik & Komlósy (2011), outlines an LFG analysis of Hungarian finite sentence structure, predominantly driven by discourse functional assumptions and considerations. She postulates two sentence structure types, and she assumes that both structures are available to both neutral (N) and non-neutral (NN) sentences, which are distinguished by their different prosodic behaviours. (2) shows one of the two structures. Here the immediately preverbal XP has a presentational-focus-like function in N sentences and the standard identificational focus function in NN sentences. The other structure differs in one important respect: the preverbal element is a VM, and the VM and the verb are dominated by V′. The VM receives the usual phonological-word-initial stress in N sentences and the focus stress in NN sentences.

(2)



Laczkó (2014b), after a detailed critical overview of previous LFG approaches, postulates the skeletal sentence structure in (3).[13] He argues against assuming an IP for the structural-categorial representation of Hungarian sentences and he argues for S as the core category.[14] He proposes a CP/S alternative that is closest in spirit to É. Kiss' (1992) special GB approach.[15]

(3)



Adopting one of the most crucial aspects of É. Kiss's (1992) analysis, he assumes that vms and focused constituents target the Spec,VP position. He employs disjunctive functional annotations to capture this preverbal complementarity.[16]

Consider the following generalization. 'The daughters of S may be subject and predicate' (Bresnan 2001: 112). In his analysis, Laczkó proposes that this generalization should be modified in the following way.

(4) The daughters of S may be subject/topic and predicate.

He points out that this modification receives independent support from the following rule from Bresnan & Mchombo (1987).[17]

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[13] In (3) t stands for topic (position), q stands for quantifier (position), sp stands for the specifier position. S* and VP* encode the possibly iterative left-adjunction of XP(t) and XP(q) to S and VP, respectively.

[14] In LFG IP and S are taken to be parametric options in Universal Grammar.

[15] For a comparison of these GB and LFG approaches, see Laczkó (2020).

[16] For details and the discussion of what other elements are assumed to compete for the Spec,VP position, see Section 3.1 and Section 4.

[17] On the basis of (5), *subject and/or topic* is even more appropriate than *subject/topic* in (4).

(5) $$\mathrm{S} \longrightarrow \begin{pmatrix}\mathrm{NP}\\ (\uparrow \textsc{subj})=\downarrow\end{pmatrix}, \begin{pmatrix}\mathrm{NP}\\ (\uparrow \textsc{topic})=\downarrow\end{pmatrix}, \begin{pmatrix}\mathrm{VP}\\ \uparrow=\downarrow\end{pmatrix}$$

Laczkó argues that a VP can contain a subject if the XP in [$_S$ XP VP] is a topic. This requires all other occurrences of VP to be subjectless. In this scenario, the following three parametric options seem to emerge across languages: (i) strictly VP-external subject, as in English; (ii) VP-internal subject in a designated position, as in Russian[18]; (iii) VP-internal subject without a designated position, see Hungarian.

This section has demonstrated that LFG provides a suitably flexible formal apparatus by the help of which the sentence structures of typologically different languages can be described in a principled manner with respect to discourse functional configurationality.

3 Verbal modifiers and focus

In this section we discuss analyses of verbal modifiers in Hungarian (Section 3.1) and Estonian (Section 3.2).

3.1 Hungarian

As has been pointed out in Section 2, the crucial (cross-)theoretical question to address in the case of Hungarian is how to account for the preverbal complementarity of focused constituents and verbal modifiers. Compare the examples in (6). (6a) is a neutral sentence and the VM *oda* 'to.there', which is categorially a preverb, immediately precedes the verb. By contrast, (6b) is a non-neutral sentence, and in it the VM can neither precede nor follow the focused constituent (in SMALLCAPS) in the preverbal domain.

(6) Hungarian:

a. János minden-t oda adott Mari-nak.
John.NOM everything-ACC VM gave Mary-DAT
'John gave everything to Mary.'

b. János minden-t (*oda) MARI-NAK (*oda) adott oda.
John.NOM everything-ACC VM Mary-DAT VM gave VM
'John gave everything TO MARY.'

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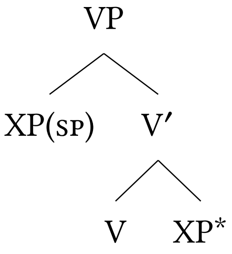
[18] See King (1995), for instance.

The cross-theoretic question is whether we should assume that the two constituents fight for one and the same syntactic position or that they occupy two distinct positions. With the salient exception of É. Kiss (1992, 1994), the GB/MP mainstream assumes two distinct positions, and employs a variety of principles that block the simultaneous occurrence of constituents in these positions: see Brody (1990) and É. Kiss (2004), for instance, and also see Laczkó (2021) for a comparative overview of different analyses of the complementarity of focused constituents and verbal modifiers in Hungarian.

Several LFG approaches have a similar view, see Ackerman (1987, 1990), Payne & Chisarik (2000), Mycock (2006, 2010), the basic idea being that vms get semantically and morphologically incorporated into the verb.[19] In Section 2 we also pointed out that Gazdik (2012) has a special proposal. She employs two distinct sentence structures, both having neutral and non-neutral versions. The main point here is that the basic vm vs. focus contrast is treated in two different structural dimensions. Thus, this can be regarded as an extreme instance of assuming that the two elements do not fight for the same syntactic position.

By contrast, Laczkó (2014b) argues that focus constituents (ordinary foci, the immediately preverbal *wh*-phrases and negated constituents)[20] and vms (of various types) target the same Spec,VP position, hence their complementarity. In (7) we repeat the relevant part of his overall sentence structure shown in (3) in Section 2.

(7)



Laczkó (2014b) employs disjunctive functional annotations to capture the complementarity of the elements he assumes to compete for this position.

As we pointed out in Section 2, vms come in several varieties: preverbs, idiom chunks, secondary predicates, designated reduced or full arguments. Preverbs are the central and theoretically by far the most challenging members of this

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[19] At first sight, it can be taken to be a supporting fact that the vms of the preverb type and the verb make up one phonological word, i.e. it is only (the first syllable of) the preverb that receives word-initial stress. However, even XP vms follow the same pattern (in which the following verb loses its word-initial stress).

[20] On the details of negation in Hungarian, see Section 4.

heterogeneous group, because their combination with the finite verb, often called particle-verb construction (pvc), exhibits both lexical and syntactic properties (and the former motivate the incorporation analysis). Their most salient lexical characteristics are as follows. The preverb can affect the argument structure of the main verb, pvcs are often non-compositional, and both non-compositional and compositional pvcs can undergo productive derivational processes like event nominalization. However, the preverb and the main verb are strictly separable syntactically under clearly definable circumstances. For instance, as exemplified in (6) above, a focused constituent, as a rule, immediately precedes the main verb, and in such cases the preverb must occur postverbally.

In several recent LFG approaches, for instance Forst et al. (2010), Laczkó & Rákosi (2011), Rákosi & Laczkó (2011), Laczkó (2013a) and Laczkó (2014b), it is assumed that preverbs and other types of vms uniformly occupy a distinct preverbal syntactic position (typically Spec,VP), as opposed to the vm-incorporation analysis, which is primarily motivated by the preverbal complementarity of vms, focused and *wh*-constituents.

Forst et al. (2010) propose an LFG-XLE treatment of a variety of particle-verb constructions in English, German and Hungarian. Their main claim is that non-compositional and non-productive pvcs should be treated radically differently from compositional and productive pvcs. The former are best analyzed along lexical lines with the help of XLE's concatenation device. By contrast, the authors argue that the productive pvc types call for a syntactic treatment. One of the most important motivations for this sharp distinction is that productive pvcs can be analyzed 'on the fly', i.e. automatically and straightforwardly, in the syntax, without previously and lexically encoding them. Their solution is complex predicate formation in the syntax by applying XLE's restriction operator.[21]

Laczkó & Rákosi (2011) and Rákosi & Laczkó (2011) explore the tenability and implementational applicability of the approach proposed by Forst et al. (2010) by each developing an LFG-XLE analysis of two different pvc types. Laczkó & Rákosi (2013) posit this approach in a cross-linguistic and cross-theoretical context. As opposed to previous LFG accounts, Laczkó (2013a) argues that compositional pvcs should also be treated lexically in a manner similar to the treatment of non-compositional pvcs. He points out that one of the advantages of this uniform lexical treatment is that classical LFG's view of the distribution of labour between the lexical and the syntactic components of grammar can be maintained, at least

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[21] For formal details, see Forst et al. (2010).

in this domain. He also shows how various morphological processes (often consecutively) involving pvcs can be handled (e.g. causativization, nominalization, and preverb reduplication), which may cause potential problems for a syntactic analysis of compositional pvcs.

Laczkó (2014b) captures the preverbal complementarity of focused constituents and vms by assuming that they fight for the same Spec,VP position. He encodes this by associating the disjunctive sets of annotations in (8) with this position. The first disjunct of the main disjunction says that a constituent bearing any grammatical function can have the focus discourse function. The second disjunct handles vms. Laczkó employs XLE's check feature device here.[22]

(8)

$$\begin{array}{l} \{\ (\uparrow \text{gf}) = \downarrow \\ \ \ (\uparrow \text{focus}) = \downarrow \\ \mid (\downarrow \text{check\_vm}) =_c + \\ \ \ \{\ \uparrow = \downarrow \\ \ \ \mid (\uparrow \text{gf}) = \downarrow \}\} \end{array}$$

The check feature in (8) is used for all types of vms. It requires the presence, in Spec,VP, of an element lexically marked with the defining counterpart of this feature. Preverbs are intrinsically associated with this feature, i.e. in their lexical forms they are associated with the defining member of the check_vm feature pair, and they receive the functional (co-)head annotation, see the first disjunct in the second major disjunct. All the other types of vms are specified for this status by individual verbs. It depends on the verb whether it selects a vm, and, if so, which argument (bearing any subcategorized grammatical function) will be singled out, see the second disjunct in the second major disjunct.[23]

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[22] The essence of this device is that check features come in pairs: there is a defining equation and it has a constraining equation counterpart. These check feature pairs, which can be used both in c-structure representations and lexical forms, can ensure that two elements will occur together in a particular configuration or a particular element occurs in a particular position. The check feature in (8) is of the latter type.

[23] Laczkó also assumes that a *wh*-phrase (or, in multiple *wh*-questions the immediately preverbal *wh*-phrase) also fights for the Spec,VP position, so he adds another disjunction to (8) to capture this, by using additional (interrogative) check features: for details, see Laczkó (2014b). In addition, he assumes that negated constituents also occupy this position. Furthermore, he postulates that in the type of predicate negation in which there is no focused constituent, the negative marker also targets this position. Therefore, he adds two more disjuncts, see Section 4.

Laczkó (2014a) outlines an LFG analysis of a variety of VMs other than preverbs: bare nouns,[24] OBL XP arguments, XCOMP arguments and idiom chunks. The crucial aspect of this analysis is that in the lexical form of the verb taking any one of these VM types it is specified that either the verb occurs in a sentence containing a focused constituent or else its designated complement must occupy the Spec,VP position.[25]

3.2 Estonian

Tamm (2004c) presents a detailed description of PVCs in Estonian, and she outlines an LFG analysis. She points out that Estonian separable particles are basically comparable to their Hungarian counterparts, the most important difference being that aspectual particles typically occupy the clause final focus position. Tamm distinguishes three basic uses of Estonian particles, and she discusses the particle *ära,* which can perform all the three functions. Consider her examples.

(9) Directional (deictic) use of *ära*, Estonian:
ära veerema
away roll
'roll away'

Tamm points out that verbs combining with *ära* in this use have an implicit path argument that is only optionally realized overtly. The closest Hungarian counterpart is *el* 'away' (as in *el-gurul* 'roll away').

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[24] Viszket (2004) offers a detailed empirical description of a whole range of bare noun phrases in Hungarian. In neutral sentences these constituents can only occur immediately preverbally, in the VM position. In her LFG account of the syntax of bare noun phrases, Viszket adopts Laczkó's (1995, 2000b) [+VM] feature and she also introduces a special [•VM] feature. Her new feature, when associated with a predicate in its lexical form, bans the occurrence of a bare NP in the VM position; practically, it prevents such a constituent from occurring in neutral sentences. Viszket identifies seven major types of predicates that need to be provided with this feature in their lexical forms. For instance, the verbs of PVCs, the predicates of certain idioms and certain predicates with resultative XCOMPs belong here. These types also have the [+VM] feature. In addition, there are predicates without the [+VM] feature that also need [•VM]. For example, nominal and adjectival predicates, and verbs that always need word-initial stress belong here. On partitive mass and plural NPs in Estonian, corresponding to bare nominal VMs in Hungarian, see Tamm (2007a,c).

[25] In her review, Anne Tamm points out that there are similarities between Laczkó's analysis of Hungarian particle verbs and the analysis of Estonian particle verbs and aspect in Rätsep (1969) written in Estonian, which Tamm (2012c: 62–63, 72–75) has summarized, or Rätsep's (1978) account of government structures of complex verbs in Estonian.

(10) Completive use of *ära*, Estonian:
Naaber suri ära.
neighbour die.PST.3SG ÄRA
'The neighbour died.'

Verbs that combine with *ära* in this use have a theme or patient argument, obligatorily realized as a subject or an object. The closest Hungarian equivalents are *meg* 'PFV' (as in *meg-hal* 'PFV-die') and *el* 'away' (as in *el-olvad* 'away-become.melted').

(11) Bounding use of *ära*, Estonian:
Ta suudles tüdruku ära.
s/he kiss.PST.3SG girl.GEN ÄRA
'S/he did the kissing of a girl.'

This sentence is appropriate in the following situation, for instance. Someone makes a bet to kiss a girl, and when this goal is achieved, the result can be reported by using this PVC. The closest Hungarian counterparts are *meg* 'PFV' (*meg-ebédel* 'have/eat up one's lunch') and *ki* 'out' (as in *ki-alussza magát* out-sleep oneself.ACC 'sleep one's share, as much as needed').

Tamm assumes that *ära* in its directional use has a PRED feature, and she gives the following lexical representation (Tamm 2004c: 231).

(12) *ära* P (↑ PRED) = 'AWAY⟨(↑ SUBJ)⟩'
{ ((XCOMP ↑) B1) ∨ ((XCOMP ↑) B2) }

This encodes that the particle functions as the PRED of the lexical verb, and it has a subject argument. In addition, it has disjunctive existential constraints on the boundedness (B) attributes.

Tamm assumes that *ära* in its completive use also has a PRED feature, see her lexical form in (13) (Tamm 2004c: 232).

(13) *ära* P (↑ PRED) = 'UP, COMPLETELY⟨(↑ SUBJ)⟩'
{ ((XCOMP ↑) B1) = MAX ∨ ((XCOMP ↑) B2) }

As opposed to its previous two uses, Tamm assumes that *ära* in its bounding use has no PRED feature, and it only encodes B and focus specifications, see (14) (Tamm 2004c: 229).

(14) *ära* Prt (↑ B1) = MAX
(↑ B2) = MIN
(↑ FOCUS B1) = MAX
(↑ FOCUS B2) = MIN

The particle in this use contributes f-structure information about the aspectual features of the clause, see the first two annotations, and it also encodes that this boundedness is the focused information, see the last two annotations.

In addition, verbal predicates can also carry aspectual information in their lexical forms. For instance, Tamm assumes that *suudlema* 'kiss', see (11) for instance, has the following lexical representation.

(15) *suudlema* V (↑ PRED) = 'KISS⟨(↑ SUBJ)(↑ OBJ)⟩'
(↑ B2)

This verb has an existential constraint on B2, which can be unified with the MIN value of the B2 of the particle in (14). Finally, the partitive and total case-markers on object arguments also encode aspectual information, so the entire aspectual feature value set of an Estonian sentence comes from three main sources via unification: verbs, aspectual particles and partitive/total case markers.[26]

3.3 Concluding remarks

At the end of Section 3 we can make the following concluding remarks.

Hungarian VM phenomena are relevant from both cross-theoretical and LFG-specific perspectives in two important respects.

First, the focus-VM complementarity is a general generative theoretical issue. As the foregoing discussion shows, LFG provides a flexible formal platform even for alternative analyses significantly different in nature, which may be due to partially different views of the relevant components of the architecture of LFG.

Second, the behaviour of Hungarian PVCs, representing the major class of VMs, is of great importance in the realm of complex predicates across typologically different languages, see Alsina et al. (1997) in general and Ackerman & Lesourd (1997) in that volume, in particular. The mixed lexical-morphological and syntactic properties of compositional and productive as well as non-compositional and unproductive PVCs pose a substantial challenge for both syntactically and lexically oriented generative theories, including LFG. From their entirely lexicalist perspective, Ackerman et al. (2011) give a taxonomic overview of a variety of approaches to complex predicates in LFG and HPSG. They point out that the classical models of the two theories rejected argument-structure-changing operations in the syntax, including complex predicate formation: see Bresnan (1982) and Pollard & Sag (1987). However, some more recent views in both theories admit syntactic complex predicate formation: see Alsina (1992, 1997), Butt (2003)

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[26] On the aspectual interaction of various verb types and partitive/total case in Estonian, see the discussion of Tamm's (2006) analyses in Section 6.2.

and Müller (2006). By contrast, Ackerman et al. (2011), in their Realization-Based Lexicalism (RBL) model, reject complex predicate formation in the syntax, and, as a trade-off, they admit analytic, i.e. multiple-word, forms of predicates in their lexicon as a marked option. As regards the treatment of Hungarian PVCs, Ackerman (2003) develops an RBL analysis. Forst et al. (2010), Laczkó & Rákosi (2011), Rákosi & Laczkó (2011) and Laczkó & Rákosi (2013), in their LFG-XLE framework, handle the productive types in the syntax by means of the RESTRICTION operator. By contrast, Laczkó (2013a), in the same framework, argues that both productive and unproductive PVCs need a lexical treatment.

As regards Estonian, Tamm's (2004c) analysis has demonstrated that LFG also provides an appropriate formal apparatus for capturing the interplay of discourse functionality and the complex, multidimensional aspectuality system of this language.

4 Negation in Hungarian

Miestamo et al. (2015) discuss negation in Uralic in a comprehensive and systematically comparative fashion.[27] They show that 17 Uralic languages employ negative auxiliaries. Hungarian, Khanty, Mansi and Estonian are exceptions in that they have no such auxiliaries. Of all these languages, we are only aware of a few LFG analyses of negation in Hungarian (most of them being rather sketchy and covering only some aspects of negation phenomena).

Laczkó (2014c) develops the first comprehensive LFG-XLE approach to the following six major types of clausal (aka predicate) and constituent negation in Hungarian: (i) ordinary constituent negation (the negated constituent is focused); (ii) universal quantifier negation without (another) focused element (= ordinary constituent negation, i.e. the negated universal quantifier is focused); (iii) universal quantifier negation with focus (= there is a preverbal focused constituent following the negated universal quantifier); (iv) predicate negation, without focus, the negative particle precedes the verb; (v) predicate negation, with focus, the negative particle precedes the verb; (vi) predicate negation, with focus, the negative particle precedes the focus.[28] He proposes the following structural analysis.[29]

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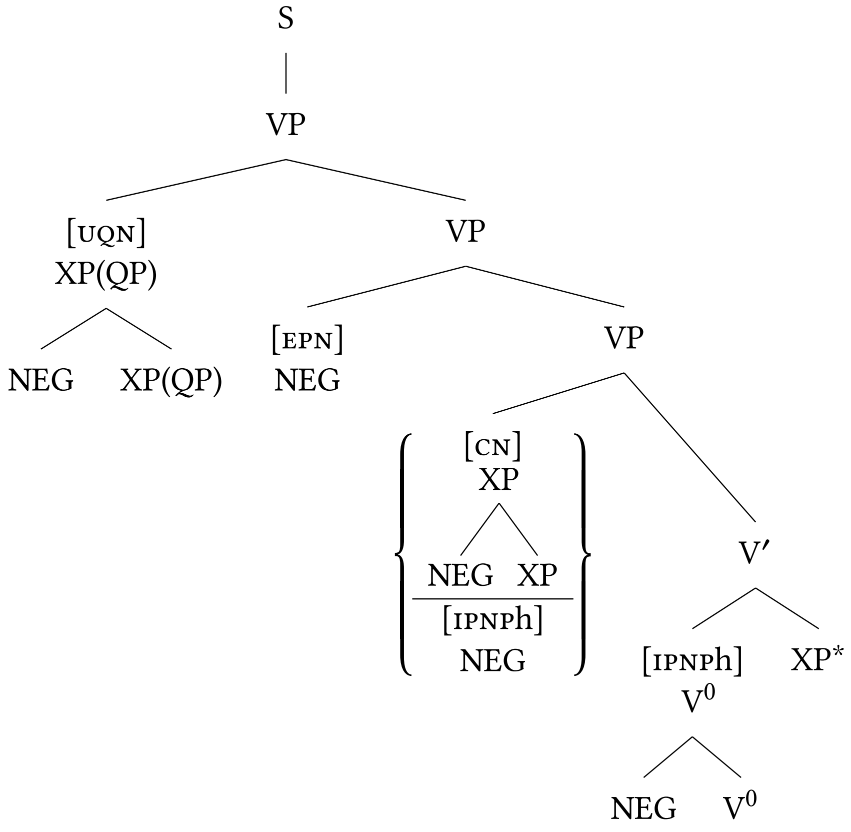
[27] There is a publicly accessible database on negation in Ob-Ugric and Samoyedic languages at https://www.univie.ac.at/negation/index-en.html.

[28] Payne & Chisarik (2000), in their OT-LFG framework, also sketch an analysis of some of these types. For a critical overview, see Laczkó (2014c).

[29] In (16) NEG stands fo the (category of the) negative particle and the abbreviations in square brackets indicate the types of negation: [UQN] = universal quantifier negation, [EPN] = (VP-)external predicate negation, [CN] = constituent negation, [IPNPh] = (VP-)internal predicate negation, phrasal adjunction, [IPNH] = (VP-)internal predicate negation, head-adjunction. The curly brackets signal the complementarity of [CN] and [IPNPh].

(16)



In XLE grammars three devices are used for the encoding of negation: (i) the negative morpheme (whether bound or free) can be represented as a member of the ADJUNCT set; (ii) it can encode the [NEG +] feature value; (iii) it can encode the [POL NEG] feature value. Laczkó (2015) points out that these devices are not used uniformly or consistently across the XLE grammars of various languages. He makes the following proposal. Type (i) is most appropriate when a language uses a free morpheme for the expression of negation, a negative particle. Type (ii) is best for bound negative morphemes. Type (iii) is most natural for encoding the scope of negation. In this proposed system, he develops an LFG-XLE analysis of Hungarian negative concord items.

In Laczkó's (2014c) approach negated constituents also occupy the Spec,VP position, see [CN] in (16). In addition, in the case of clause negation, the negative particle is also assumed to be in Spec,VP when there is no focused constituent there, see [IPNPh]. In his rules, Laczkó assumes that the negative particle has the category NEG, and he uses a special XLE-style phrasal categorial label for negated constituents: XPneg. His XPneg rule is given in (17).

(17) $$\text{XPneg} \longrightarrow \underset{\downarrow \in (\uparrow \text{ADJ})}{\text{NEG}} \quad \text{XP}$$

On the basis of these assumptions and rules, he adds the following two disjuncts to the disjunction in Spec,VP established so far, handling focused constituents and vms, shown in (8) in Section 3.1.[30]

(18) $$\left\{ \ldots \;\middle|\; \begin{array}{c} \text{XPneg} \\ (\uparrow \text{gf})=\downarrow \\ (\uparrow \text{focus})=\downarrow \end{array} \;\middle|\; \begin{array}{c} \text{NEG} \\ \downarrow \in (\uparrow \text{adj}) \\ (\uparrow \text{focus})=\downarrow \end{array} \right\}$$

As this section has shown, LFG provides an inventory of appropriate formal devices for analyzing complex negation phenomena in languages like Hungarian. At the same time, the treatment of these negation phenomena motivates examining the nature of the relevant formal devices carefully.

5 Copula constructions

5.1 Hungarian

The two major general LFG strategies for the treatment of copula constructions (ccs) across languages are represented by Butt et al. (1999) and Dalrymple et al. (2004). In the former approach, ccs are treated in a uniform manner functionally. The copula is always assumed to be a two-place predicate. It subcategorizes for a subject (subj) argument, which is uncontroversial in any analysis of these constructions, and the other constituent is invariably assigned a special, designated function designed for the second, 'postcopular' argument of the predicate: predlink. As opposed to this approach, in Dalrymple et al.'s (2004) view, the subj & predlink version is just one of the theoretically available options. In addition, they postulate that the copula can be devoid of a pred feature (and, consequently, argument structure) and in this use it only serves as a pure carrier of formal verbal features: tense and agreement. Finally, it can also be used as a one-place 'raising' predicate, associating the xcomp function with its propositional argument and also assigning a non-thematic subj function. When the postcopular constituent has the predlink function, it is closed in the sense that its subject argument is never realized outside this constituent. The xcomp and the predlink types involve two semantic and functional levels (tiers): the copula selects the relevant constituent as an argument. By contrast, when the copula is a mere formative, the two elements are at the same level (tier): the postcopular constituent is the real predicate and the copula only contributes morpho-syntactic features.

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[30] Based on their prosodic and semantic behaviour, he assumes that both types of negative elements are focused constituents.

In LFG's formal system, they are functional coheads. All this is summarized in Table 2.

Table 2: Three types of copular constructions, Dalrymple et al. (2004)

role of the postcopular constituent		
open		closed
(A) main PRED, the copula is a formative: functional coheads (single-tier)	(B) XCOMP of the copula main PRED: 'be⟨(↑ XCOMP)⟩(↑ SUBJ)' (double-tier)	(C) PREDLINK of the copula main PRED: 'be⟨(↑ SUBJ)(↑ PREDLINK)⟩' (double-tier)

As regards the treatment of copula constructions, Laczkó (2012) develops the first comprehensive LFG analysis of the following five most important types of CCS in Hungarian: (i) attribution or classification; (ii) identity; (iii) location; (iv) existence; (v) possession. He subscribes to the view, advocated by Dalrymple et al. (2004) and also by Nordlinger & Sadler (2007), among others, that the best LFG strategy is to examine all CCS individually, and to allow for diversity and systematic variation both in c-structure and in f-structure representations across and even within languages. This means that he rejects Butt et al.'s (1999) and Attia's (2008) uniform PREDLINK approach at the f-structure level. Table 3 summarizes the most important aspects of his analysis.[31]

Here we can only highlight the most crucial ingredients of this approach, concentrating on the 'copula's function' and 'argument structure' columns in the table. In the attribution/classification type the copula has no PRED feature and, thus, no argument structure, cf. column (A) in Table 2. The versions of the copula in all the other four CC types are two-place predicates. In the identity and possession types the second argument is assumed to have the PREDLINK function, cf. column (C) in Table 2, while in the location and existence CCS it bears the OBL_{LOC} function, which is a variant of the closed type of postcopular constituents in column (C) in Table 2. Thus, in Laczkó's (2012) analysis the copula has five dis-

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[31] The following abbreviations are used in Table 3: COP = copula, ATTR/CLASS = attribution/classification, PR3: COP = is the copula present in the present tense and 3rd person paradigmatic slots? PR3: NEG = how is negation expressed in PR3? VM = which element (if any) occupies the VM position in neutral sentences? S = SUBJ, PL = PREDLINK, interch = the two arguments' grammatical functions are interchangeable in the 3rd person, spec = specific, def = definite, FOC = FOCUS, agr = agreement.

Table 3: Laczkó's (2012) analysis of Hungarian copula constructions

CC TYPE	PR3		COPULA'S	ARGUMENT		OTHER
	COP	NEG	FUNCTION	STRUCTURE	VM	TRAITS
ATTR/CLASS	-	*nem*	formative	-	AP/NP	NP: -spec
IDENTITY	-	*nem*	predicate	<S, PL>	SUBJ	S: +spec, interch.
LOCATION	+	*nincs*	predicate	<S, OBL>	OBL	S: +spec
EXISTENCE	+	*nincs*	predicate	<S, (OBL)>	-	S: -spec COP: FOC
POSSESSION	+	*nincs*	predicate	<S, PL>	-	S: -def S&PL agr. COP: FOC

tinct lexical forms, which encode their respective sets of properties indicated in Table 3.

5.2 Inari Saami and Finnish

Toivonen (2007) analyzes subject-verb agreement phenomena in Inari Saami with a brief comparison with the corresponding Finnish phenomena, see Section 7.1.1. In her general approach, she also proposes an LMT (Lexical Mapping Theory: Findlay et al. 2023 [this volume]) analysis of Inari Saami possessive constructions, again with a brief comparison with the Finnish counterparts. The empirical generalizations that she starts with, and which are relevant here, are as follows. (i) The possessed item is the subject. (ii) The possessed item bears nominative case. (iii) The possessor bears locative case. Consider one of her examples in (19), illustrating these facts.

(19) Inari Saami:
Muste lah tun.
I.LOC are.2SG you.NOM.SG
'I have you.'

Toivonen assumes that the Inari Saami copula in this function is a two-place predicate with a theme (possessum) argument and a location (possessor) argument that receive the [$-r$] and the [$-o$] intrinsic specifications, respectively, and they are mapped onto SUBJ and OBL, respectively: see (20).

(20)

$$\begin{array}{llccl} & & \text{theme} & \text{location} & \\ \textit{le}\delta\textit{e} & \langle & \text{x} & \text{y} & \rangle \\ & & [-r] & [-o] & \\ & & | & | & \\ & & \textsc{subj} & \textsc{obl} & \end{array}$$

Toivonen compares Inari Saami and Finnish possessive constructions. For her comparison from the perspective of agreement, see Section 7.1.1. Here we concentrate on the GFs of the arguments of the possessive copulas of the two languages. Compare Toivonen's Inari Saami example in (19) above with her corresponding Finnish example in (21).

(21) Finnish:

Minulla	on	sinut.
I.ADE	is.3SG	you.ACC.SG

'I have you.'

She makes the following generalizations about Finnish possession CCs. The possessum is either in nominative case (ordinary noun phrases) or in accusative case, see (21), and it has the OBJ function. The possessor is an oblique case-marked noun phrase, and it has the SUBJ function.

These two sections have shown that the behaviour of copula constructions in Hungarian, Inari Saami and Finnish exhibits remarkable variation, especially in the case of possession CCs. We can make the following concluding observations. On the one hand, the LFG framework, in this case, too, provides appropriate formal tools for feasible analyses of these construction types. On the other hand, the complexity of these phenomena can be used to argue for particular approaches in the inventory of LFG's alternative formal devices in this particular domain.

6 Aspects of argument realization

6.1 Finnish

Pylkkänen (1997) develops an event-structure-based linking approach to Finnish causatives. She claims that her theory is minimalistic in two respects. On the one hand, in formalizing the relationship between event participants it minimizes reference to the thematic role properties of these participants (e.g. agent, theme and cause) by referring to events themselves. The basic assumption is that if one eventuality causes another then the participants of the former always rank higher than those of the latter. On the other hand, an adequately developed system of inferring prominence relations obviates the need for argument structure, the level of representation mediating between event structure and grammatical functions. Pylkkänen's system of inferring prominence from lexical semantic representations capitalizes on the following two assumptions proposed by Parsons (1990): (i) thematic roles are relations between events and individuals; (ii) causation is a relation between events. As a consequence, the thematic hierarchy is treated as applying at the level of individual events and not at the level of predicates. From this it follows that a predicate can have more than one thematic hierarchy: as many thematic hierarchies as events. All participants can be organized into a prominence hierarchy by ranking the individual thematic hierarchies with respect to each other. This ranking is regulated by Parsons' second assumption: the causal relations between events. In essence, if E1 CAUSES E2, then $\text{E1}_{\Theta\text{H}}$ (the thematic hierarchy of E1) is ranked higher than $\text{E2}_{\Theta\text{H}}$ (the thematic hierarchy of E2). Consider Pylkkänen's two hierarchies in (22) and (23).

(22) Thematic Hierarchy: agent/experiencer > other > theme

(23) Event Hierarchy: cause(e1,e2) → $\text{E1}_{\Theta\text{H}} > \text{E2}_{\Theta\text{H}}$

Then linking constraints provide the mapping between the prominence hierarchy resulting from (22) and (23) and the following grammatical function hierarchy.

(24) $\text{SUBJ} > \text{OBJ} > \text{OBJ}_{\theta} > \text{OBL}$

In order for the linking constraints to be unifiable, Pylkkänen converts Parsons' logical forms into attribute-value matrices. Consider her f-structure and event structure representation of (25), one of her examples, in (26).

(25) Finnish:
Matti kävel-yttä-ä koiraa.
Matti.NOM walk-CAUS-3SG dog.PAR
'Matti walks the dog.'

In the event structure there are ranked participants. IND means 'index', which is a 'pointer' to an event participant, and RANK indicates the prominence of the participant concerned. In the case of (25), the RANK1 participant is realized as the subject, while the RANK2 and RANK3 participants are realized as the object.

(26)
$$\left[\begin{array}{ll}
\textsc{f-str} & \left[\begin{array}{ll} \textsc{subj} & \left[\begin{array}{ll}\textsc{pred} & \textsc{matti}\\ \textsc{case} & \textsc{nom}\end{array}\right] \\ \textsc{obj} & \left[\begin{array}{ll}\textsc{pred} & \textsc{dog}\\ \textsc{case} & \textsc{par}\end{array}\right]\end{array}\right]\\
\textsc{eventstr} & \left[\begin{array}{ll} \textsc{e1} & \left[\begin{array}{ll} \theta\textsc{\_rels} & \left[\begin{array}{ll}\textsc{agent} & \left[\begin{array}{ll}\textsc{ind} & \textsc{matti}\\ \textsc{rank} & 1\end{array}\right]\\ \textsc{theme} & \left[\begin{array}{ll}\textsc{ind} & \textsc{dog}\\ \textsc{rank} & 3\end{array}\right]\end{array}\right]\end{array}\right]\\
\textsc{e2} & \left[\begin{array}{ll}\theta\textsc{\_rels} & \left[\begin{array}{ll}\textsc{agent} & \left[\begin{array}{ll}\textsc{ind} & \textsc{dog}\\ \textsc{rank} & 3\end{array}\right]\end{array}\right]\\ \textsc{sem\_type} & \textsc{walk}\end{array}\right]\\
\textsc{rel} & \textsc{cause}(\textsc{e1},\textsc{e2})\end{array}\right]
\end{array}\right]$$

6.2 Estonian

Tamm (2006) develops an LFG analysis of the interaction of transitive telic verbs and aspectual case in Estonian. In this language the objects of telic verbs can bear either partitive (PAR) case or total (TOT) case. The choice between partitive and total is regulated by the aspectual features of the sentence, compare Tamm's examples in (27) and (28).[32]

(27) Estonian:
Mari kirjutas raamatu ühe aastaga.
Mari.NOM write.PST.3SG book.TOT one.GEN year.COM
'Mari wrote a/the book in a year.'

(28) Estonian:
Mari kirjutas raamatut terve aasta.
Mari.NOM write.PST.3SG book.PAR whole.TOT year.TOT
'Mari was writing a/the book for a whole year.'

Tamm shows that the sentence in (27), with its object in total case, has a perfective interpretation, and the sentence in (28), with its object in partitive case, is imperfective, as is supported by the types of the adjuncts in them: 'in a year' vs. 'for a year'. In addition, Tamm shows that Vendlerian achievement verbs like

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[32] The lexical entries for the Estonian case-markers encoding aspectual features are modeled as semantic (Butt & King 2004) and constructive cases (Nordlinger & Sadler 2004), and they provide the formal tools for Tamm's analysis. On the terminology of Finnic core cases, see Tamm (2011a, 2012c). On partitives in Finnish, see Vainikka & Maling (1996).

võitma ‘defeat’ are compatible with objects in partitive case in Estonian, although the sentences they occur in are perfective by default, see her example in (29).

(29) Estonian:
Mari võitis Jürit.
Mari.NOM defeat.PST.3SG George.PAR
‘Mary defeated George.’

In her analysis, Tamm introduces the boundedness aspectual feature: B with two values: MIN and MAX. She associates this feature both with the lexical forms of the two transitive verb types seen above and with the lexical representations of case markers in the following way. Her basic generalization is that ‘write’-type verbs are boundable, and ‘defeat’-type verbs are bounded. In the lexical form of the former boundedness is encoded as an existential constraint, while in the lexical form of the latter it is encoded as a defining equation: the B feature has the MIN value, see (30) and (31), respectively.

(30) kirjutama ‘WRITE’… (↑ B)

(31) võitma ‘DEFEAT’… (↑ B) = MIN

As regards case, the total case-marker, attached to an object noun phrase, introduces the MAX value for B, while the partitive case-marker specifies B as ≠MAX. These values are encoded with inside-out function application, see (32) and (33).

(32) *tot* (↑ CASE) = TOT
((OBJ ↑) B) = MAX

(33) *par* (↑ CASE) = PAR
((OBJ ↑) B) ≠ MAX

In this system, a ‘write’-type verb requires that the sentence should be marked for boundedness, and its underspecified B feature admits either of the two object cases. For instance, Tamm gives the following lexical representations for the verb and the object in (27).

(34) *kirjutas* V (↑ PRED) = ‘WRITE⟨(↑ SUBJ)(↑ OBJ)⟩’
(↑ TENSE) = PST
(↑ PERS) = 3
(↑ NUM) = SG
(↑ B)

(35) *raamatu* N (↑ PRED) = ‘BOOK’
(↑ CASE) = TOT
((OBJ ↑) B) = MAX

On the basis of this, her f-structure representation of (27) is as follows.

(36)
$$\left[\begin{array}{ll} \text{PRED} & \text{‘WRITE}\langle\text{SUBJ, OBJ}\rangle\text{’} \\ \text{B} & \text{MAX} \\ \text{TNS} & \text{PST} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \\ \text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘Mari’} \\ \text{CASE} & \text{NOM} \\ \ldots & \end{array}\right] \\ \text{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘BOOK’} \\ \text{CASE} & \text{TOT} \\ \text{NUM} & \text{SG} \\ \ldots & \end{array}\right] \end{array}\right]$$

Obviously, the f-structure representation of (28) would be different from (36) in one important respect: the value of B would be ≠MAX on the basis of (33).

By contrast, the value of the B feature of a ‘defeat’-type verb is MIN, which only allows compatibility with an object in partitive case, given that total case encodes the opposite value: MAX. Tamm offers the following lexical representations for the verb and the object in (29), and she points out that there is no value clash with respect to the B feature.

(37) *võitis* V (↑ PRED) = ‘DEFEAT⟨(↑ SUBJ) (↑ OBJ)⟩’
(↑ TNS) = PST
(↑ PERS) = 3
(↑ NUM) = SG
(↑ B) = MIN

(38) *Jürit* N (↑ PRED) = ‘George’
(↑ CASE) = PAR
((OBJ ↑) B) ≠ MAX

As another argument-realization topic, Torn (2006) discusses the status of certain non-core arguments and adjuncts of verbal predicates in Estonian. She points out that fundamentally there are two approaches to these constituents. One of them regards non-core arguments as oblique case-marked indirect objects, separating them from adjuncts, while the other lumps the two groups together as adverbials. Torn subscribes to the first approach.

By way of illustration, Torn shows that in this language participants of an event that are indirectly affected are realized by noun phrases bearing the same 'local' case suffixes as are used to express spatial adverbial dependents: see her examples in (39) and (40).

(39) Adverbial allative, Estonian:
Mees istus diivanile.
man.NOM sat sofa.ALL
'A man sat onto the sofa.'

(40) Oblique allative, Estonian:
Ema andis lapsele raha.
mother.NOM gave child.ALL money.PAR
'The mother gave money to the child.'

Torn says that *diivanile* 'onto the sofa', a noun phrase in allative case, is an ungoverned adverbial constituent in (39), while *lapsele* 'to the child', a noun phrase in allative case here, too, expresses the indirectly affected argument of the ditransitive verb *andma* 'give' in (40). In her terminology, *diivanile* in (39) is an adverbial modifier, and *lapsele* in (40) is an object adverbial.

Torn offers the following three arguments for distinguishing object adverbials from adverbial modifiers. (i) A verbal predicate selects a particular governed case for its object adverbial and not a semantically compatible set of cases. (ii) An object adverbial constituent can serve as an antecedent in an obligatory control construction. (iii) It is a functional similarity between object adverbials on the one hand, and subjects and objects on the other, that they can be involved in systematic case alternations. Such alternations can never involve adverbial modifiers.

Torn adopts LFG's LMT classification of governable grammatical functions. In this setting, she assumes that locative case-marked noun phrases can have either the OBL or the ADJUNCT function.

7 Morpho-syntactic phenomena

7.1 Agreement

7.1.1 Subject-verb agreement in Inari Saami and Finnish

Toivonen (2007) examines verbal inflectional morphology in Inari Saami. She develops her analysis by concentrating on the Saami copula *leδe* 'to be'. In this language, as in various Northern Uralic languages, the number feature has three possible values: singular, dual and plural. It is another special property of this language that there can be either full agreement or partial agreement between the subject and the verb. Animate and specific subjects trigger the former, see (41), inanimate subjects trigger the latter, see (42).

(41) Inari Saami:
Meecist lava uábbi já viljá.
forest.LOC are.3DU sister.NOM and brother.NOM
'In the forest are my sister and brother.'

(42) Inari Saami:
Riddoost láá kyehti keeδgi.
beach.LOC are.3PL two rock
'On the beach are two rocks.'

Subject noun phrases headed by unspecific human nouns and animal nouns can trigger either full or partial agreement. (43) illustrates the unspecific human case.

(43) Inari Saami:
Táálust lava/láá kyehti ulmuu.
house.LOC are.3DU/are.3PL two person
'There are two people in the house.'

Toivonen presents the paradigms of the copula in this three-way number and dual agreement system as in Table 4. She develops an LFG analysis with fully specified and underspecified lexical forms of verbal predicates. Consider her representations of four morphological forms of the copula in (44–47).

(44) *lava* V (↑ PRED) = 'BE'
(↑ TENSE) = PRS
(↑ MOOD) = INDICATIVE
(↑ SUBJ NUM) = DU
(↑ SUBJ PERS) = 3
(↑ SUBJ HUM) = +

Table 4: Agreement paradigms for 'to be'

		full	**partial**
SG	1	lam	lii
	2	lah	lii
	3	lii	lii
DU	1	láán	láá
	2	leppee	láá
	3	lava	láá
PL	1	lep	láá
	2	leppeδ	láá
	3	láá	láá

(45) *lam* V (↑ PRED) = 'BE'
(↑ TENSE) = PRS
(↑ MOOD) = INDICATIVE
(↑ SUBJ NUM) = SG
(↑ SUBJ PERS) = 1
(↑ SUBJ HUM) = +

(46) *lii* V (↑ PRED) = 'BE'
(↑ TENSE) = PRS
(↑ MOOD) = INDICATIVE
(↑ SUBJ NUM) = SG

(47) *láá* V (↑ PRED) = 'BE'
(↑ TENSE) = PRS
(↑ MOOD) = INDICATIVE

Toivonen makes crucial use of the principle of morphological blocking as developed by Andrews (1990). The basic idea is that if a subject noun phrase is compatible with more than one verb form, it will select the variant that exhibits the largest number of its own feature values. This explains, for instance, why human subjects do not freely co-occur with *láá* or why singular subjects cannot co-occur with *láá*. The answer to the first question is that *láá* has no [+human] feature, see (47). The answer to the second question is that there are more specific forms of the copula in that they also encode the [+singular] feature, compare (47) with (45) and (46).

Toivonen also briefly compares the Inari Saami agreement system with the corresponding Finnish system. She points out that Finnish has no grammatical dual. In addition, Finnish does not exhibit partial agreement. Furthermore, animacy has not been grammaticalized in standard Finnish. It is another significant difference that in Inari Saami, verb agreement is always triggered by grammatical subjects, while in Finnish several independent conditions need to be simultaneously satisfied for agreement to take place. First, in Finnish, as well as in Estonian,[33] only nominative NPs trigger agreement, compare Toivonen's examples in (48) and (49).

(48) Finnish:
Autot ajavat yleensä kovaa moottoriteillä.
cars.NOM drive.3PL generally hard motorways.ADE
'Cars generally drive fast on the motorways.'

(49) Finnish:
Linja-autoja kulkee nykyisin joka sunnuntai.
buses.PAR run.3SG nowadays every Sunday
'Nowadays, buses run every Sunday.'

In (48) the nominative subject triggers agreement, while in (49) the subject is in partitive case and the verb takes 3SG default agreement.

A Finnish verb also has default agreement in existential and possessive constructions. (50) illustrates the latter type.

(50) Finnish:
Koulussa on uudet opettajat.
school.INE is.3SG new.NOM.PL teachers.NOM
'The school has new teachers.'

In this example, although the (post-verbal) subject is nominative, it is not in its preverbal canonical position; therefore, here, too, the verb displays 3SG default agreement.

As regards their possessive constructions, Inari Saami and Finnish differ in two significant respects. On the one hand, in Inari Saami possessive constructions pronouns are in nominative case, while in Finnish the corresponding pronouns take accusative case, compare (51) and (52). On the other hand, the possessum is always in nominative case in Inari Saami, it has the subject function, and it always triggers agreement, while in Finnish the possessum is either in nominative

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[33] See Hiietam (2003), for instance.

case (ordinary noun phrases) or in accusative case, and the verb always carries 3sg default agreement, compare (53) and (54).

(51) Inari Saami:
Muste lah tun.
I.loc are.2sg you.nom.sg
'I have you.'

(52) Finnish:
Minulla on / *olen sinut.
I.ade is.3sg / is.1sg you.acc.sg
'I have you.'

(53) Inari Saami:
Muste lava puásui já peenuv.
I.loc are.3du reindeer.nom and dog.nom
'I have a reindeer and a dog.'

(54) Finnish:
Minulla on / *olen poro ja koira.
I.ade is.3sg / is.1sg reindeer.nom and dog.nom
'I have a reindeer and a dog.'

Toivonen makes the following concluding generalization about Finnish possessive constructions. There is no normal agreement in them, because the possessum is not the subject, and because the subject possessor is not in nominative case. This is why 3sg default agreement is employed.

Toivonen offers a comparative overview of the agreement systems of Inari Saami and Finnish shown in Table 5.

7.1.2 Aspects of differential object marking in Uralic

Coppock & Wechsler (2010) point out that there is object agreement in Nenets, Enets, Nganasan and Selkup in the Samoyedic family and in Mordvinian (Finno-Volgaic), Hungarian (Ugric), Ostyak and Vogul (both Ob-Ugric) in the Finno-Ugric family. These languages exhibit remarkable variation with respect to the feature specifications of their object agreement. In Hungarian and Samoyedic there are two conjugation paradigms: subjective and objective, and the latter is used in the case of definite and third person objects. In Ob-Ugric languages there is a subjective conjugation and three objective conjugation paradigms, one

Table 5: Agreement in Inari Saami and Finnish

	Inari Saami	Finnish
Partial agreement	✓	
Default agreement		✓
Animacy effects	✓	
Agreement in possessive construction	✓	
Agreement in existential construction	✓	
Possessed nouns in nominative case	✓	✓
Possessed pronouns in nominative case	✓	

for each possible number value of the object (singular, dual and plural). In Mordvinian there is genuine agreement for both person and number between the verb and the object. Coppock & Wechsler (2010) concentrate on Northern and Eastern Ostyak, Hungarian and Samoyedic.[34]

In Northern Ostyak the verb agrees with its object in number but not in person: see (55) and (56). An additional factor is that the object has to be topical, otherwise the subjective conjugation is used.

(55) Northern Ostyak:
Ma täm kälang wel-sə-l-am.
I this reindeer kill-pst-plObj-1sgSubj
‘I killed these reindeer.’

(56) Northern Ostyak:
Xŭńśi näng mŭng-iluw xäĺśa want-lə-l-an?
when you we-acc where see-prs-plObj-2sgSubj
‘When did you see us where?’

Coppock & Wechsler (2010) postulate the following diachronic analysis of these facts.

At the first stage third person pronouns were incorporated (↓ pred)=‘pro’ and (↓ index pers)=3 with the three number values (↓ index num)=*n*. This was combined with the topicality condition: ($\downarrow_\sigma$ df)=topic.

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[34] Also see Coppock & Wechsler (2012) on Hungarian.

(57) V_{aff}
(↑ OBJ) = ↓
(↓ PRED) = ‘PRO’
($\downarrow_{\sigma}$ DF) = TOPIC
(↓ INDEX PERS) = 3
(↓ INDEX NUM) = *N* where *N* ∈ {SG, DU, PL}

At the second stage the PRED ‘pro’ was dropped.

(58) V_{aff}
(↑ OBJ) = ↓
~~(↓ PRED) = ‘PRO’~~
($\downarrow_{\sigma}$ DF) = TOPIC
(↓ INDEX PERS) = 3
(↓ INDEX NUM) = *N* where *N* ∈ {SG, DU, PL}

The authors claim that it is reasonable to assume that at this stage person specification was present because Eastern Ostyak still manifests this stage.

At the third stage the person specification was lost in Northern Ostyak, see (59), but this did not happen in Eastern Ostyak.

(59) V_{aff}
(↑ OBJ) = ↓
~~(↓ PRED) = ‘PRO’~~
($\downarrow_{\sigma}$ DF) = TOPIC
~~(↓ INDEX PERS) = 3~~
(↓ INDEX NUM) = *N* where *N* ∈ {SG, DU, PL}

As a result, these objective conjugation suffixes became usable with first and second person objects, too.

Coppock & Wechsler (2010) also show that Hungarian has two conjugations that are conditioned by the definiteness of the object by using the following examples. The general pattern is that definite objects trigger the objective agreement type, see (60), and indefinite objects require the subjective type, see (61).

(60) Hungarian:
Lát-om a madar-at.
see-PRS.1SG.DEF the bird-ACC
‘I see the bird.’

(61) Hungarian:
Lát-ok egy madar-at.
see-PRS.1SG.INDF a bird-ACC
‘I see a bird.’

In addition, the objective agreement type is sensitive to the person feature of the object: in the pronominal domain only third person pronouns trigger it, see (62), while first and second person pronouns require the subjective conjugation, see (63). Coppock & Wechsler (2010) refer to this as the third person restriction in this language.

(62) Hungarian:
Lát-ják őt/őket.
see-prs.3pl.def it/them
'They see it/them.'

(63) Hungarian:
Lát-nak engem/téged/minket.
see-prs.3pl.indf me/you/us
'They see me/you/us.'

It is another property of the Hungarian object agreement system that it is not sensitive to the number value of the object.

Coppock & Wechsler (2010) propose the following diachronic analysis. At the first stage, just like in the case of Northern and Eastern Ostyak, third person pronoun incorporation took place, see (57) above. The second stage was also the same: the pred 'pro' was dropped and the topicality condition retained, see (58). This is the present-day Eastern Ostyak system. At the third stage the number constraint was dropped, but the person restriction was retained, see (64) and compare it with (59) characterizing Northern Ostyak.

(64) V_{aff} (↑ obj) = ↓
~~(↓ pred) = 'pro'~~
($\downarrow_\sigma$ df) = topic
(↓ index pers) = 3
~~(↓ index num) = *n* where *n* ∈ {sg, du, pl}~~

Finally, at the fourth stage the topicality constraint was reanalyzed as a definiteness constraint, see (65).

(65) V_{aff} (↑ obj) = ↓
~~(↓ pred) = 'pro'~~
~~($\downarrow_\sigma$ df) = topic~~ (↑ obj def) $=_c$ +
(↓ index pers) = 3
~~(↓ index num) = *n* where *n* ∈ {sg, du, pl}~~

Dalrymple & Nikolaeva (2011) investigate differential object marking (DOM) by exploring syntactic, semantic and informational structural differences between marked and unmarked objects in a wide range of genetically and typologically different languages. As regards Uralic, they concentrate on Tundra Nenets in the Samoyedic subfamily and on Ostyak (Khanty), Vogul (Mansi) and Hungarian in the Finno-Ugric subfamily.[35]

Dalrymple & Nikolaeva (2011) develop a formal theory of information structure and its place in the architecture of LFG. In this theory information structure is closely related to semantic structure. It is a favourable aspect of this approach that it makes possible a simple specification of the informational structural status of an argument by providing a DF feature value in its semantic structure.

In Tundra Nenets there is only a single object function: OBJ. First and second person (pronominal) objects do not agree with the verb, just like in Hungarian, see (63) above. Third person objects optionally agree with the verb. If there is agreement, the object has the TOPIC DF, while no such function is associated with it in the absence of agreement. Dalrymple & Nikolaeva (2011) model this in the following way.

(66) Agreement with third person topical objects:

$(\uparrow \textsc{obj pers}) = 3$
$((\uparrow \textsc{obj})_\sigma\ \textsc{df}) = \textsc{topic}$

This specification encodes that the semantic structure contributed by the third person object is associated with the topic role in information structure.

Dalrymple & Nikolaeva (2011) also distinguish a language type in which there are two object functions: OBJ and $\textsc{obj}_\theta$. They claim that Ostyak belongs to this type, in addition to Mongolian, Chatino and Hindi, among others. The $\textsc{obj}_\theta$ function in these languages is only available to patient/theme arguments. Dalrymple & Nikolaeva (2011) make the following empirical generalizations. Although Ostyak has two object functions, they cannot co-occur in a sentence, because this language does not have a double object construction. In the case of verbs such as ‘give’ there are the following two possibilities: either the goal or the theme must have an OBL function. When the goal has a dative oblique function, the theme has two object choices. If it is topical, it has the agreeing OBJ function, and if it is not topical, it has the non-agreeing $\textsc{obj}_{\textsc{theme}}$ function.

Dalrymple & Nikolaeva (2011) compare the Nenets type and the Ostyak type of DOM in the following way.

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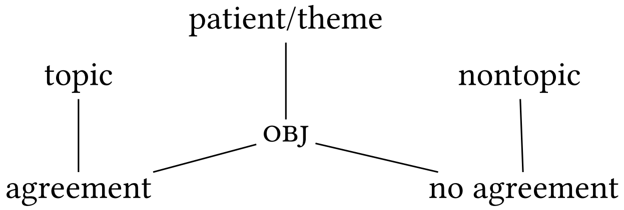
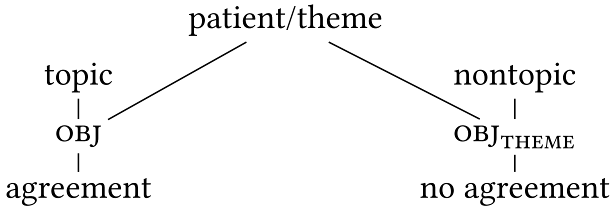
[35] On aspectual DOM in Estonian, see the discussion of Tamm (2006) in Section 6.2.

(67) Nenets monotransitives with third person objects:



(68) Ostyak monotransitives with patient/theme objects:



Dalrymple & Nikolaeva (2011) also point out that in the Ob-Ugric branch of Finno-Ugric languages Vogul follows the same DOM pattern as Ostyak: object marking is information structure driven: topicalization by means of object agreement. The authors hypothesize that this also held for Proto-Ob-Ugric. There are no attested semantic restrictions on agreeing objects in Ob-Ugric. As shown above, object agreement works differently in Hungarian. First and second person pronouns never trigger agreement, just like in Tundra Nenets, see above. Third person object agreement is not regulated by information structure: it is triggered by definiteness. It is only definite third person objects that trigger agreement irrespective of their discourse function status.

The authors suggest that earlier Hungarian was closer to Ostyak and Vogul, and in modern Hungarian definiteness marking is an innovation, after the development of the grammatical category of definiteness and the appearance of grammatical articles. Their reconstruction of the relevant linguistic historical processes is as follows. They assume that the Ob-Ugric system of DOM, which is exclusively based on information structure, is the most archaic type, and probably it can be hypothesized for Proto-Eastern-Uralic, i.e. the Proto-Uralic dialects from which the Samoyedic and Ugric languages developed. At a later stage, agreement became reduced to third person topical objects in Samoyedic and Proto-Hungarian as a consequence of the fact that third person was frequently associated with secondary topicality. By contrast, first and second person pronouns occupy the highest position on a scale of topic-worthiness. Dalrymple & Nikolaeva (2011) suggest that the Samoyedic languages (Nenets, Selkup and Nganasan) and Old Hungarian grammaticalized the tendency that first and second person pronouns are likely primary topics and unlikely secondary topics. Thus, they cannot correspond to the primary object, given that in these languages it tends to be strongly associated with secondary topic. No such restrictions hold for third person objects. Hungarian and (possibly) Selkup represent the next historical stage, at which the grammatical marking of third person topical objects is extended to non-topical definite objects. According to Dalrymple & Nikolaeva (2011) this change manifests the spreading of grammatical marking to non-topical objects that exhibit topic-worthy features with the concomitant loss of relatedness to information structure.[36]

This section on DOM has shown how complex these phenomena are in Uralic languages in general and in Finno-Ugric languages in particular. It has also demonstrated that LFG's well-developed modular architecture provides the necessary and appropriate formal devices to capture both the synchronic differences between languages and the diachronic processes in a principled manner.

7.2 Evidentiality

Asudeh & Toivonen (2017) propose a modular LFG approach to evidentiality, which is a well-established morpho-syntactic category in a considerable number of languages, for instance, Tariana, Cherokee, Cheyenne, Quechua and Tuyuca. These languages employ fully grammaticalized evidentiality morphology, which encodes the source and reliability of speakers' knowledge. Other languages, e.g. English, do not have such evidentiality marking, and they use alternative means to express sources of evidence or degrees of certainty about evidence (*apparently, I saw that…*, etc.). For the description of grammaticalized evidentiality they use the following f-structure features: [DIRECT ±], [VISUAL ±], [REPORTED ±], which also express semantic content to be captured as modifiers on events in Glue Semantics. In languages like English (with non-grammaticalized evidentiality) predicates like *sound* and *seem* optionally encode evidentiality information for the semantic component of the theory. The authors argue that LFG's modular architecture is especially well-suited to capturing the systematic similarities and

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[36] Dalrymple & Nikolaeva make the following footnote comment. 'An alternative explanation was recently suggested by Coppock & Wechsler (2010), who claim that object agreement in proto-Uralic was initially restricted to third person topical objects. It later spread to all topical objects in Northern Ostyak and Vogul, whereas Samoyedic languages preserve the original situation. This suggestion provides an elegant analysis of feature loss as a mechanism of historical change: Northern Ostyak lost the specification that restricted topical agreement to third person objects (the (↑ OBJ PERS)=3 specification for agreeing verbs). However, the causal mechanism of this development remains unclear: it presupposes the spread of marking to unlikely contexts' (Dalrymple & Nikolaeva 2011: 201).

differences between grammaticalized and non-grammaticalized ways of expressing evidentiality across languages.

Szabó (2021) points out that in the family of Uralic languages both evidentiality systems can be found. For instance, the Finnic, the Saamic and the Mordvinian languages and Hungarian do not have grammaticalized evidentiality. By contrast, Estonian, Livonian, Mari, Komi, Udmurt as well as the entire Ob-Ugric and Samoyedic branches employ grammaticalized evidentiality.

Szabó (2021) sketches an LFG approach to grammaticalized evidentiality in Udmurt. She shows that there are two past tense paradigms in this language, and the 2^{nd} past is used to express the source of information, among other aspects of morpho-syntax. Therefore, this verb form is multiply ambiguous. Szabó (2021: 82) captures this by proposing that the 2^{nd} past contributes the following attribute-value pair to the f-structure of a sentence.[37]

(69) $\left[\textsc{source}\ \ \textsc{res} \vee \textsc{pfv} \vee \textsc{hear} \vee \textsc{folk} \vee \textsc{mir} \vee \textsc{infer} \vee \textsc{non-v}\right]$

As (69) shows, in this domain the f-structure is multiply ambiguous with all these disjunctive values for SOURCE, and the assumption is that it is basically the context that disambiguates.

Tamm (2008) shows that in Estonian partitive case-marking has either epistemic modality or aspectual use. In the former, it encodes incomplete evidence (cf. grammaticalized evidentiality marking), and in the latter, it presents an event as incomplete. The lack of partitive-marking indicates complete evidence and complete event, respectively. In this language both verbs and object arguments can be marked for partitive. Tamm proposes the lexical form in (70) for the aspectual partitive case marker on the object, and the lexical forms in (71) and (72) for the impersonal and personal evidentiality markers on verbs, respectively.

(70) (↑ CASE) = PARTITIVE
((OBJ ↑) EVENT) ≠ COMPLETE

(71) *[-ta-vat]* (↑ FORM) = PARTITIVE EVIDENTIAL
(↑ MODE OF COMMUNICATION) = INDIRECT
(↑ EVIDENCE) ≠ COMPLETE
(↑ VOICE) = IMPERSONAL

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[37] Where RES = resultative, PFV = perfective, HEAR = hearsay, FOLK = folklore, MIR = mirative, INFER = inferential, NON-V = non-volitional.

(72) *[-va-t]* (↑ FORM) = PARTITIVE EVIDENTIAL
(↑ MODE OF COMMUNICATION) = INDIRECT
(↑ EVIDENCE) ≠ COMPLETE
(↑ VOICE) = PERSONAL

Tamm sketches a Discourse Representation Theory-based semantic description associated with the f-structure representation.

For further discussions and analyses of evidentiality, see Szabó (2017) on Udmurt, and Tamm (2004c, 2012a) on Estonian. On partitives, also see Tamm (2012b).

8 Noun phrase phenomena in Hungarian

8.1 C-structure issues

As we show below, Hungarian noun phrases have been analyzed as either NPs or DPs in LFG approaches. Both views are fully legitimate in this framework, given that the standard LFG inventory of functional categories contains D (in addition to I and C).[38] It is a crucial property of possessive noun phrases in this language that the possessor can be expressed in either nominative or dative case, and the two variants occupy distinct syntactic positions. Despite this fact, only one of them can occur in any single possessive noun phrase, that is they are in complementary distribution, as opposed to the possible co-occurrence of *'s* and *of* possessors in English.

Chisarik & Payne (2003: 189) use an NP approach to the representation of Hungarian and English noun phrases, see the structures they assume for (73) and (75)[39] in (74) and (76), respectively.

(73) Hungarian:
a király-nak a lány-a
the king-DAT the daughter-POSS.3SG
'the king's daughter'

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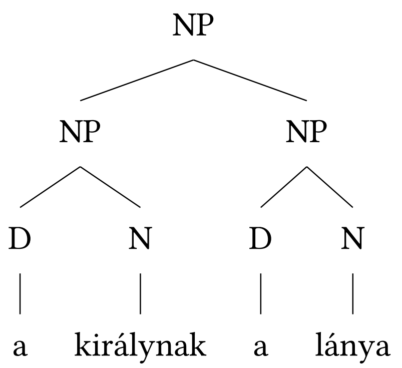
[38] It is not unusual to find alternative categorial analyses of the same construction types in LFG. For instance Bresnan (2001) treats finite English sentences that contain no auxiliaries (e.g. *Mary opened the door*) as having the category S, while Dalrymple (2001) employs an IP approach.

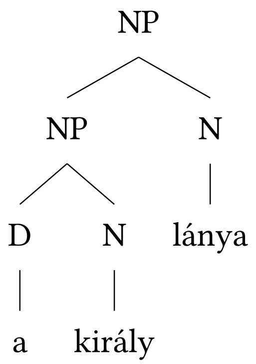
[39] Notice that Hungarian possessive noun phrases belong to the head-marking type.

(74)



(75) Hungarian:
a king lány-a
the king.NOM daughter-POSS.3SG
'the king's daughter'

(76)



They provide the following justifications for these representations. On the one hand, the dative possessor, see (74), can function as a predeterminer to coordinated NPs as in their example in (77).

(77) Hungarian:
a király-nak [$_{\text{NP}}$ [a fi-a] és [a lány-a]]
the king-DAT the son-POSS.3SG and the daughter-POSS.3SG
'the king's son and daughter'

On the other hand, the nominative possessor stands in complementary distribution with the definite article, just like the *'s* possessor in English.

The following remarks can be made on this approach. First, the coordination facts can also be captured in a DP analysis in which the dative possessor is in Spec,DP and Chisarik and Payne's NP is a D′, where the definite article is the

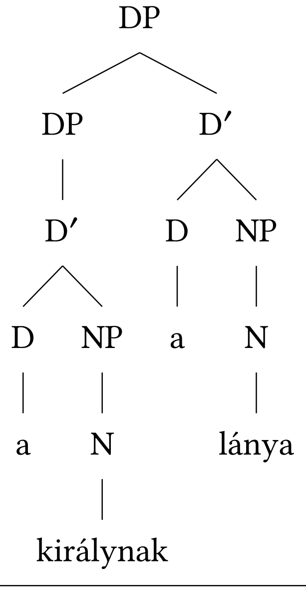
D head and the other constituent is (the head of) an NP.[40] Second, it would need some justification to assume that a word-level functional category (D) is in complementary distribution with a phrasal category (NP).[41] Third, in the case of pronominal nominative possessors there is no complementary distribution with the definite article; moreover, they must co-occur, compare (78) and (79).[42]

(78) Hungarian:
(*a) János lány-a
the John.NOM daughter-POSS.3SG
'John's daughter'

(79) Hungarian:
*(az) ő lány-a
the he.NOM daughter-POSS.3SG
'his daughter'

Motivated by Szabolcsi's (1994) seminal GB analysis, Laczkó in Laczkó (1995) and all subsequent work adapts a DP approach.[43] The essential aspects of his structural representation of (73) and (75) would be as in (80) and (81), respectively.

(80)



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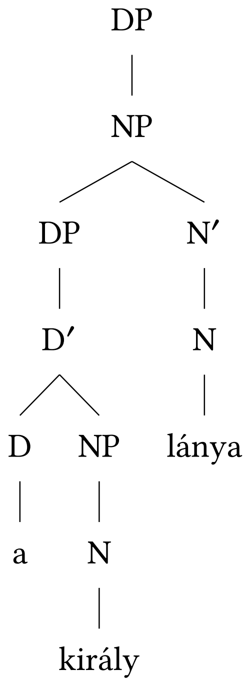
[40] See Laczkó's (1995) DP structure in (80) below.

[41] It seems to be a further minor complication that the functional category D is used in an unusual way: it does not head and project a DP.

[42] (78) shows the grammaticality properties of this construction type in standard Hungarian. However, Szabolcsi (1994) documents a dialectal version in which even such non-pronominal nominative possessor constructions follow the pattern exemplified in (79).

[43] Without adopting theory-specific details like moving the nominative possessor from Spec,NP to Spec,DP, where it acquires dative case, as in Szabolcsi's (1994) GB analysis.

(81)



This approach avoids the complications mentioned in connection with Chisarik & Payne's (2003) NP analysis.

8.2 Event nominalization

8.2.1 Argument structure inheritance

Following Grimshaw (1990) and Szabolcsi (1994), among others, Laczkó in Laczkó (1995) and in all relevant subsequent work assumes that complex event nominals (cens) derived by the *-ás/-és* suffix (henceforth: ás suffix) inherit the argument structure of the input verb, as opposed to simple event nouns (sens) and result nouns (reses). The most important properties of Hungarian cens are as follows; see also Laczkó (2000b, 2003, 2009a).

When an ás noun has both a simplex form and a complex form containing a perfectivizing preverb, the latter is always a cen and the former is very often ambiguous: cen vs. sen and/or res. Compare the examples in (82).

(82) Hungarian:

a. Anna vizsgáztat-ás-a
Anne.nom examine-ás-poss.3sg
'Anne's examination'
cen: Anne = patient
sen: Anne = examiner or examinee

b. Anna le-vizsgáztat-ás-a (a professzor által)
Anne.NOM PFV-examine-ÁS-POSS.3SG the professor by
'the examination of Anne (by the professor)'
CEN: Anne = patient

c. Anna vizsgá-ja
Anne.NOM exam-POSS.3SG
'Anne's exam'
SEN: Anne = examiner or examinee

(82a) contains a derived nominal without a perfectivizing preverb, and it can be used as either a CEN with an argument structure or as a SEN without an argument structure (with only a lexical conceptual structure). In the former use *Anna* is interpreted as the patient argument of the nominal predicate, in the latter use it is interpreted as a participant in an examination situation, whether the examiner or the examinee. By contrast, in (82b) the derived nominal contains a perfectivizing preverb, and it can only be analysed as a CEN with obligatory argument structure and *Anna* must be interpreted as the patient argument. In (82c) the head is an underived noun and it can only be a SEN.

The expression of the arguments of the derived nominal predicate is as obligatory as in the case of the input verb.

(83) Hungarian:
A vizsgáztat-ás két órá-ig tart-ott.
the examine-ÁS-POSS.3SG two hour-for last-PST.3SG
'The examination lasted for two hours.' (SEN)

(84) Hungarian:
*A le-vizsgáztat-ás két órá-ig tart-ott.
the PFV-examine-ÁS-POSS.3SG two hour-for last-PST.3SG
'The examination lasted for two hours.' (CEN)

As (83) shows, when no complement is present, an otherwise ambiguous (CEN/SEN) nominal must be interpreted as a SEN. (84) demonstrates that an 'only CEN' nominal cannot occur without its obligatory internal argument(s). The external argument can be suppressed optionally, see (82b) above.

CENs cannot be pluralized, see (85).

(85) Hungarian:
*Anna le-vizsgáztat-ás-a-i
Anne.NOM PFV-examine-ÁS-POSS.3SG-PL
'*the examinations of Anne' (CEN)

When an adjunct in the DP with a derived nominal head is expressed by a postpositional phrase, this PP has to be 'adjectivalized' either by combining it with a formative element, one of the present participial forms of the copula: *való* 'being', glossed as VALÓ, or by attaching the adjectivizing suffix *-i* (glossed as AFF) to the postposition. In such cases, the VALÓ version is only compatible with the CEN reading of an otherwise ambiguous nominal predicate, while the *-i* variant retains the ambiguity, cf. (86a) and (86b). This is Szabolcsi's (1994) famous *való*-test for unambiguously identifying CENS in Hungarian.[44]

(86) Hungarian:

a. az ebéd után való beszélget-és
the lunch after VALÓ converse-ÁS
'conversing after lunch' (CEN)

b. az ebéd után-i beszélget-és
the lunch after-AFF converse-ÁS
'conversing after lunch' (CEN)
'the conversation after lunch' (SEN)

The core arguments of CENS can receive a variety of [−*r*] GFS in several LFG approaches to Hungarian, see Section 8.2.2. Non-core arguments are typically expressed by case-marked DPs and postpositional phrases, and they are mapped onto OBL functions. Adjuncts can also be expressed by case-marked DPs and PPs. In addition, they can be realized by APs, especially when the input verb would take an AdvP for the same kind of modification, e.g. *váratlan-ul* 'unexpectedly' (Adv) vs. *váratlan* 'unexpected' (A). For empirical generalizations about the major (structural and categorial) ways of realizing OBL and ADJUNCT functions in CEN constructions and LFG analyses, see Laczkó (1995, 2003).

The Hungarian event nominalization phenomena presented above are relevant for theorizing in generative grammar in general and in LFG in particular for the following reasons. Grimshaw's (1990) influential proposal substantially distinguishing CENS from SENS and RESES is based on English data, primarily on *-tion* nominalization. In this language, however, these derived nouns are genuinely ambiguous and, therefore, it is often difficult to employ Grimshaw's diagnostics, e.g. (non-)pluralizability, to definitely tell the CEN and SEN uses apart. Due to this fact, Grimshaw's theory has been criticized from a variety theoretical perspectives, see Laczkó (2000b) and the references therein. By contrast, in Hungarian there are clear morphological and syntactic indicators, and the diagnostics can

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[44] Also see Laczkó & Rákosi (2007).

be applied reliably and unambiguously. This situation has motivated some LFG practitioners to investigate event nominalization thoroughly and, among other things, to develop various LMT analyses of argument realization in this domain, see Section 8.2.2.

8.2.2 Functional issues

A variety of inventories of GFS in Hungarian DPs with CEN heads and a consequential variety of LMT analyses have been proposed, see Table 6.[45]

Table 6: GFS in Hungarian DPs

	Laczkó (1995)	Chisarik & Payne (2003)	Laczkó (2004)
DP_{DAT}	POSS	SUBJ	SUBJ/POSS
DP_{NOM}	POSS	NCOMP	SUBJ/POSS
DP_{OBL}/PP	OBL	OBL	OBL

Laczkó (1995) uses GFS standardly employed in noun phrases (POSS and OBL). Assuming that POSS is a semantically unrestricted function, he develops an LMT approach in which there is a POSS Condition that is the nominal domain counterpart of the SUBJ Condition in the verbal domain. The SUBJ Condition requires that every (verbal) predicator must have a Subject, see Bresnan (1990), for instance. Laczkó's (1995: 85) POSS Condition states: 'every event nominal predicator must have a Possessor'.

Rather exceptionally in the generative literature on Hungarian noun phrases, Chisarik & Payne (2003) assume that the two possessor constituents bear distinct GFS, both of which are taken to be semantically unrestricted. The dative realizes the SUBJ function in the nominal domain, while the nominative expresses a new, DP-specific function: NCOMP. SUBJ is considered to be discourse-related, while NCOMP is not.

Laczkó (2004) assumes that both the dative possessor and the nominative possessor can overtly realize either the SUBJ or the POSS GFS, both of which are regarded as semantically unrestricted. Furthermore, the SUBJ argument can also be expressed by an LFG-style PRO. Given this nature and distribution of these GFS, Laczkó's LMT analysis can adopt the SUBJ Condition from the verbal domain. In addition, his approach can formally handle (anaphoric) control into possessive DPs in Hungarian with the standard LFG mechanism even in the case of CENS

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[45] Charters (2014) proposes a new DF in Hungarian possessive DPs: ANCHOR.

derived from transitive verbs, which Laczkó's (1995) system cannot do. Consider the following examples.

(87) Hungarian:

a. Péter elkezdte a kiabál-ás-t.
Peter.nom started the shout-Ás-acc
'Peter started the shouting.'

b. Péter elkezdte a dal enekl-és-é-t.
Peter.nom started the song.nom sing-Ás-poss.3sg-acc
'Peter started the singing of the song.'

In Laczkó's (1995) system, the f-structure of the DP in (87a) contains a poss pro, which is anaphorically controlled by the matrix subject, and in (87b) *a dal* 'the song' has the poss function, and (in the absence of any other available gf for the agent controllee) Laczkó is forced to assume that control takes place in a different dimension. By contrast, in Laczkó's (2004) approach there is a controlled pro subj in both cases, and in (87b) *a dal* 'the song' has the poss function. Laczkó's (2004) subj & poss theory receives further independent support from Laczkó & Rákosi (2019), who argue that this gf inventory is necessary for the adequate LFG handling of certain binding facts in Hungarian DPs. Laczkó (2008b, 2009b), in response to Kenesei (2005), proposes that both t participial constructions and cen constructions should have a dual pro & suppression analysis for an adequate treatment of binding and control phenomena.

8.3 Possessives

8.3.1 Finnish

Toivonen (2000) develops an analysis of the morpho-syntax of Finnish possessive noun phrases. This language has the widely attested poss pro-drop in the case of first and second person possessors, see a 1sg example in (88), and Toivonen's lexical representation of the pronoun and the possessive suffix (glossed as poss) in (89) and (90), respectively.

(88) Finnish:
Pekka näkee (minun) ystävä-ni.
Pekka sees my friend-poss.1sg
'Pekka sees my friend.'

(89) *minun:*

$$\left[\begin{array}{ll} \textsc{poss} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \end{array}\right] \end{array}\right]$$

(90) *-ni:*

$$\left[\begin{array}{ll} \textsc{poss} & \left[\begin{array}{ll} (\textsc{pred} & \text{‘}\textsc{pro}\text{’}) \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \end{array}\right] \end{array}\right]$$

In the third person there is an interesting split between the possessive pronoun and the possessive suffix when the latter provides the PRED feature (i.e. in the case of pro-drop). The pronoun must not be bound by the matrix subject, while the POSS-PRO must, cf. (91) and (92).

(91) Finnish:
Pekka näkee hänen ystävä-nsä.
Pekka sees his/her friend-POSS.3SG
‘Pekka sees his/her$_{*i/j}$ friend.’

(92) Finnish:
Pekka näkee ystävä-nsä.
Pekka sees friend-POSS.3SG
‘Pekka sees his/her$_{i/*j}$ friend.’

Furthermore, the 3SG.POSS suffix cannot agree with a non-human possessor:

(93) Finnish:
sen ruokaa(*-nsa)
its food-POSS.3SG
‘its food’

Toivonen captures these facts by means of the following lexical forms.[46]

(94) *hänen:*

$$\left[\begin{array}{ll} \textsc{poss} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 3 \\ \textsc{gend} & \textsc{hum} \\ \textsc{num} & \textsc{sg} \\ \textsc{sb} & - \end{array}\right] \end{array}\right]$$

(95) *pron. -nsA:*

$$\left[\begin{array}{ll} \textsc{poss} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 3 \\ \textsc{sb} & + \end{array}\right] \end{array}\right]$$

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[46] SB stands for obligatorily subject bound.

(96) *agr. -nsA:* $\left[\textsc{poss}\ \left[\textsc{pers}\ 3\right]\right]$, GEND$=_c$ HUM

Toivonen also compares corresponding possessive noun phrase constructions in Estonian and Northern Saami. Toivonen (2001) provides a historical context for her analysis in Toivonen (2000), and she also discusses dialectal variation in Finnish with respect to these phenomena. Her proposal involves the erosion of features other than PRED 'pro', which makes it very similar to Coppock & Wechsler's (2010) analysis of Ostyak and Hungarian in Section 7.1.2.

8.3.2 Hungarian

Laczkó (2001) develops an LFG approach to the inflectional phenomena in Hungarian possessive DPs in the spirit of Item and Arrangement morphology.[47] Consider the following examples.

(97) Hungarian:

a. a toll-a-i-nk
the pen-POSS-PL-1PL
'our pens'

b. a toll-a-i
the pen-POSS-PL.3SG
'her pens'

c. a toll-a
the pen-POSS.3SG
'her pen'

d. a hajó-i
the ship-POSS.PL.3SG
'her ships'

Laczkó postulates the following sets of functional annotations in the lexical forms of *-a* and *-i*, the main point being that the same morphological form (morph) can encode fewer or more features depending on what other morphs it is combined with, see the optional features in (98).

(98) a. *-a* (↑ POSS) [97a, 97b]
(↑ POSS PERS) = 3 [97]
(↑ POSS NUM) = SG
((↑ POSS PRED) = 'PRO')

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[47] By contrast, Laczkó (2018) proposes a Word and Paradigm approach, arguing that it has considerable implementational advantages.

b. *-i* (↑ poss) [97a]
(↑ num)
(↑ poss pers) = 3 [97b, 97d]
(↑ poss num) = sg
((↑ poss pred) = 'pro')

9 Further reading

Limitations of space have prevented us from discussing additional phenomena in Finno-Ugric languages and their analyses. Below we provide references to further works that we recommend to the interested reader.

On predicate-argument relationships in Hungarian, see Komlósy (1992, 1994) and Rákosi (2008). On causatives in Hungarian, see Komlósy (2000). On argument realization alternations in Finnish and Estonian, see Ackerman & Moore (1999), in Hungarian, see Ackerman (1992) and Laczkó (2013b). On Uralic conjugation classes and verbs imposing restrictions on argument structure, see Abondolo (1998), Nikolaeva (2014) and Tamm & Vainikka (forthcoming). On argument vs. (thematic) adjunct issues in Hungarian, see Rákosi (2003, 2006a,b, 2012). On the grammaticalization of the Estonian perfective particles, see Tamm (2004b). On scalar verb classes, aspect and partitive and total case assignment in Estonian, see Tamm (2012c). On the pragmatics of morphological case in the verbal domain of Finnic languages, see Tamm (2011b). On Estonian object and adverbial case marking with verbs of motion, see Tamm (2007b). On case and aspectuality in Estonian, see Tamm (2008, 2012b). On raising and equi constructions in Estonian, see Tamm (2004c, 2008). On a variety of analyses of *wh*-questions in Hungarian, see Mycock (2004, 2006, 2010, 2013), Gazdik (2010) and Laczkó (2014b, 2021). On two Finno-Ugric contributions to the comp debate in LFG,[48] see Belyaev et al. (2017) for comp on the basis of Moksha Mordvin phenomena and Szűcs (2018a) against comp on the basis of Hungarian facts. On 'operator raising' in Hungarian, see Coppock (2003) and Szűcs (2013, 2014, 2018b). On binding and control relations of anaphors in Hungarian, see Rákosi (2009, 2010), Laczkó & Rákosi (2019), Szűcs (2019) and Laczkó et al. (2020). On reflexivity and binding in Uralic languages, see Volkova (2014, forthcoming). On participial constructions in Hungarian, see Komlósy (1992, 1994) and Laczkó (1995, 2000a, 2005). On derived and inherent relational nouns in Hungarian, see Laczkó (2008a, 2009b). On elliptical noun phrases in Hungarian, see Laczkó (2007). On modelling (in)definiteness

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[48] For instance, see Dalrymple & Lødrup (2000) and Lødrup (2012) for comp, and Alsina et al. (2005) and Patejuk & Przepiórkowski (2016) against comp, and the references in these papers.

and (typological) variation in Hungarian possessive DPs, see Laczkó (2017). On a special system of person and number marking in possessive noun phrases in Northern Ostyak, see Ackerman & Nikolaeva (1997). On natural and accidental coordination in Finnish noun phrases, see King & Dalrymple (2004) and Dalrymple & Nikolaeva (2006). On a lexical analysis of a Hungarian phrasal adjectival derivational suffix, see Laczkó (1997). On extraction from partitive DPs in Hungarian, see Chisarik (2002).

10 Conclusion

In this chapter we have discussed some salient, sometimes competing, LFG analyses of a variety of (morpho-)syntactic phenomena in Finno-Ugric languages, with occasional glimpses at alternative generative approaches, on the one hand, and at some related phenomena in languages belonging to Samoyedic, the other major branch of Uralic languages, on the other hand. We have dealt with clausal c-structure representational issues, verbal modifiers, focused constituents, negation, copula constructions, argument realization, subject-verb agreement, differential object marking, evidentiality and a set of noun phrase phenomena related to event nominalization.

On the basis of the interim conclusions at the end of various sections, we can make the following overall concluding remarks at the end of this chapter. On the one hand, LFG provides an appropriate and suitably flexible formal apparatus for a principled analysis of all the phenomena in all the Finno-Ugric languages discussed here. The range of these phenomena is considerably wide and varied, see above, containing several cases that pose serious challenges for generative grammar at large, for instance, the treatment of complex predicates, negation, copula constructions, discourse functions, agreement and event nominalization. On the other hand, the analysis of some of these phenomena can also contribute to LFG-internal theorizing, see, for instance, the choice between LFG treatments of complex predicates involving PVCs and clause negation.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

ADE	adessive case (marker)	PAR	partitive case
ÄRA	Estonian particle	TOT	total case
ÁS	Hungarian event nominalizer suffix	VALÓ	Hungarian adjectivalizing participle
INE	inessive case	VM	verbal modifier

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Chapter 32

LFG and Romance languages

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This chapter is an overview of the main topics in the Romance languages that have been the object of analysis within LFG. The topics reviewed include the analysis of verbal clitics, considering their morphological and c-structure status, their role in f-structure, and the role of the anaphoric reflexive clitics in a-structure, the grammatical function of direct and indirect objects and of clausal complements, passive and impersonal constructions, and complex predicates such as the causative construction.

1 Introduction

This section consists of a brief presentation of the Romance languages and an overview of the chapter.

1.1 Brief presentation of the Romance languages

The Romance languages developed out of the varieties of Latin spoken in the areas under Roman domination as a result of the expansion of Latin throughout the territories around the Mediterranean Sea from the fifth century BC to the sixth century AD. The main present-day Romance languages with a standard form and/or official status in some state or region within a state are:

- The closely related Portuguese and Galician;
- Spanish, or Castilian;
- Catalan, with Valencian as a regional name;

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- French;
- Occitan, with a variety of regional names including Provençal, Langue d'Oc, Gascon, Limousin, etc.;
- Sardinian;
- Italian;
- Raeto-Romance, with Romansh, Ladin and Friulian as regional names;
- Romanian.

In addition, there are a number of languages without an official status, such as Asturian and Aragonese in Spain, Walloon, Picard and Bourguignon in France, the Italo-Romance varieties Piedmontese, Ligurian, Lombard, Sicilian, Neapolitan in Italy, and Corsican in France, and the Daco-Romance varieties Aromanian, Istro-Romanian, and Megleno-Romanian, to name just a few. As a consequence of the colonial policies of European states from the fifteenth to the nineteenth centuries, some of the Romance languages have large numbers of speakers outside Europe; this is the case of Spanish, Portuguese, and French, which are, in this order, the Romance languages with the largest numbers of speakers.

Because of their (relatively recent) common ancestry, the Romance languages share many structural patterns, but they also have significant differences. Readers interested in finding more information about any aspect of this language family should consult Ledgeway & Maiden (2016).

1.2 Overview of the chapter

The choice of topics dealt with in this chapter is conditioned by the existence of LFG work on specific topics, theoretical interest, and space limitations. Most of the LFG work on Romance is on Spanish, French, Italian, Catalan, and Portuguese. Consequently, this chapter will deal mostly with these languages.

Section 2 focuses on so-called clitics in Romance. First, it addresses the debate about their morphological status: are clitics affixes or independent words? Second, it addresses their syntactic status: do they fill a grammatical function (GF) and, if so, what GFs can they fill? Can they be agreement markers? Do they have other roles? And, finally, the status of the anaphoric reflexive clitic is debated. Section 3 discusses arguments, GFs, and case and addresses issues such as the inventory of GFs in LFG and what GFs should be used for objects in the

Romance languages, subject-object alternations, passivization, etc. Section 4 discusses complex predicate constructions such as the causative construction and the restructuring construction.

Following are some topics not discussed in detail in this chapter:

- The phenomena that, in Rizzi (1997) and subsequent works, are known as corresponding to the structure of the left periphery. Although there is not much LFG work on this topic within the Romance languages, Estigarribia (2005, 2013) analyses clitic left dislocation in Spanish; Gazdik (2008, 2010) studies interrogatives and multiple questions in French; and Zipf & Quaglia (2017) discuss word order and information structure in Italian matrix wh-questions. See Zaenen 2023 [this volume] for a general discussion.

- Determiners and the structure of the NP. A salient feature of the Romance languages in general is the existence of a clitic-like definite article. In many of these languages it is homophonous (or partially so) with the third person pronominal accusative clitic. Article-preposition contracted forms in French are analyzed in Wescoat (2007) as lexical items involving lexical sharing. Alsina (2010) takes this idea a step further and assumes that the definite article in Catalan is always an affix that attaches to a word with lexical sharing. Alsina (2011) identifies three types of determiners in Catalan depending on whether they must co-occur with a head noun, may (but need not) co-occur with a head noun, or cannot do so, and provides an analysis within LFG.

- Agreement. Verb agreement is generally taken to be agreement with the subject. However, Alsina & Vigo (2014) show that the finite verb may agree with a non-subject (a nominative complement) in Catalan and Spanish, as can be seen in copular constructions; Alsina & Yang (2018) extend this assumption to intransitive clauses with an indefinite postverbal logical subject. Carretero García (2017) proposes an analysis of the special form of adjectives used for agreement with non-count nouns in Asturian.

- Diachrony. The diachronic development of infinitival complements from Latin to the Romance languages is discussed by Vincent (2019).

- Finiteness and tense, in connection with the morphology-syntax interface, are dealt with in Barron (2000) and Schwarze (2001a), using data from Italian and French, respectively.

- Auxiliaries. Butt et al. (1996) develop the idea of having a level of representation different from f-structure, called m-structure, for the analysis of auxiliaries in French, as well as in English and German. Schwarze (1996) proposes an analysis of auxiliaries in Spanish, Italian and French, including auxiliary selection in the latter two languages.

2 Clitics

The term "clitic" in this chapter is used as a purely descriptive term (without any theoretical implications) to refer to the class of phonologically dependent particles that attach to a verb and generally provide information about a GF of the clause. Section 2.1 focuses on the debate as to whether clitics are syntactically independent words (though phonologically dependent) or affixes, what their correct analysis should be, and what implications this analysis has. In Section 2.2, we examine the f-structure status of clitics as the expression of an argument, as an agreement marker, and as the expression of a non-argument of the verb. The reflexive clitic, in its "anaphoric" use, is discussed in Section 2.3.

2.1 Morphological status

One of the central issues in the analysis of clitics is their morphological status: are they independent syntactic constituents or are they affixes? If they are affixes, should we treat them as morphemes – linguistic signs consisting of a phonological representation and a semantic and f-structure representation – or should we treat them as the overt realization of particular bundles of morphological or syntactic features within a realizational approach to morphology?

2.1.1 Affixes vs. independent words

The most common assumption in connection with this issue in LFG is that they are independent syntactic constituents. This is not only the oldest approach, as it is found in the earliest analyses of clitics within LFG, as in Grimshaw (1982), but it is a very prevalent one, as it is found up to the present (see, for example, Schwarze (2001b) for French and Italian, Estigarribia (2005, 2013) for Spanish, Quaglia 2012 for Italian, and Barbu & Toivonen 2018 for Romanian). Grimshaw (1982: 90) posits the following c-structure rule in order to account for the position of clitics in French:

(1) $\mathrm{V}' \longrightarrow (\mathrm{CL})_1\ (\mathrm{CL})_2\ (\mathrm{CL})_3\ (\mathrm{AUX})\ \mathrm{V}$

In this approach, clitics are a special grammatical category (CL) that occupies a position in the c-structure. By a rule such as (1), the position of clitics is restricted to being adjacent to a verb (or an auxiliary).

However, proponents of clitics as syntactic constituents generally do not present arguments in favor of their position and against treating clitics as affixes, presumably because that position is seen as the default assumption, given that the standard orthographies in general separate clitics from their hosts by means of spaces, hyphens or apostrophes, at least in preverbal position, which induces the belief that clitics are words. (But see Schwarze 2001b, who makes an explicit defense of clitics as c-structure constituents, in French and Italian.)

On the other hand, proponents of treating clitics as affixes have presented evidence in favor of this assumption that is highly problematic for the assumption that clitics are independent syntactic constituents. Evidence that clitics are morphological units (not c-structure constituents) has been presented, within different frameworks, by Bonet (1991, 1995); Miller (1992); Crysmann (1997); Miller & Sag (1997); Monachesi (1999); Luís & Sadler (2003); Luís & Spencer (2005), among others. Some of the evidence, of a strictly syntactic nature, is that clitics cannot be topicalized, cannot be substituted by full pronouns, cannot be coordinated, and cannot be modified. The following Portuguese examples illustrate the failure of coordination of clitics:[1]

(2) Portuguese (Crysmann 1997)

a. * eu vi o e Paulo.
I saw.1SG 3SG.M.ACC and Paul
'I saw him and Paul.'

b. * eu não o e a conheço.
I not 3SG.M.ACC and 3SG.F.ACC know.1SG
'I do not know him and her.'

There is also evidence that can be classified as morphophonological. Clitics exhibit a high degree of selection with respect to their host: in most Romance languages, the clitic cluster must be adjacent to the verb. This is always the case

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[1] Examples, including cited ones, are glossed according to the Leipzig glossing rules, replacing the original glosses, if necessary. Unreferenced examples reflect the author's judgments. Clitics are glossed indicating only the corresponding features of person, number, gender, and case that are morphologically relevant. The reflexive clitic (*se*, *si*, *s'*, and cognate forms) is glossed as REFL (even when its meaning is not reflexive). Forms that cannot be glossed in a simple way are glossed with the form in small caps; example: the genitive and partitive clitic *en* in Catalan or French is glossed as EN.

when the clitic cluster is postverbal. The exception to the adjacency requirement of the verb and the clitic cluster is only found when the clitic cluster is preverbal in modern Portuguese (Crysmann 1997, Luís & Otoguro 2004), as well as in medieval Spanish and Portuguese (Fontana 1993, 1996, Fischer 2002), and only in very restricted contexts. There are morphophonological alternations that are restricted to clitic combinations. For example, in Portuguese, when a third person accusative clitic (*-o,-a,-os,-as*) is in a clitic combination (either with a verb or with another clitic) following an oral coronal continuant (/s/, /z/, /r/), this consonant is replaced by [l] (see Crysmann 1997): *comprar + o* → *comprá-lo* buy.inf it, *nos o dão* → *no-lo dão* us-it give.3pl, etc. This alternation does not occur across word boundaries: *todos os alunos* 'all the students'. The same clitics are preceded by /n/ when suffixed to a verb form ending in a nasal vowel, as in *eles conhecem + o/a* → *eles conhecem-no/na* 'they know him/her' (see Crysmann 1997), but this nasal insertion does not occur across word boundaries: *eles conhecem o aluno/a aluna* vs. **eles conhecem no aluno/na aluna* 'they know the student.m/the student.f'.

One of the most compelling sources of morphophonological evidence for the affixal nature of clitics is the existence of opaque clitic combinations, i.e. combinations of clitics that do not coincide with the form of the corresponding clitics used in isolation (Bonet 1995). One of the clearest examples of opaque clitic combinations is the so-called "spurious *se*" in Spanish. While the clitic form of the third person singular indirect object is *le* in isolation, as in (3b), when it combines with a third person accusative object, such as *lo* in (3a), it adopts the form *se*, as in (3c), elsewhere used only as a third person reflexive clitic. The transparent combination **le lo* (or **lo le*) does not exist.

(3) Spanish (Bonet 1995: 608)

a. El premio, lo dieron a Pedro ayer.
the price 3sg.m.acc gave.3pl to Pedro yesterday
'The price, they gave it to Pedro yesterday.'

b. A Pedro, **le** dieron el premio ayer.
to Pedro, 3sg.dat gave.3pl the price yesterday
'Pedro, they gave him the price yesterday.'

c. A Pedro, el premio, **se lo** dieron ayer.
A Pedro the price se 3sg.m.acc gave.3pl yesterday
'Pedro, the price, they gave it to him yesterday.'

Another instance of an opaque clitic combination, among those reported in Bonet (1995), is the combination in standard Italian of the impersonal clitic *si* with the third person reflexive clitic *si*: instead of the expected *si si* sequence (possible in certain dialects of Italian), the sequence *ci si* is found:

(4) Italian (Bonet 1995: 609)

a. Lo si sveglia.
3sg.m.acc impers wake.up.3sg
'One wakes him/it up.'

b. Se lo compra.
refl 3sg.m.acc buy.3sg
'S/he buys it for herself/himself.'

c. Ci si lava
refl impers wash.3sg
'One washes oneself.'

These opaque clitic combinations are completely unexpected under the treatment of clitics as words and very difficult to explain in that approach. On the other hand, if clitics are affixes, this kind of allomorphy is much more natural.

In addition, there is phonological evidence for the affixal status of clitics. One of the sources of such evidence is word stress. While clitics in most cases are stressless and have no effect on the stress pattern of the word they are attached to, there are some Romance varieties in which clitics affect the stress pattern of their host. This is the situation in the Catalan dialects of Mallorca and Minorca: the first column in (5) illustrates verb forms without postverbal clitics and the second column shows the same verb forms with postverbal clitics:

(5) Mallorcan Catalan (Colomina i Castanyer 2002: 579)

dona 'give' [ˈdonə]	dona'm 'give me' [doˈnəm]
agafa 'pick up' [əˈɣafə]	agafa'l 'pick it up' [əɣəˈfəl]
entra 'enter' [ˈəntrə]	entra-hi 'enter there' [ənˈtrəj]

In these dialects, the presence of a clitic in postverbal position causes stress to be placed on the final syllable of the verb form, instead of on the penultimate syllable. Given that word stress in Catalan does not depend on elements external to the word, one must conclude that clitics are part of the word at the point in the derivation in which word stress placement rules apply. In other dialects, clitics are affixes that do not affect stress placement.

All of these facts argue conclusively for treating clitics as word parts, specifically, affixes.

2.1.2 Alternative analyses of clitics as affixes

The affixal status of clitics is consistent with two approaches to morphology, in particular, to inflectional morphology: the morpheme-based approach and the realizational approach. Within the morpheme-based approach, an affix is a linguistic sign, consisting of a phonological representation and a semantic and/or syntactic representation. Under this view, an affix is very much like a word, only, instead of being an element that can appear as a terminal node in the c-structure, it is part of a word and combines with other word parts in a tree structure to form a word. Within the realizational approach, an affix is the phonological realization or spell-out of semantic and/or syntactic features of a word, possibly mediated by morphological features. In inflectional morphology, for every lexeme there are as many feature combinations as there are possible forms in the paradigm of the lexeme and there are rules spelling out specific features or feature combinations as particular affixes.[2]

To compare the two approaches, consider the form *lo* that appears in Italian examples such as (4a), (4b). In a morpheme-based approach, the form *lo* would have a dictionary entry that, instead of specifying its grammatical category, as it would for a word, indicates what kind of word part it is.[3] For the purpose of illustration, we can assume that form would be classified as a special kind of affix, which we can call *cl* (for clitic), as in (6):

(6) *lo* *cl* (↑ PRED)=‘PRO’
(↑ CASE)=ACC
(↑ PERS)=3
(↑ GEND)=M
(↑ NUM)=SG

Affixes of type *cl* combine with other *cl* elements to form a clitic cluster (CCL). In Italian, a CCL attaches preverbally (as a prefix) to finite verb forms except for imperatives and postverbally (as a suffix) to imperatives and non-finite verb forms.

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[2] These two approaches are mutually exclusive within LFG, although they are not necessarily so in a derivational framework such as Minimalism. As pointed out by a reviewer, this would be the case with Distributed Morphology (Halle & Marantz 1993), which is claimed to be both morpheme-based and realizational. In this framework, morphemes are bundles of morphosyntactic features as terminal nodes in the syntax without a phonological representation and are subsequently assigned a phonological form.

[3] Standardly, in LFG the term “lexical entry” refers to the information associated with a fully inflected word, as it appears in the syntax. Since clitics, as affixes, are not fully inflected words, I avoid using the term “lexical entry” to refer to the phonological, morphological, f-structure, and semantic information that characterizes a sublexical element such as an affix, but use the term “dictionary entry” instead.

There has to be some mechanism to place clitics in the right order within a CCL: as we see in (4), *lo* precedes the impersonal clitic *si* but follows the third person reflexive *si* (which takes on the form *se* in this context). This can be achieved by having a template with several clitic positions and having each clitic subclassified as to the position it occupies in the template. Alternatively, there can be linear precedence rules that are sensitive to the syntactic features of the clitics (such as person, case, reflexivity, etc.) and order the clitics within a CCL according to these features.

In a realizational approach, there are rules that spell out bundles of f-structure features (or the corresponding morphological features) as the appropriate clitic form. So, if a verb form has the f-structure features in (6), a rule is triggered that introduces the form *lo* in a CCL, along the following lines:

(7) [PRED 'PRO', CASE ACC, PERS 3, GEND M, NUM SG] ⟶ CCL {...lo...}

As in the previous approach, there would also have to be a mechanism such as a template, linear precedence rules, or ordered blocks of rules to obtain the right order of clitics when more than one is present in a CCL.

At first sight there might seem to be little difference between the two approaches. Both approaches can account with a similar degree of success for the strictly syntactic evidence for the affixal nature of clitics noted in Section 2.1.1 (such as the failure to be topicalized, substituted by full pronouns, coordinated or modified): these processes affect c-structure units, which clitics are not in either approach. The phonological evidence for the affixal status of clitics (e.g. instances in which stress assignment applies to the word structure that includes clitics) is accounted for in a similar way whether affixes are viewed as morphemes or as the product of spell-out rules.

Many of the morphophonological arguments for the affixal status of clitics can also be accounted for in either approach. To account for an allomorphic alternation such as the *o/lo/no* alternation in Portuguese noted earlier, within the morpheme-based approach, we would have to assume that the third person singular accusative masculine clitic morpheme has three allomorphs that are phonologically conditioned; within the realizational approach, we would have to assume that there are three different spell-out rules for the same syntactic (or morphological) feature bundle each one with a different phonological context. The existence of opaque clitic combinations, such as the ones illustrated in (3) and (4), is probably the strongest argument in favor of the realizational approach. From the morphemic perspective, these can be thought of simply as instances of allomorphic alternations. To use the example of the Spanish spurious *se*, illustrated in (3), the third person dative clitic morpheme would have two allomorphs: *se*, when it co-occurs with another third person clitic; and *le*, elsewhere. A problem with this approach is that it fails to explain the observation by Bonet (1995) that, in opaque clitic combinations, the unexpected form always coincides with a clitic that exists independently in the language. If the third person dative *se* is an allomorph of the more general *le*, it is just an accident that it is homophonous with the third person reflexive *se*; it could just as easily be *che*, *je*, *na*, or any other form that does not coincide with an existing clitic. On the other hand, the realizational approach has the means of capturing that observation, as in Bonet (1995); see also Grimshaw (1997) using Optimality Theory.[4]

2.1.3 Proclisis and enclisis in European Portuguese

This subsection illustrates to what extent Romance data can call standard LFG assumptions into question, in particular, the way the Lexical Integrity Principle is to be interpreted. The position of clitics (or, more exactly, of the CCL) in European Portuguese (EP) with respect to the verb of their clause poses an important problem for theories of syntax, morphology, and the syntax-morphology interface. Two properties that distinguish EP from the other modern Romance languages are relevant in this context:[5]

- With finite verb forms, the CCL can appear after the verb (enclisis) or before it (proclisis), depending on the kind of syntactic constituent, if any, that precedes the verb.
- When it appears before the verb, it need not be adjacent to it, but may be separated from it by words such as some adverbs and the negation *não* (interpolation) (see Section 2.1.1).

These properties are a problem for the affixal treatment of clitics. If we assume that clitics are affixes in both preverbal and postverbal position, the fact that the choice between the two positions is dependent on a syntactic property (the presence or absence of certain types of syntactic constituents before the verb)

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[4] The facts involving the expression and omission of the reflexive clitic in Catalan presented in Alsina (2020) are further evidence for the realizational treatment of clitics in Romance.

[5] An additional specificity of the positioning of CCL in EP is the phenomenon of mesoclisis: with future and conditional verb forms, the enclitic position is not after the tense, aspect and person affixes, but before them. See Luís & Spencer (2005) for an analysis within LFG and realizational morphology. When a present tense form such as *mostramos* ‘we show’ combines with the clitic complex *lho* (3.DAT+3SG.M.ACC) in enclitic position, the result is *mostramos-lho* ‘we show it to him’, but, if instead we use a future tense form such as *mostraremos* ‘we will show’, the enclitic attachment of *lho* results in *mostrar-lho-emos*, not **mostraremos-lho*.

is a prima facie problem for that assumption. The standard view of the syntax-morphology interface in a lexicalist framework assumes that the morphology may impose constraints on the syntax, but the syntax cannot impose constraints on the morphology. But, in the case in point, a particular morphological property – the linearization of CCL before or after V – is determined by the syntax.

Example (8) shows that the same finite verb form, here *vê*, can take a clitic before it, as in *me vê*, or after it, as in *vê-me*, depending on what precedes it.

(8) Portuguese (Luís & Otoguro 2004)

a. O João raramente me vê.
the João rarely 1SG see.3SG

b. O João vê-me raramente.
the João see.3SG-1SG rarely
'João rarely sees me.'

The accepted assumption in work such as Luís & Sadler (2003), Luís & Otoguro (2004, 2005), and Luís & Spencer (2005), among others, is that enclisis is the default linearization of CCL and the verb in EP, whereas proclisis is triggered by the presence of certain c-structure constituents in preverbal position, which can be referred to as proclisis-triggers. So, for example, a non-quantified preverbal subject, such as *o João* in (8), is not a proclisis-trigger, which implies that the default option of enclisis is chosen in (8b); on the other hand, the adverb *raramente* in preverbal position is a proclisis-trigger, which explains the proclitic sequence *me vê* in (8a).

The approach adopted in Luís & Sadler (2003) is that all syntactic constituents that are proclisis-triggers are associated with the f-structure feature (↑ TYPE) = NON-NEUTRAL (or with the morphological feature [Restricted:Yes] in Luís & Otoguro 2004). For example, the negative element *não* is associated with this feature. (It has not been possible to find a common configurational or semantic/discourse denominator for the set of syntactic contexts that trigger proclisis; hence the proposal of having an f-structure feature for proclisis.)

The linearization rule 'Proclitic-LR', which ensures that CCL is placed preverbally, applies only under the existence of the (↑ TYPE)=NON-NEUTRAL feature in the f-structure of the verb. In the absence of this feature, the linearization rule that places CCL postverbally applies. So, the TYPE feature reflects the idea that proclisis is the marked option in EP.

However, the two alternative sequences *vê-me* and *me vê* are not identical from the syntactic point of view: even though they are both assumed to be a word from the morphological point of view, the form with enclisis, *vê-me*, is assumed to constitute a single X^0 (either I or V), whereas the form with proclisis, *me vê*, is assumed to correspond to two different c-structure positions. This assumption is necessary in order to account for two phenomena: scope over coordinated VPs and so-called interpolation. Focusing on interpolation, we find that certain words, which are clearly independent syntactic constituents, can appear between the proclitic CCL and the verb. These words can be the negative element *não*, certain adverbs like *ainda* 'yet', subject pronominals, and a combination of them, as in (9):

(9) Portuguese (Luís & Otoguro 2005)
... acho que ela o ainda não disse.
... think.1sg that she 3sg.m.acc yet not told.3sg
'... I think that s/he hasn't told it to him/her/them yet.'

The clitic *o* in (9) is separated from the verb *disse* by two words: *ainda* and *não*. This indicates that *o* and *disse* must be two independent c-structure elements (c-structure words). On the other hand, according to Luís & Sadler (2003), Luís & Otoguro (2004, 2005), and Luís & Spencer (2005), these two elements constitute a single unit at the morphological level (a morphological word). This is a departure from the standard idea in LFG that words – the minimal units of c-structure – are the output of the morphological component and, so, there should be no reason to distinguish between a c-structure word and a morphological word.

The exact implementation of the syntactic representation of the form with proclisis varies depending on the work. In Luís & Sadler (2003), the proclitic CCL attaches to the left of the VP headed by the verb that constitutes a morphological word with the preverbal CCL. In Luís & Otoguro (2004), it is assumed that, in certain cases, i.e. proclisis, a morphological token may correspond to two or more c-structure terminals.

In both approaches, a morphological unit is decomposed into two elements in the c-structure, which is a clear violation of the Lexical Integrity Principle – the idea that the internal structure of words is invisible to the c-structure. More specifically, this treatment of proclisis in Portuguese can be seen as a violation of Zwicky's Principle of Morphology-Free Syntax, according to which "syntactic rules cannot make reference to the internal morphological composition of words or to particular rules involved in their morphological derivation" (Zwicky 1987: 650), which he considers equivalent to the Lexicalist Hypothesis or the belief that syntax is blind to morphology (O'Neill 2016: 244).

2.2 F-structure status

In this subsection we address the issue of the GF that the clitic corresponds to, if any, and its status as a pronoun or an agreement marker, leaving aside the reflexive clitic, to be discussed in Section 2.3 and Section 3.2.

2.2.1 The GF the clitic corresponds to

In most cases, a clitic corresponds to a GF in its clause. In some languages (e.g., Spanish, Portuguese, Catalan, Italian), a clitic cannot correspond to the subject; it can correspond to an object only, both accusative and dative, as in Spanish and Portuguese, or to an object, as well as an oblique, as in Catalan and Italian. In French, clitics can correspond to a subject, in addition to objects and obliques.[6]

The most common situation with clitics is that in which the clitic is in complementary distribution with the phrasal expression of the GF that the clitic corresponds to. As Grimshaw (1982: 88) notes for French, "accusative clitics are in complementary distribution with NP objects." With a verb like *voit* 'sees', which requires a direct object, either an NP object or an accusative clitic satisfies this requirement, as in (10b) and (10c) respectively, but they cannot co-occur, as in (10d):

(10) French (Grimshaw 1982: 88)

a. * Jean voit.
John see.3SG
'John sees.'

b. Jean voit l'homme.
John see.3SG the.man
'John sees the man.'

c. Jean le voit.
John 3SG.M.ACC see.3SG
'John sees him.'

d. * Jean le voit l'homme.
John 3SG.M.ACC see.3SG the.man
'John sees him the man.'

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[6] Some Northern Italian languages also require a subject clitic, in a wide range of modalities (see Renzi & Vanelli 1983 and Cardinaletti & Repetti 2010). See Poletto & Tortora (2016) for variation in subject clitics in the different Romance languages that are claimed to have subject clitics.

How these facts are explained depends in part on whether we treat clitics as c-structure constituents or as affixes and, within the affixal treatment, as morphemes or as exponents of morphological or syntactic features. We shall consider the different approaches to clitics in explaining distributional facts such as those illustrated in (10).

Grimshaw (1982) takes the position that clitics are c-structure constituents belonging to the CL (clitic) grammatical category – let us call it the clitic-as-word approach. The observation that the direct object requirement is satisfied by either an NP following the verb or an accusative clitic before the verb is explained: (a) by annotating as an obj both the NP daughter of VP and one of the CL (clitic) positions daughters of V'; (b) by assuming that both nouns and pronouns, including pronominal clitics, have a pred feature in their lexical entries and that the clitic *le* has the lexical entry in (11); and (c) by appealing to the standard well-formedness conditions of Consistency, Completeness, and Coherence.

(11) *le* CL (↑ pred) = ‘pro’
(↑ case) = acc
(↑ num) = sg
(↑ pers) = 3
(↑ gend)=m

This clitic, in the appropriate CL position, satisfies the obj requirement of the verb and provides the necessary pred feature to satisfy Completeness. It is an alternative to the NP realization of the object, in which a noun provides the pred feature. This explains the alternative expression of the object illustrated in (10b) and (10c). In addition, if both ways of expressing the obj are used in the same clause, a violation of Consistency results, as the obj would have two pred values, given the convention that pred values are not unifiable, which accounts for (10d).

The affixal treatment of clitics is common to the two approaches in Section 2.1.2. In the morpheme-based approach, the main difference with the clitic-as-word approach is that clitics are not joined to a verb in the c-structure, but are joined to it in the lexicon. A clitic such as *le*, being a morpheme, has a “sublexical” entry identical or very similar to that in (11), except that “CL” is not a c-structure category, but a type of affix. One could either assume that there is a word template with different clitic affix positions, one of which would be annotated as the obj, and then a sublexical entry like that in (11) would fit into that position providing the f-structure features to the obj. Alternatively, the clitic-affix *le* would be specified in its sublexical entry with features indicating the GF they correspond to, such as (↑ obj pred) = ‘pro’, (↑ obj case) = acc, etc. The concatenation of a clitic (or clitic cluster) with a verb yields a word whose f-tructure information is the union of that of the clitic and that of the verb, so that a word such as *le voit* carries the f-structure information of the clitic and the f-structure information of the verb *voit*. This would be an instance of pronominal incorporation similar to the analysis of object markers in Chicheŵa by Bresnan & Mchombo (1987).

Within the realizational approach, the phonological representation of the clitic – *le*, in the French example (10b) – is the result of exponence rules and linearization rules, to use the concepts of Luís & Sadler (2003). Adapting the approach of Luís & Sadler (2003) to the present example, we can assume that one of the forms of the paradigm of the verb *voit* has the morphological feature (or m-feature) bundle {ACC,3,SG,M}. This feature bundle is realized phonologically as *le* and this exponent is linearized preceding the verb stem, giving the form *le voit*. In addition, there is a mapping between the m-features and f-structure features. Specifically, the m-feature bundle {ACC,3,SG,M} corresponds to the same f-structure features of the OBJ as those in (11). This is shown schematically in (12a) for the phonological realization and in (12b) for the f-structure correspondence.

(12) a. {ACC,3,SG,M} → /lə/, preceding *voit*
b. {ACC,3,SG,M} → (↑ OBJ PRED)=‘PRO’
(↑ OBJ CASE)=ACC
(↑ OBJ NUM)=SG
(↑ OBJ PERS)=3
(↑ OBJ GEND)=M

So, in this view, the word *le voit* is lexically assigned the syntactic features of *voit*, as well as the syntactic features in (12b). Since this word carries the f-structure information of the object, the use of this word satisfies the object requirement of the verb and precludes the appearance of an NP object for the same reasons noted for the clitic-as-word approach.

2.2.2 Agreement vs. pronoun; clitic doubling

In many cases, a clitic is not in perfect complementary distribution with the corresponding phrasal expression, but some amount of clitic doubling is found. In European Spanish, clitic doubling with direct objects (or accusative objects) is found only with pronominal expressions: a definite pronominal direct object is obligatorily expressed as a clitic, optionally doubled by the phrasal expression, as in (13):

(13) European Spanish (Andrews 1990: 540)

a. Lo vimos (a él).
3SG.M.ACC see.PST.1PL A HIM
'We saw him/HIM.'

b. *vimos a él.

In contrast, Rioplatense Spanish (also called Porteño and River Plate Spanish), as well as other varieties of South American Spanish, has a much more general use of direct object clitic doubling, as in (14):

(14) Rioplatense Spanish (Estigarribia 2005)

a. Yo las tenía guardadas las cartas.
I 3PL.F.ACC have.PST.1SG stored the letters
'I had the letters stored.'

b. ¿La vas a llamar a Marta?
3SG.F.ACC go.2SG A call A Marta
Are you going to call Marta?

In these cases, there is a single GF corresponding to the direct object, which is encoded in the c-structure by both the direct object clitic and by its phrasal expression: *las* and *las cartas* in (14a) and *la* and *a Marta* in (14b). The standard way of analyzing clitic doubling is to assume that it is a kind of agreement: the clitic in examples such as (14) merely specifies the formal features of person, number and gender of the object, while the corresponding phrasal expression contributes, in addition, the semantic PRED feature of the object. This means that there are two sets of specifications associated with clitics that have the dual function exemplified in (13a): as the sole expression of the object, the clitic is lexically associated with the [PRED 'PRO'] feature needed to satisfy Completeness; as an agreement marker, the clitic lacks this feature in its set of lexical specifications, enabling it to satisfy Uniqueness. This choice is assumed regardless of whether clitics are treated as words, as morphemes, or as exponents.

This analysis follows the treatment given in Bresnan & Mchombo (1987) to subject markers (SM) in Chicheŵa, in contrast with object markers (OM). (See also Fassi Fehri 1984, 1988.) OMs in Chicheŵa are assumed to be always incorporated object pronouns and thus are lexically associated with the [PRED 'PRO'] feature. SMs in Chicheŵa are claimed to be alternatively pronouns and agreement markers, which follows from the optional [PRED 'PRO'] feature in the sublexical entry of the SM. Andrews (1990) adapts this idea to the analysis of clitic doubling in

Spanish. This way of analyzing the dual function of clitics is used in Mayer (2006) for Limeño Spanish, in Estigarribia (2013) for Rioplatense Spanish, and in Barbu & Toivonen (2018) for Romanian, among others.[7]

The two sets of lexical specifications associated with clitics that have the dual function just mentioned may differ in more features that in the presence or absence of the [PRED ‘PRO’] feature. In Estigarribia (2013), it is proposed that the doubling use of the direct object clitic in Rioplatense Spanish not only lacks the pronominal feature, but carries a constraint that the object cannot be non-specific. The pronominal (or non-doubling) use of the clitic is necessarily definite and specific, but a direct object clitic can double (or agree with) an NP with specific reference (not necessarily definite).

Andrews (1990) explains the facts of European Spanish illustrated in (13) by assuming that direct object clitics also have two lexical entries: the pronominal entry, with the [PRED ‘PRO’] feature, and the doubling entry, which has a constraining [PRED ‘PRO’] specification, instead of the defining one. This constraining specification effectively restricts the doubling use to situations in which the clitic doubles a pronominal phrase (such as *a él*, in (13a)). The obligatoriness of the clitic double with pronominal NPs is explained by appealing to Andrews’s Morphological Blocking Principle. Without this principle, the clitic double would just be an option with pronominal object NPs.

Given two lexical items L1 and L2 such that L1’s f-structure specifications are a proper subset of those of L2, the Morphological Blocking Principle requires the use of L2 – the more highly specified lexical item – in a structure in which both L1 and L2 are compatible. In order for this principle to be able to choose between a verb form with a clitic and the same verb form without that clitic, it is necessary to assume that a verb form with a clitic is a lexical item. In other words, the Morphological Blocking Principle presupposes the affixal status of clitics. Given that a clitic is always associated with a set of f-structure features not present in the verb form to which it attaches, a lexical item consisting of a verb and a clitic is always going to be more highly specified in terms of f-structure features than the same lexical item without the clitic. So, if the lexical item with the clitic can be used, it must be used. This explains the obligatoriness of the clitic double in cases like (13).

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[7] Although this section deals with object clitics, it should be mentioned that subject clitics, in those languages that have them (e.g. French and Northern Italian languages), also vary as to whether they function as pronouns or as agreement markers, depending on the language and on the context (Poletto & Tortora 2016). See Cardinaletti & Repetti (2010) for the claim that subject clitics in Northern Italian languages should be analyzed as pronouns.

Constructions that are similar to clitic doubling but which need to be distinguished from it are clitic left dislocation and clitic right dislocation. Languages that do not have clitic doubling or make a very restricted use of it allow these dislocation constructions quite freely. Catalan, which only allows clitic doubling of the direct object in pronominal cases, does not allow a doubling clitic with a neutral intonation in an example like (15a), but allows a direct object clitic, and in fact requires it, when the apparent direct object is fronted, as in (15b), or postposed, with a clear intonational break, as in (15c):[8]

(15) Catalan (Vallduví 2002: 1233–1237)

a. (*El) va regalar el llibre a la biblioteca.
3sg.m.acc pst.3sg give.inf the book a the library
'She/he gave the book to the library.'

b. El llibre, el va regalar a la biblioteca.
the book 3sg.m.acc pst.3sg give.inf a the library
'The book, she/he gave it to the library.'

c. El va regalar a la biblioteca, el llibre.
3sg.m.acc pst.3sg give.inf a the library the book
'She/he gave it to the library, the book.'

The left or right dislocations in (15) fulfill functions at the information-structure level, but from the f-structure point of view the dislocated phrase does not fill an in-clause GF, but should be analyzed as a udf (unbounded dependency function). In other words, the phrase *el llibre* 'the book' is not an object in either (15b) or (15c), but a udf anaphorically bound to the object clitic *el*. It is this element that fulfills the accusative object function in these examples.

2.2.3 Non-argument clitics

While clitics in most cases either fulfill a GF that is an argument of the clause or agree with it, there are many instances in which clitics are neither an argument nor a marker of agreement with an argument. This is the case with the reflexive clitic, which can have an inherent use (see Section 2.2.3.1), an anaphoric use

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[8] The periphrastic past perfect tense in Catalan consists of an auxiliary form, such as *va* in (15), and an infinitive. The auxiliary is diachronically descended from the present indicative tense of *anar* 'go', but synchronically it is not the same form. The past tense auxiliary has the forms *vaig* or *vàreig* (1sg), *vas* or *vares* (2sg), *va* (3sg), *vam* or *vàrem* (1pl), *vau* or *vàreu* (2pl), and *van* or *varen* (3pl), whereas the present indicative of *anar* 'go' has the forms *vaig* (1sg), *vas* (2sg), *va* (3sg), *anem* (1pl), *aneu* (2pl), and *van* (3pl). For this reason, the past tense auxiliary is not glossed as if it were a form of *anar* 'go'.

(Section 2.3), and a use as a marker of passivization or impersonalization (Section 3.2). We shall focus here on two non-argument uses of clitics, leaving aside the reflexive clitic: (a) inherent clitics; and (b) clitics as adjuncts.[9]

2.2.3.1 Inherent clitics

Inherent clitics cannot alternate with a phrasal expression and their semantic contribution is not compositional: the predicate consists of a verb and a specific clitic or clitic combination. Examples of verbs with inherent clitics in Catalan include the following: *dinyar-la* 'die', *tocar-hi* 'have a grasp of things', *anar-se'n* 'go away', *jugar-se-la* 'take a risk', etc. Without the clitic or clitics, the verb either does not exist (e.g. *dinyar*) or has a different meaning and argument structure (e.g. *tocar* 'touch'). While one might like to think of these clitics as affixes attached to their verb, they cannot be treated as inseparable affixes, since they can appear separated from the verb by a number of auxiliaries and restructuring verbs, as in the following examples, where the verb and its associated clitics are underlined:

(16) Catalan

a.

L'	hauries	poguda	dinyar.
3sg.f.acc	have.cond.2sg	could.ptcp.f.sg	die.inf

'You could have died.'

b.

Se	l'	està	començant	a	jugar.
refl	3sg.f.acc	be.3sg	beginning	to	play.inf

'He is beginning to take a risk.'

These examples show that the word to which the inherent clitics attach is not the verb that must be used in combination with these clitics. The string of auxiliaries and restructuring verbs in (16) is clearly not a word, but a sequence of verbs, each one imposing a form requirement on the next. For example, the auxiliary *haver*, in the form *hauries* in (16a), requires the following verb to be in the past participle form, and the verb *poder*, in the form *poguda*, requires the following verb to be in the infinitive form. In addition, *poguda* is in the feminine singular

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[9] In addition, one can argue that the clitic *en/ne* found in Catalan, French, and Italian has two other non-argument uses: the partitive use and the genitive use. In the partitive use, the clitic appears instead of the head noun of an object of the verb (see Alsina & Yang 2018 for an analysis of the partitive clitic in Catalan) and cannot be argued to substitute for the whole object. In the genitive use, it fills the complement of a nominal or adjectival complement of the verb and therefore does not correspond to an argument of the verb. Because of space limitations, I will not discuss these uses further.

form (as opposed to the unmarked *pogut*) showing agreement with the feminine singular clitic *la*, which in this respect behaves like a direct object. The position in which inherent clitics are realized and the possibility of triggering past participle agreement, among other facts, are the same as with any other clitic.

One might assume that verbs with inherent clitics are listed in the lexicon with one or more fully specified GFs that have no semantic content. For example, *dinyar-la* would fully specify an accusative object with no correspondence to an argument at a-structure or to a semantic participant.[10] It would be listed as the verb *dinyar* taking a feminine singular accusative object, as indicated in (17):

(17) *dinyar* V
$$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{die}\langle\textsc{arg}\rangle\text{’} \\ \textsc{obj} & \left[\begin{array}{ll} \textsc{case} & \textsc{acc} \\ \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{fem} \end{array}\right] \end{array}\right]$$

Under a realizational approach to clitic morphology, we can assume that the features of the object in (17) are mapped onto the clitic *la*. As for the position of this clitic in a string of restructuring verbs, it is no different from that of any clitic. The syntactic dependents of the most embedded verb following a string of restructuring verbs can cliticize onto the highest verb in the string of verbs.

One of the uses of the reflexive clitic is as an inherent clitic. In this use, there is no reflexive interpretation. Following Grimshaw (1982), we can distinguish two classes of verbs within the class of verbs that take an inherent reflexive clitic: the lexically stipulated class of reflexive verbs and the class of inchoative verbs (in Grimshaw's terminology). The first class consists of verbs that are lexically required to take a reflexive clitic and either do not exist in a non-reflexive form or are not related in a systematic way with their non-reflexive counterpart. Examples of this class in Catalan are *desmaiar-se* 'faint' or *penedir-se* 'repent', which do not exist without a reflexive clitic. In the second class we find the intransitive alternant of the causative alternation, such as *trencar-se* 'break.INTR' or *obrir-se* 'open.INTR' in Catalan. See Alsina (2020) for a treatment of inherently reflexive verbs.

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[10] One could debate whether this object should have a [PRED 'PRO'] feature. Depending on how one views the syntax-morphology mapping for clitics, this feature might be necessary. On the other hand, the presence of this feature on a non-semantic GF would yield a violation of Coherence, according to some definitions of this condition which require a PRED feature on all and only those GFs with semantic content.

2.2.3.2 Clitics as adjuncts

Although clitics generally correspond to objects (or subjects, in languages with subject clitics, such as French), in some languages they can also correspond to obliques: this is the case of *en* and *y* in French, *en* and *hi* in Catalan, and *ne* and *ci* or *vi* Italian. The clitic *y/hi/ci*(*vi*) may correspond either to an argument of the verb or to an adjunct, as we see in (18) for French and in (19) for Catalan:

(18) French (Schwarze 2001b)

a. J' y ai pensé.
I Y have.1SG thought
'I have thought of it.'

b. Je l' y ai vu.
I 3SG.F.ACC Y have seen
'I saw him there.'

(19) Catalan (Todolí 2002)

a. Encara no s' hi han acostumat.
still not REFL HI have.3PL accustomed
'They haven't got used to it yet.'

b. No es pot circular sense casc, però molts motoristes hi circulen.
Not REFL can ride.INF without helmet, but many motorcyclists HI ride.3PL
'You cannot ride without a helmet, but many motorcyclists do so.'

In (18a) and (19a), *y/hi* corresponds to an argument, but in the (b) examples it is an adjunct: in (18b) it expresses the location in which an event takes place, and in (19b) it expresses the means or manner. One can take this to mean that *y/hi* has a double function, being alternatively an oblique or an adjunct, as in Schwarze (2001b). Or one can take this as evidence that there is no adjunct grammatical function, as argued in Alsina (1996b). According to Alsina (1996b), the distinction between argument and adjunct is made at the level of a-structure: a GF that corresponds to a position at the a-structure is an argument, whereas a GF with semantic content that does not is an adjunct. This distinction need not be duplicated at the level of GFs by increasing the inventory of GFs with ADJ, and adjuncts are simply obliques (OBL) at the level of GFs. Consequently, all we need to say about *hi/y* is that it corresponds to an OBL. By not restricting it to arguments, it follows that it can correspond to either an argument or an adjunct.

2.3 The anaphoric reflexive clitic

We can define reflexive clitics as those that show agreement in person and number with the logical subject[11] of the predicate that the clitic combines with. First and second person clitics do not have a special reflexive form distinct from their non-reflexive form. The third person does have a specific form for the reflexive use, *se* (and cognate forms), which, however, does not distinguish singular from plural. The third person form, being the only one that is unambiguously reflexive, will be normally used to illustrate the behavior of reflexive clitics.

In this section, we will only consider what we might call the anaphoric use of the reflexive clitic, by which the predicate has a semantically reflexive or reciprocal interpretation. In Section 2.3.1, we compare the pronominal analysis and the valence-reducing analysis of the anaphoric reflexive. And in Section 2.3.2, we consider three variants of the valence-reducing analysis.

The other uses of the reflexive clitic are the inherent use (Section 2.2.3) and the passive and impersonal use (Section 3.2).[12]

2.3.1 The reflexive clitic as an argument or as a marker of valence-reduction

In general, any verb that can take an object (direct or indirect) can also take a reflexive clitic instead of the phrasal object, so that the logical subject and another direct argument of the verb are interpreted as being the same set of participants: this is the anaphoric use of the reflexive clitic. The interpretation is reflexive or reciprocal depending on whether the same participant (individual or group) is involved in the relation – reflexive interpretation – or a different participant of the set is involved – reciprocal. Using Catalan to exemplify the anaphoric use of the reflexive clitic, (20a) is a transitive sentence in which the direct, or accusative, object is expressed as an NP; (20b) shows that a reflexive clitic can be used instead of the NP object, in this case with a reflexive interpretation; and this sentence resembles (20c), where a pronominal non-reflexive clitic is used instead of the object NP. The examples in (21) show the possibility of the reflexive

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[11] See the glossary for the definition of *logical subject.*

[12] The homonymy or syncretism of the anaphoric reflexive with the passive/impersonal reflexive is complete in some Romance languages (e.g. Spanish, Catalan, or French), but is not complete in some others, specifically, in Italian. In Italian, in both uses, it has the form *si* when it is not in combination with another clitic, but, when the two uses co-occur in the same clause, we obtain the combination *ci si*, as in *ci si lava* in (4c). In addition, the anaphoric reflexive precedes a third person accusative clitic, whereas the impersonal reflexive follows it, as shown in (4). This indicates that they are different morphs in Italian, which explains the possibility of their co-occurrence together with another clitic, as *ce lo si compra* ‘one buys it for oneself’, as pointed out by an anonymous reviewer.

clitic appearing instead of a dative object and yielding a reciprocal or reflexive interpretation.

(20) Catalan

a. Mira com contradiu el director.
look how contradict.3SG the manager
'See how she contradicts the manager.'

b. Mira com es contradiu.
look how REFL contradict.3SG
'See how she contradicts herself.'

c. Mira com el contradiu.
look how 3SG.M.ACC contradict.3SG
'See how she contradicts him.'

(21) Catalan

a. Avui els estudiants enviaran regals a la professora.
today the students send.FUT.3PL presents A the teacher
'Today the students will send the teacher presents.'

b. Avui els estudiants s' enviaran regals.
today the students REFL send.FUT.3PL presents
'Today the students will send each other/themselves presents.'

c. Avui els estudiants li enviaran regals.
today the students 3SG.DAT send.FUT.3PL presents
'Today the students will send her presents.'

This pattern of facts lends itself to an analysis in which the reflexive clitic only differs from pronominal object clitics in its anaphoric properties, being obligatorily bound by some antecedent in a local domain, and is the realization of an argument of the clause. This is in fact the analysis proposed in Alencar & Kelling (2005), which we can call the "pronominal analysis." In examples like (20b) and (21b), the reflexive clitic would be argued to realize an accusative object or a dative object, just like the non-reflexive clitics do. However, this analysis has been shown to be problematic since Grimshaw (1982). Grimshaw (1982, 1990) gives compelling evidence for the claim that the reflexive clitic in its anaphoric use should be treated as not realizing an argument of the clause but as valence-reducing morphology.

The clearest evidence presented by Grimshaw (1982, 1990) for the valence-reducing analysis of the reflexive clitic concerns the behavior of the causative construction. The logical subject of the infinitive in a causative construction, with *faire* in French, is realized differently depending on the transitivity of the infinitive: indirect object if the infinitive has a direct object, and direct object otherwise, as shown in (22):

(22) French (Grimshaw 1990: 153)

a. Il fera boire un peu de vin *(à) son enfant.
he make.FUT.3SG drink.INF a bit of wine A his child
'He will make his child drink a little wine.'

b. Il fera partir {les/*aux} enfants.
he make.FUT.3SG leave.INF the/*A.the children
'He will make the children leave.'

When the infinitive has a reflexive clitic corresponding to its direct object, it behaves like an intransitive verb and its logical subject is realized as a direct object, as in (23a). In contrast, if the direct object of the infinitive is expressed as a non-reflexive clitic, its logical subject is an indirect object, as in (23b).

(23) French (Grimshaw 1990: 153)

a. La crainte du scandale a fait se tuer {le/*au} frère
the fear of.the scandal has made REFL kill.INF the/*A.the brother
du juge.
of.the judge
'Fear of scandal made the brother of the judge kill himself.'

b. La crainte du scandale l'a fait tuer {au/*le}
the fear of.the scandal 3SG.M.ACC.has made kill.INF A.the/*the
juge.
judge
'Fear of scandal made the judge kill him.'

If we assume that the reflexive clitic is not an object, unlike the non-reflexive clitic, but an element of the morphology that signals the binding of two arguments so that there is only one open argument position, we explain that the verb behaves like an intransitive verb.

Grimshaw (1982) also presents NP extraposition in French as evidence for the intransitive behavior of reflexivized verbs, i.e., verbs with an anaphoric reflexive clitic. French allows arguments that can normally appear as subjects, as in (24a), to alternatively appear as objects with a dummy *il* in subject position, as in (24b):

(24) French (Grimshaw 1982: 112)

a. Un train passe toutes les heures.
A train passes all the hours

b. Il passe un train toutes les heures.
IL passes a train all the hours
'A train goes by every hour.'

However, the construction of NP extraposition, illustrated in (24b), is restricted to intransitive verbs. In addition, there are semantic constraints on NP extraposition, but the intransitivity requirement is independent of these semantic restrictions. A reflexivized verb behaves like an intransitive verb in allowing NP extraposition, unlike verbs with non-reflexive object clitics, as the contrast in (25) illustrates:

(25) French (Grimshaw 1982: 113)

a. Il s' est dénoncé trois mille hommes ce mois-ci.
IL REFL is denounced three thousand men this month
'Three thousand men denounced themselves this month.'

b. * Il l' a dénoncée trois mille hommes.
IL 3SG.F.ACC has denounced three thousand men
'Three thousand men denounced it.'

2.3.2 Three alternative valence-reducing analyses

Having shown that reflexive cliticization turns a transitive verb into an intransitive one, three possibilities emerge as to how the two argument roles involved in the binding relation signaled by the reflexive clitic map onto only one GF (typically the subject, but not necessarily, as shown in (25a)). The three analyses, described in (26), have in common the idea that the anaphoric reflexive clitic signals the binding at the level of argument structure of the logical subject and another core argument of the same predicate:

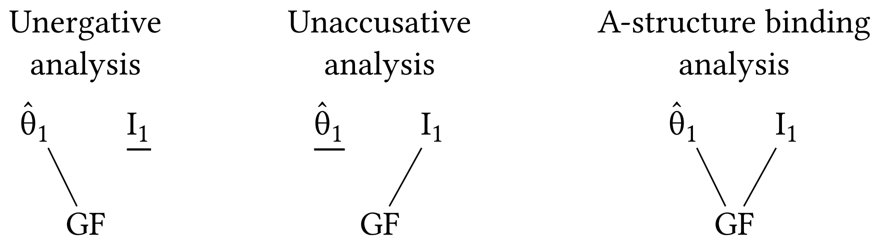
(26) a. *The unergative analysis*: the lower argument is lexically bound and therefore unable to be expressed as a GF; only the logical subject is expressed as a GF. Proposed by Grimshaw (1982).

b. *The unaccusative analysis*: the logical subject is lexically bound and therefore unable to be expressed as a GF; only the lower argument in the binding relation is expressed as a GF. Proposed by Grimshaw (1990).

c. *The a-structure binding analysis*: both arguments involved in the binding relation are expressed as a GF and are expressed as the same GF. Proposed by Alsina (1993, 1996b).

Schematically, the three analyses can be depicted as in (27), where “$\hat{\theta}$” represents logical subject, “I” represents internal argument, co-subscripting signifies binding of arguments, and underlining of an argument signifies that the argument has no mapping to GF:

(27)



Grimshaw (1982) does not present evidence specifically for the unergative analysis. The evidence presented in Grimshaw (1990) for the unaccusative anaysis rests primarily on the facts of auxiliary selection in Italian, as we shall see. Some of the evidence presented in favor of this analysis is really neutral with respect to the other two analyses in competition. Since, according to Grimshaw (1990: 154), reflexivization satisfies an external argument (by binding), it cannot apply to predicates that do not have an external argument or have a suppressed external argument. It follows that it cannot apply to passives or subject-raising predicates. This explains the contrast between English and French with subject-raising verbs (from Grimshaw 1990: 155):

(28) a. They appear to each other to be intelligent.
b. * Jean se semble intelligent. (French)
Jean REFL seems intelligent.
‘Jean seems intelligent to himself.’

Grimshaw (1990) takes the ungrammaticality of (28b) to follow from the assumption that a raising verb like *sembler* ‘seem’ does not have an external argument. However, it can also be attributed to the observation that this verb does not have two arguments that can be involved in binding: the subject in (28b) is not an argument of the raising verb, but of its complement, so that the two arguments that would be involved in binding in (28b) belong to two different predicates. And the three analyses described in (26)–(27) require that the two arguments involved in reflexive cliticization be arguments of the same predicate.

As for auxiliary selection in Italian, unergative verbs select *avere* 'have' as the auxiliary in perfective compound forms and unaccusative verbs select *essere* 'be' (following Perlmutter 1978, 1983, 1989 and Rosen 1984; see Loporcaro 2016 for an update), as shown in (29). The fact that reflexivized verbs select *essere*, as in (30), even though their non-reflexive counterparts select *avere*, is taken as evidence in Grimshaw (1990) that reflexivized verbs are unaccusatives:

(29) Italian (Katerinov 1975)
a. Avete viaggiato bene?
have.2PL travelled well
'Have you travelled well?'
b. Sono uscito.
be.1SG gone.out
'I have gone out.'

(30) Italian (Katerinov 1975)
a. Maria e Paola si sono salutate.
Maria and Paola REFL be.3PL greeted.F.PL
'Maria and Paola greeted each other.'
b. Mi sono comprato una casa nuova.
1SG be.1SG bought a house new
'I bought myself a new house.'

If the expressed argument in reflexivized verbs is the internal argument, and the external argument is not assigned to a GF, as in the unaccusative analysis in (27), it is clear that reflexivized verbs are like unaccusative verbs. However, let us suppose that the relevant notion for auxiliary selection is that verbs whose highest GF maps onto an internal argument select *essere* (where SUBJ ranks higher than OBJ, and OBJ than OBL). Then, both the unaccusative analysis and the a-structure binding analysis fare equally in predicting that both unaccusative verbs and reflexivized verbs select *essere*.

But the a-structure binding analysis does not treat reflexivized verbs as unaccusatives, since the highest GF of the former is an external argument, as well as an internal argument. This has an advantage over the unaccusative analysis as it allows us to explain two facts that the unaccusative analysis fails to explain. First, the highest GF of reflexivized verbs, being an external argument, tends to be a subject much more so than that of unaccusative verbs, which is not an external argument. This contrast between reflexivized verbs and unaccusative verbs can be clearly illustrated by using the same verb with a reflexive clitic yielding a potential ambiguity between the anaphoric and the passive interpretations. Using Catalan data, a sentence like (31a) is ambiguous between these two interpretations, whereas (31b) only allows the anaphoric interpretation:

(31) Catalan

a. Es defensaran dos diputats al parlament.
REFL defend.FUT.3PL two deputies at.the parliament
'Two deputies will defend themselves at the parliament.'
'Two deputies will be defended at the parliament.'

b. Dos diputats es defensaran al parlament.
two deputies REFL defend.FUT.3PL at.the parliament
'Two deputies will defend themselves at the parliament.'
*'Two deputies will be defended at the parliament.'

The preverbal position of the NP, with no object clitic anaphorically dependent on it attached to the verb, unambiguously signals that the NP is the subject – or, more exactly, a topic anaphorically linked to the null pronominal subject. While an internal argument, especially if expressed as an indefinite NP, is assigned the object function, an external argument favors the assignment to the subject function.

The contrast between the reflexivized verb and the reflexive passive form is even clearer, when, under the appropriate discourse conditions, we omit the noun *diputats* from (31). If the NP *dos* is postverbal, with obligatory presence of the partitive clitic *en*, only the passive interpretation is allowed; if the NP *dos* is preverbal, with no partitive clitic, only the reflexivized reading is possible:

(32) Catalan

a. Se' n defensaran dos al parlament.
REFL EN defend.FUT.3PL two at.the parliament
*'Two will defend themselves at the parliament.'
'Two will be defended at the parliament.'

b. Dos es defensaran al parlament.
two REFL defend.FUT.3PL at.the parliament
'Two will defend themselves at the parliament.'
*'Two will be defended at the parliament.'

If, as assumed in Grimshaw (1990), the reflexive passive and the reflexivized verb have the same syntactically expressed arguments, namely, the internal argument in both cases, the difference shown in (31) and (32) would be completely unexpected. On the other hand, under the a-structure binding analysis of reflexivized forms, these forms have a GF that is both an internal and an external argument, contrasting with reflexive passive forms, in which the highest GF is only an internal argument.

The second fact that favors the a-structure binding analysis is found in triadic predicates: when the binding relation involves an argument that in the non-reflexivized form of the verb is a dative object, the corresponding GF is not dative in the reflexivized form, but nominative. If argument realization with reflexivized verbs were the same as with unaccusative or passive verbs, we would not expect dative case to disappear. Dative case is retained under passivization, blocking the dative expression from being the passive subject. We see this not only with participial passives, but also with reflexive passives, as in (33b). The goal argument is dative and cannot be expressed as a nominative phrase in a reflexive passive, as in (33c). However, in the reflexivized form, in (33d) with a reciprocal interpretation, the goal argument is nominative and the subject.[13]

(33) Catalan

a. El metge va ensenyar els resultats al pacient.
the doctor PST.3SG show.INF the results A.the patient
'The doctor showed the patient the results.'

b. Es van ensenyar els resultats al pacient.
REFL PST.3PL show.INF the results A.the patient
'The patient was shown the results.'

c. * El pacient es va ensenyar els resultats.
the patient REFL PST.3SG show.INF the results
'The patient was shown the results.'

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[13] The phenomenon is illustrated with Catalan data, but the facts are essentially the same in French, Italian, and Spanish. See, for example, the Italian reflexivized form (30b), where the first person singular reflexive clitic signals the binding of the agent and the goal, which are encoded as the (null) subject.

d. Els pacients es van ensenyar les cicatrius.
the patients REFL PST.3PL show.INF the scars
'The patients showed each other the scars.'

Under the unaccusative analysis, the NP *els pacients* in (33d) is the goal internal argument, just as the phrase *al pacient* in (33b); so, it is very unclear why it has dative case in the passive example, which prevents it from being the subject, as in (33c), but not in the reflexivized form, in which the goal argument is nominative.[14] On the other hand, within the a-structure binding analysis, the phrase *al pacient* in the passive example (33b) is the goal internal argument and no other argument, whereas the phrase *els pacients* in the reflexivized structure (33d) is both the goal internal argument and the external argument. Here there are two arguments that map onto the same GF. If we assume, as in Alsina (1996b), that dative case is assigned to the GF that maps onto the more prominent of two internal arguments, as long as it is **not an external argument**, it follows that dative case will be assigned to the goal internal argument in the active and passive forms (33a) and (33b), but not in the reflexivized form (33d).

The a-structure binding analysis of the anaphoric use of the reflexive clitic just described relies on the idea essential to LFG that grammatical information is factored into different levels of representation, allowing for mismatches among these levels. In particular, the distinction between argument roles at a-structure and GFs at f-structure plays a crucial role in this analysis. If we allow for the possibility that a given GF corresponds to two different argument roles, as schematized in (27) for the a-structure binding analysis, we can explain not only the valence-reducing effect of the anaphoric reflexive clitic, but those properties of the GF that group it with an internal argument, as in the unaccusative analysis, and those properties that group it with an external argument, as in the unergative analysis.

Following the proposal in Alsina (1996b), we can illustrate this by comparing the non-reflexive use of a dyadic predicate such as *defensar* 'defend' in Catalan with the same predicate with the anaphoric reflexive clitic. This predicate has an external argument and an internal argument, represented by [Ext] and [Int] respectively at a-structure. Each argument has its linking index, represented as a subscripted number, which, in the default case, is different for each argument, entailing a different mapping to GF. This is the situation in (34a), where the external argument maps onto the subject and the internal argument onto the object.

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[14] Grimshaw (1990: 184) points out this problem in an endnote and essentially leaves it unsolved, although one of the solutions she sketches involves precisely a-structure binding.

The effect of the anaphoric reflexive clitic is to coindex the logical subject of a predicate with an internal argument, so that they have the same linking index and therefore map onto the same GF, as shown in (34b). The principles mapping argument roles to GFs are satisfied in (34b): the external argument is required to map onto the subject and the internal argument is required to map onto a direct GF (either subject or object) and, since the subject is a direct GF, both mapping requirements are met. The a-structure is represented as the value of the feature PRED in (34).

(34) a. Non-reflexive use of *defensar* 'defend':

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{defend}\langle[\textrm{Ext}]_1\ [\textrm{Int}]_2\rangle\text{'} \\ \textsc{subj}_1 & \\ \textsc{obj}_2 & \end{bmatrix}$$

b. Reflexivized use of *defensar-se* 'defend-REFL':

$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{defend}\langle[\textrm{Ext}]_1\ [\textrm{Int}]_1\rangle\text{'} \\ \textsc{subj}_1 & \end{bmatrix}$$

3 Arguments, grammatical functions, and case

This section deals with the morphosyntactic expression of arguments in terms of grammatical functions and case. Section 3.1 considers the inventory of GFs, especially the GFs of subjects, objects, and clausal complements. The passive and impersonal reflexive constructions are examined in Section 3.2.

3.1 Objects and their realization

3.1.1 Direct and indirect objects: GF and case

Traditional grammar, as well as Relational Grammar, distinguishes two kinds of objects in the Romance languages: direct object (DO) and indirect object (IO). DOs, in their phrasal expression, are generally NPs without any case marker or preposition, except that in some languages a subset of DOs are marked by a preposition,[15] whereas IOs, as phrases, are PPs introduced by the preposition *a*. Both kinds of objects can be expressed as clitics and all Romance languages have different sets of pronominal clitics in the third person for the two kinds of objects. First and second person clitics do not distinguish between the two

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[15] The prepositional marking of the DO, also known as differential object marking, is found in Spanish, Catalan, southern Italian dialects, and Sardinian, which use the same preposition as for IOs, and in Romanian, in which the preposition *pe* is used (Dragomirescu & Nicolae 2016: 920–921). See Barbu & Toivonen (2018) for the distribution of DO *pe* in Romanian.

kinds of objects.[16] Given that LFG does not have a DO and an IO in its standard inventory of GFs, researchers have accommodated this distinction into the LFG inventory of GFs in different ways. The proposals that restrict themselves to the standard LFG inventory of GFs have in common the assumption that the DO is OBJ and differ in the GF attributed to the IO, which is one of the following three: OBL, OBJ_θ, and OBJ.[17]

3.1.1.1 IO as OBL

This proposal is found in Schwarze (2001b) and Sells (2013: 185–194), although no motivation is given for adopting it instead of the available alternatives. Alsina (1996b: 150–160) enumerates eight properties that group IOs with DOs, in the class of direct functions, together with subjects, contrasting them with obliques: (1) doubling of independent personal pronouns in the verbal morphology (as clitics); (2) expression of person and number distinctions in the verbal morphology; (3) the ability to be bound at a-structure (by means of the reflexive clitic); (4) the ability to launch a floating quantifier; (5) disjoint reference of pronouns; (6) the ability to bind quantifiers; (7) the ability of independent (or strong) pronouns to function as resumptive pronouns; and (8) the ability to be the target of secondary predication. All of these properties argue against treating the IO as an oblique and show that it belongs to the class of direct GFs, together with subjects and objects.[18]

3.1.1.2 IO as OBJ_θ

This proposal is found in Falk (2001: 115–118), Alencar & Kelling (2005), Aranovich (2012), Quaglia (2012), and Carretero García (2018). Grimshaw (1982) can

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[16] Neither do third person reflexive clitics, but then, according to Section 2.3, they are not object clitics. Instances of DO-IO syncretism are found even in third person non-reflexive clitics: this is the case of Spanish *leísmo*, in which the clitic *le* is used for both IOs and human masculine DOs. Other forms of DO-IO syncretisms in third person clitics are found in regional varieties of Spanish (Tuten et al. 2016: 398).

[17] Some exceptions to this observation are found. Luís & Otoguro (2004: 344–349) treat the single object of a clause as OBJ, whether it is direct or indirect (i.e., accusative or dative) and, in ditransitive clauses, treat the DO as OBJ_θ and the IO as OBJ. Luís & Spencer (2005) use the GFs OBJ1 and OBJ2 for the IO and the DO respectively, where we can assume that OBJ1 is another name for OBJ and OBJ2 replaces OBJ_θ. No argumentation is presented for these proposals.

[18] To these properties we could add the IO-DO syncretism in first and second person and reflexive clitics in Romance in general, the partial IO-DO syncretism in third person non-reflexive clitics in Spanish (see footnote 16), and the partial syncretism in the phrasal expression of IO and DO in those languages that use the same preposition for both objects (see footnote 15).

be grouped in this proposal, as she assumes that the DO is OBJ and uses the GF A OBJ, instead of OBJ$_\theta$, for the IO. The main argument for this proposal is the observation that dative arguments cannot be encoded as subjects: they are never the subject of a passive form, with verbs that can be passivized, and are not the subject of psychological verbs of the 'like'-type. While this is true, there are many reasons for rejecting this proposal. In languages such as Chicheŵa (asymmetrical object languages), in which the OBJ-OBJ$_\theta$ distinction is strongly motivated, the OBJ has the ability to be expressed as a morphologically incorporated pronominal, can be accessed by an a-structure binding operation (reciprocalization), and alternates with the SUBJ in a passive form, whereas the OBJ$_\theta$ lacks all of these properties (see Baker 1988a,b, Alsina & Mchombo 1990, Bresnan & Moshi 1990, Alsina 1996a, among others).[19] The IO, like the DO, in Romance is able to be expressed as a morphologically incorporated pronoun, as illustrated in examples (3b), (3c) and (21c) (see also (35)), and, like the DO, can be accessed by an a-structure binding operation (by means of the reflexive clitic), as in (21b), (30b), and (33d). The only property that the IO shares with the OBJ$_\theta$ is the fact that it cannot be a subject. To focus on this one feature of the IO in order to claim that it is an OBJ$_\theta$ is to ignore the fact that there is a cluster of properties associated with the OBJ-OBJ$_\theta$ distinction, as has been mentioned, and the fact that DO and IO are distinguished by grammatical case, unlike OBJ and OBJ$_\theta$ in most asymmetrical languages.

In addition to this, there is a difference in the thematic roles that map onto OBJ$_\theta$ in the subclass of asymmetrical languages of the Chicheŵa type termed non-alternating in Alsina (1996a) and the thematic roles that correspond to IO in the Romance languages. In Chicheŵa, only thematic roles below goal in the thematic hierarchy (i.e., instrumental, theme, patient, locative) can map onto OBJ$_\theta$, as the higher roles in the hierarchy (agent, beneficiary, goal) cannot map to OBJ$_\theta$. In contrast with this, the IO in Romance typically corresponds to the higher roles in the hierarchy (agent, beneficiary, goal, experiencer).

In other words, to assume that IO is OBJ$_\theta$ implies abandoning the idea that there is a cluster of properties associated with OBJ$_\theta$ and assuming that the only necessary and sufficient condition for the OBJ$_\theta$ function is the failure of alternating with the SUBJ function, which is clearly an undesirable loss of predictive

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[19] In addition, in Chicheŵa, the OBJ precedes the OBJ$_\theta$ when both are expressed as NPs in the VP. However, this is not a necessary property of asymmetrical object languages, as there are languages of this type, including other Bantu languages, that allow either order of the objects. Also, the fact that the DO precedes the IO in Romance in the unmarked order is simply a consequence of the different grammatical category of the two objects, the DO being an NP and the IO being a PP.

power of the theory. And it also requires assuming that the mapping of argument roles to OBJ$_\theta$ may vary radically from language to language.

3.1.1.3 IO as OBJ

This proposal is argued for in Alsina (1996b) and is also found in Vanhoe (2002). It places a lot of importance on the observation that DO and IO are distinguished primarily by means of grammatical case. Both DO and IO are the GF OBJ and are distinguished because IO is dative and DO is non-dative (i.e., accusative, although nominative is also an option, see Section 3.1.3). What needs to be accounted for in this approach is case assignment, particularly, the assignment of dative case. Alsina (1996b) notes that dative case is assigned either on the basis of the semantics, specifically, the thematic role involved, or on the basis of the a-structure configuration. In the first case, dative is claimed to be assigned to arguments whose thematic role is goal and this assignment does not depend on there being a non-dative object in the clause, as illustrated in (35a). In the second case, dative is assigned to the GF corresponding to the more prominent of two internal arguments, as in (35b). As there need to be two internal arguments each mapping to a different GF for the latter type of dative case assignment, dative fails to be assigned to the single internal argument of a clause (unless it meets the semantic requirement), as in (35c). The dative-accusative case alternation in (35b)–(35c) also occurs with the causee in causative constructions depending on transitivity of the embedded infinitive (see (22) and Section 4.1).

(35) Catalan (Alsina 1996b: 172)

a. En Ferran li ha escrit (una carta).
ART Ferran 3SG.DAT has written a letter
'Ferran has written him (a letter).'

b. Li ensenyen llatí.
3SG.DAT they.teach Latin
'They teach him Latin.'

c. L' ensenyen.
3SG.M.ACC they.teach
'They teach him.'

The only property that seems to indicate that IO behaves like OBJ$_\theta$ is the claim that dative arguments are never subjects in Romance, but must be objects instead. Alsina (1996b) claims that this fact is best accounted for through a constraint prohibiting subjects with dative case. This constraint is active in the Romance languages, which do not allow dative subjects,[20] but is not active in languages such as Icelandic or Hindi (see Zaenen et al. 1985 and Mohanan 1994, respectively, among others), in which dative subjects are possible. The thematic roles to which dative case is assigned are very similar across these different languages, but Romance differs from Icelandic and Hindi basically because dative blocks the assignment of the subject function in the former, but not in the latter. Introducing the OBJ-OBJ$_\theta$ distinction in the description of the facts would just obscure the differences and similarities among these languages.[21]

Accepting the idea that IO is OBJ implies that a given clause may have more than one GF OBJ, since clauses often have an IO and a DO and sometimes even more than one IO. In this respect, OBJ would not be different from OBJ$_\theta$ or OBL$_\theta$, of which clauses may have more than one. This requires modifying the framework, which, in its standard form, does not allow multiple GFs with the same attribute, unless the GF in question is assumed to take a set of f-structures as its value rather than a single f-structure. Alsina (1996b) assumes that the only GF that is unique in a clause is the subject, whereas the other two GFs, namely, object and oblique (in a reduced inventory of GFs with only the three named GFs), are not required to be unique and can have multiple instantiations. This proposal can be implemented by assuming that both OBJ and OBL take a set of f-structures as their value, whereas SUBJ takes an f-structure as its value. See also Patejuk & Przepiórkowski (2016) for a different implementation of the idea that the inventory of GFs consists of only the three GFs mentioned.[22]

3.1.2 The GF of clausal complements

The debate about the inventory of GFs in LFG has also addressed the issue of the GF COMP, a GF that in standard LFG is reserved for clausal complements, typically finite. Alsina et al. (2005) (AMM) argue that this GF is not necessary and, in fact, complicates the statement of generalizations and that clausal complements

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[20] However, some authors have claimed that dative experiencers can be subjects, e.g. Cardinaletti (2004) for Italian and Fernández-Soriano (1999) for Spanish.

[21] Certain verbs take a dative object as their sole object. This occurs in Latin with verbs such as *subvenire* 'help', *parcere* 'spare', etc., as well as in the Romance languages. This is unlike the OBJ$_\theta$ in languages such as Chicheŵa, where it occurs only in a double object construction.

[22] This idea is also valid for asymmetrical languages like Chicheŵa, since the distinction between primary and secondary object (OBJ and OBJ$_\theta$, respectively, in standard LFG) needs to be made at the level of a-structure, as argued in Alsina (1993, 2001), by means of a feature (R) that marks secondary objects, and only at that level, so that both primary and secondary objects are simply objects at the level of GFs.

should be assumed to be either objects or obliques.[23] The argument based on Catalan is as follows. Catalan has two types of clausal complements introduced by the complementizer *que*, without a preposition: those that alternate with a nominal complement, which can be expressed by the object clitic *ho*, and that can passivize, and those that alternate with a prepositional complement, that can be expressed by one of the oblique clitics *hi* or *en*, and that cannot passivize. (36) exemplifies a complement of the first type: the verb *entendre* 'understand' can take a nominal complement, as in (36a), can cliticize its clausal complement by means of *ho*, as in (36b), and can passivize with the dependent clause as the subject, as in (36c):

(36) Catalan (AMM)

a. (La teva explicació) no l' he entesa.
the your explanation not 3sg.f.acc have.1sg understood.f
'(Your explanation$_i$) I didn't understand it$_i$.'

b. (Que hagis arribat tan tard) no ho he entès.
that have.2sg arrived so late not ho have.1sg understood
'(That you should have arrived so late$_i$) I didn't understand it$_i$.'

c. Que votessis a favor de la proposta no va ser
that vote.sbjv.2sg in favor of the proposal not pst.3sg be
entès per una part del públic.
understood by a part of-the audience
'That you should have voted in favor of the proposal was not understood by part of the audience.'

Convèncer 'convince' is a verb that takes a clausal complement of the second type: it alternates with a PP, as in (37a), but does not take a preposition, as in (37b), and can be expressed by means of the oblique clitic *en*, as in (37c):

(37) Catalan (AMM)

a. M' heu de convèncer **de** les seves possibilitats.
me have.2pl to convince of the 3poss possibilities
'You have to convince me of his possibilities.'

b. M' heu de convèncer (***de**) que torni a casa.
me have.2pl to convince of that return.1sg to home
'You have to convince me to return home.'

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[23] A defense of the GF comp can be found in Dalrymple & Lødrup (2000), Lødrup (2004, 2012), and Belyaev et al. (2017).

c. Me n' heu de convèncer.
me en have.2pl of convince
'You have to convince me of that.'

Another class of verbs that take a clausal complement introduced by *que* is illustrated by *estar d'acord* 'agree', which takes a different preposition, *en*, when the complement is not clausal, and a different clitic form, *hi* (see relevant examples in AMM).

The choice of oblique clitic (*en* vs. *hi*) is related to the choice of oblique preposition: oblique complements introduced by the preposition *de* can be expressed by means of the clitic *en*, whereas other obliques alternate with the clitic *hi*. Replacing one oblique clitic by the other one renders the sentences ungrammatical. In addition, neither of the two classes of verbs allows the dependent clause introduced by *que* to be the subject of a passive form, as illustrated in (38) for *convèncer*.

(38) Catalan (AMM)
* Que tornés a casa va ser convençut en Martí.
that return.sbjv.3sg to home past.3sg be convinced the Martí
'That he return home was convinced Martí.'

A possible LFG approach to these facts using the comp function would assume that a clausal complement can be either an obj or a comp: it is an obj in cases like (36b), where it alternates with an NP, with object clitics, and with the subject in a passive clause, whereas it is a comp in (37b), where it has none of these properties. This means that predicates like *convèncer* and *estar d'acord* have two different subcategorization frames depending on whether the complement is nominal or clausal: they take an obl for sentences such as (37a) and a comp for sentences such as (37b) and, to complicate matters further, the clitic that corresponds to the obl and to the comp is unique for each verb regardless of whether it corresponds to the obl or to the comp, as in (37c). No generalization can be made regarding the choice of clitic, given that some comps are expressed as *en* and some others are expressed as *hi*, and the choice does not depend on the comp but on the obl that appears on the alternative subcategorization frame of the verb.

If, on the other hand, we assume that there is no such GF as comp, as claimed in AMM, but clauses can be the c-structure realization of either obj or obl (just as they can be of subj), the different behavior of the clausal complements shown in (36)–(38) simply follows from their being either obj or obl, together with a constraint preventing clausal complements from taking a preposition. This constraint (let us call it *P+CP) is active in languages like Catalan or French (see

Forst 2006 for relevant data on French) and English, where clausal complements are not preceded by a preposition, but not in languages like Spanish, where complements take their required preposition regardless of the category of the complement (nominal or clausal).[24]

In languages with an active *P+CP, a verb selecting an oblique with a particular case feature (say genitive) will normally require this case feature to be overtly realized (by means of the preposition *de* or by means of the clitic *en*, which are alternative ways of realizing genitive case), but, if the realization of the oblique should cause a violation of *P+CP, an alternative expression is chosen that does not cause this violation, even though it fails to realize the case requirement. This can be done in an OT framework, although other ways of obtaining prepositionless oblique clauses are possible.

In this way, eliminating COMP from the inventory of GFs not only results in a simplification of the framework (it is preferable to have fewer theoretical constructs), but also in a simplification of the analysis (verbs that alternate between taking a PP complement and a plain clausal complement, such as *convèncer*, have only one subcategorization frame, with an OBL, rather than two, one with an OBL and one with a COMP) and it reduces the redundancy in the theory (the c-structure realization of COMP is predictably clausal, i.e., CP or IP, but not NP or PP, whereas in the framework without COMP, both OBL and OBJ can map onto either a nominal or a clausal category) and makes it possible to state generalizations that are obscured in the framework with COMP (e.g., the fact that the clitic realization that corresponds to a clausal complement is the one that corresponds to the object or oblique complement of the verb).

3.1.3 Mixed subject-object properties

It is generally assumed that the single core argument of unaccusative verbs alternates between subject and object.[25] It can be shown that this argument sometimes has objecthood properties and sometimes has subjecthood properties. A paradox arises when we observe that this argument can have both types of properties in the same structure.

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[24] Danish, according to Nigel Vincent (p.c.), is another language where the *P+CP constraint is not active: e.g. *det endte med at han blev fyret* 'it ended with that he was fired'.

[25] The Unaccusative Hypothesis – the idea that intransitive verbs are classified into two classes depending on whether their core argument has some objecthood properties or not – was originally proposed by Perlmutter (1978) within the framework of Relational Grammar and subsequently adapted to other frameworks. See Section 2.3.2 for the different behavior of unaccusative and unergative verbs with respect to auxiliary selection in Italian.

Evidence for assuming that the single core argument of unaccusative verbs can be expressed as an object is provided by the possibility of encoding this argument by means of the partitive clitic in those languages that have it, such as Catalan, French, and Italian. Since Perlmutter (1983), Rosen (1984), and Burzio (1986) for Italian (see also Alsina 1996b for Catalan), the claim is that this clitic must correspond to a direct object.[26] Example (39) shows that the unaccusative verb *sortir* 'go out' in Catalan allows its single core argument to be expressed by means of the partitive clitic, which, in this example, corresponds to the postverbal NP *un*. Given the claim just noted, this NP has to be a direct object.

(39) Catalan (Alsina & Yang 2018: 48)
Cada dia surten molts trens, però avui només n' ha sortit un.
every day leave.3PL many trains but today only EN has left one
'Every day many trains leave, but today only one has left.'

Additional evidence supporting the claim that the argument partially encoded by the partitive clitic is an object comes from past participle agreement. In Catalan, the past participle optionally agrees in gender and number with a third person object clitic, when co-occurring with the perfective auxiliary *haver* 'have'. The partitive clitic is one of the third person object clitics that can trigger past participle agreement, as in (40):

(40) Catalan (Fabra 1912: 160)
N' han arribats molts.
EN have.PL arrive.PTCP.M.PL many.M.PL
'Many have arrived.'

In addition, the possibility of expressing the single direct argument of an intransitive verb as a bare indefinite NP provides further evidence for the objecthood of this argument, given the observation that this type of expression is excluded for the subject of transitive verbs.

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[26] The claim that, among intransitive verbs, only unaccusatives allow the partitive clitic, though commonly accepted, has been questioned by various scholars, who have pointed out that unergative verbs also allow the partitive clitic corresponding to their single core argument, at least under certain circumstances, such as Lonzi (1986) and Saccon (1995) for Italian, Cortés & Gavarró (1997) and Alsina & Yang (2018) for Catalan. Regardless of the correctness of this claim, the shared assumption is that the partitive clitic in these languages corresponds to a DO, which implies that the single core argument of an intransitive verb can be encoded as an object.

Alongside the object encoding of the single direct argument in examples like (39)–(40), it is also possible for this argument to be expressed as the subject. The clearest evidence for this alternative encoding is the possibility of subject pro-drop. In a subject pro-drop language such as Catalan, a subject (and only a subject) can be null and be interpreted as having a definite referent, which indicates that, in (41), the missing argument, the logical subject of *sortir* 'leave', is its subject:

(41) Catalan (based on Alsina & Yang 2018: 50)
Avui Ø surten tard.
today leave.3PL late
'Today they are leaving late.'

If we should take verb agreement to be a subjecthood diagnostic in Catalan, we would have a problem in examples like (39)–(40). We find that the verb does not only agree with the subject, as is the case in (41), but also with the argument that is claimed to be an object. In (40), for example, the single core argument of *arribar* 'arrive' is expressed as the NP *molts* 'many', which has been argued to be an object, and yet this object agrees with the finite verb form *han*. But there is no need to assume that the agreement trigger is a subject. The verbal agreement facts of languages like Icelandic or Hindi indicate that the verb can agree with a grammatical function other than the subject, provided that it is in nominative case. And there is independent evidence that this is the case in Catalan as well. As shown in Alsina & Vigo (2014), in copular constructions with a predicative NP in Catalan, which are characterized by having two nominative phrases, the verb agrees with the nominative phrase that is higher in a person-number hierarchy where first and second person outrank third person and, among third persons, plural outranks singular (similar facts are found in Spanish and Italian). This indicates that what is necessary is for the agreement trigger to be a nominative expression.

Alsina & Yang (2018) propose an argument realization theory in which case is assigned to arguments independently of their GF and has the effect of constraining the GF assigned to an argument. According to their case assignment principles, nominative is assigned as a default to a core argument: a core argument that is not assigned dative or accusative case receives nominative. A constraint disallowing subjects with a case value other than nominative ensures that subjects in Catalan, and in the Romance languages in general, are nominative. Crucially, while all subjects are nominative, not all nominative arguments are subjects. The single core argument of an unaccusative verb is assigned nominative case and maps either onto the subject or the object.[27]

Thus, the paradox noted at the beginning of this subsection disappears. The single core argument of an unaccusative seems to have simultaneous subjecthood and objecthood properties: in examples like (39)–(40) it is encoded by the partitive clitic and triggers past participle agreement, which are properties of objects, and it triggers finite verb agreement, which is usually assumed to be a property of subjects. However, once we observe that finite verb agreement is triggered by the nominative argument, all we need to assume is that the single core argument of a verb is always nominative and alternates between the subject and the object functions. As a nominative object, it has the standard objecthood properties, shared with accusative objects, and triggers finite verb agreement, a property of nominative arguments.

3.2 Passive and impersonal constructions

In this subsection we deal with passive and impersonal constructions. In Section 3.2.1, we compare the participial passive (or passive with auxiliary ESSE 'be') and the reflexive passive. And in Section 3.2.2, we review the evidence for considering the reflexive passive and the reflexive impersonal as the same or different constructions.

3.2.1 Two passive constructions

All Romance languages have two passive constructions, which we will call the participial passive and the reflexive passive. (The reflexive impersonal construction will be discussed in Section 3.2.2.) The participial passive is characterized by having the main predicate in the past participial form,[28] by the agreement in gender and number of this participle with its subject, by the fact that this subject has the same thematic role as the accusative object of the corresponding active

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[27] Alsina & Yang (2018) assume that this nominative argument maps onto the subject, when it is definite, and onto the object, when it is indefinite. This follows from treating the Subject Condition as a constraint in an OT setting and ranking it below an Indefinite Subject Ban, which penalizes an indefinite subject, in subject pro-drop languages like Catalan. So, the single core argument is a subject in an example like (41), but is an object in examples like (39)–(40).

[28] The assumption that past participles (of transitive verbs) can be passive and that it is the participial morphology that signals that the construction is passive is made in Bresnan (1982: 9–10) for English and in Loporcaro et al. (2004) for Romance, among others. The syntactic structure in which the participle is used (e.g., whether the auxiliary is 'be' or 'have') constrains the choice of the active or passive reading of the participle.

form, and by the fact that the thematic role of the subject of the corresponding active form is either unexpressed or expressed by means of an oblique phrase (introduced by the preposition *da* in Italian, *par* in French, *por* in Spanish and Portuguese, *per* in Catalan, etc.). The passive participle can be used heading an adjunct clause, modifying either a clause or a noun, or as the main predicate of the clause along with a special auxiliary for passive clauses – the equivalent of *be* in the different languages (*ser*, *être*, *essere*, etc., although some languages have additional passive "auxiliaries," such as *venire* or *andare* in Italian), as in the Catalan examples in (42):

(42) Catalan

a. Examinada la situació pels experts, la solució
examine.PTCP.F.SG the.F.SG situation by.the experts the solution
arribarà aviat.
arrive.FUT.3SG soon
'Once the situation has been examined by the experts, the solution will arrive soon.'

b. La situació serà estudiada pels experts fins a
the.F.SG situation be.FUT.3SG study.PTCP.F.SG by.the experts until A
l' últim detall.
the last detail
'The situation will be studied by the experts up to the last detail.'

Participial passives are also known as periphrastic passives, as they require an auxiliary in order to function as the main predicate of a clause other than an adjunct clause; however, since they can occur without an auxiliary in adjunct clauses such as in (42a), the term "participial passive" seems more appropriate.

The reflexive passive (or "Middle se" to use Grimshaw's (1982) term) is characterized by the use of the reflexive clitic in the third person. The effects of this clitic on the mapping between arguments and GFs are very similar to those of the participial passive: the logical subject is suppressed, i.e., not expressed as a direct GF, and the direct object of the active form is the nominative GF, typically the subject. However, with the reflexive passive, the suppressed logical subject is generally not expressible as an oblique phrase. Morphologically, the reflexive passive is identical to the anaphoric and inherent uses of the reflexive reviewed in Section 2.2.3 and Section 2.3 and, potentially, gives rise to ambiguities with those uses of the reflexive. Two examples of reflexive passives in Catalan are given in (43), using verbs that, without the reflexive clitic, are transitive (i.e. take a direct, or accusative, object).

(43) Catalan

a. Aquesta obra s' estrenarà demà.
this play REFL premiere.FUT.3SG tomorrow
'This play will be premiered tomorrow.'

b. Es preparen moltes pizzes en aquest local.
REFL prepare.3PL many pizzas in this establishment
'Many pizzas are prepared in this establishment.'

The direct object of the non-reflexive form corresponds to the nominative GF in the reflexive passive. As a nominative GF, it shows agreement with the verb: singular in (43a) vs. plural in (43b). It can be the subject, and often is (see Section 3.1.3): as such, it can appear in clause-initial position without an agreeing clitic on the verb, as in (43a), can be omitted with a definite interpretation, as in (44a), and cannot be expressed by means of a definite clitic, as in (44b):[29]

(44) Catalan

a. S' estrenarà demà.
REFL premiere.FUT.3SG tomorrow
'It will be premiered tomorrow.'

b. * Se les preparen en aquest local.
REFL 3PL.F.ACC prepare.3PL in this establishment
'They are prepared in this establishment.'

In subject pro-drop languages, like Catalan, subjects can be omitted with a definite interpretation, accounting for (44a). And definite object clitics such as *les* can only correspond to objects, which explains (44b).

Whereas the anaphoric and inherent uses of the reflexive clitic are compatible with all person features (first, second, and third), the reflexive passive can only occur with the third person clitic. It is not possible to have a reflexive passive with a first or second person subject, as that would require a first or second person reflexive clitic. Compare a well-formed participial passive with a first person subject, (45a), with the corresponding ill-formed reflexive passive, (45b).

(45) Catalan

a. He estat vist passant per la plaça.
have.1SG been seen passing by the square
'I have been seen walking across the square.'

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[29] (44b) is grammatical with an anaphoric interpretation, irrelevant here: 'They prepare them for themselves in this establishment.'

b. * M' he vist passant per la plaça.
me have.1sg seen passing by the square
'I have been seen walking across the square.'

The two passive constructions are different morphologically, but share the definitional properties of a passive construction: the logical subject cannot be encoded as a direct GF and there is an internal argument encoded as a nominative GF, often the subject.

3.2.2 Reflexive passive and reflexive impersonal: one or two constructions?

The construction that we may call the impersonal reflexive, which is common at least in Spanish, Catalan, and Italian, like the reflexive passive also involves the reflexive clitic. It has a passive-like interpretation, as the argument that would be the subject without the reflexive clitic is unexpressed and interpreted as an arbitrary or unspecified human. It is found with intransitive predicates of both agentive and non-agentive types, as in (46). It also occurs with transitive verbs, in which case the internal argument should be analyzed as an accusative object because it does not agree with the verb and can be expressed by means of a definite object clitic, as in (47).

(46) Catalan

a. Demà no es treballa.
tomorrow not refl work.3sg.
'There is no work tomorrow.'

b. No se surt fins que ho digui jo.
not refl go.out.3sg until that ho say.sbjv.1sg I
'No one goes out until I say so.'

c. S' ha de ser tossut per fer això.
refl have.3sg of be.inf stubborn to do.inf this
'You've got to be stubborn to do this.'

(47) Catalan

a. S' ha seguit els sospitosos fins al seu pis.
refl have.3sg followed the suspects until a.the their flat
'The suspects have been followed up to their flat.'

b. Se' ls ha seguit fins al seu pis.
refl 3pl.m.acc have.3sg followed until a.the their flat
'They have been followed up to their flat.'

There are clear similarities between the reflexive passive and the impersonal reflexive constructions that make it desirable to assume that the reflexive clitic performs the same function in both cases. The two constructions share the fact that the logical subject is not expressed and is interpreted as an arbitrary or unspecified human and that they can only be used with the third person form of the reflexive clitic. For this reason it is not possible to distinguish them semantically. This has led some researchers, such as Cardona (2015), to claim that both constructions should be treated as a passive construction.[30]

However, no attempt to derive the two constructions from a single operation performed by the reflexive clitic has successfully explained all the facts of both constructions. The main objections to such a reductionist approach, which would assume that the reflexive clitic is the morphological exponent of a passive operation in both constructions, have been pointed out in Yang (2019). The first objection concerns the conditions on accusative case assignment. Accusative case can only be assigned in an argument structure that contains an external argument expressed as a direct function. This explains the observation that passive sentences in Romance, including reflexive passive sentences, do not have accusative objects: for this reason the reflexive passive (44b) is ungrammatical, as it has an object clitic that corresponds to an accusative object. But if the impersonal reflexive were also a passive form, we would not be able to explain the grammaticality of (47b), which does contain a clitic corresponding to an accusative object. As a passive form, it would not have a direct function mapped onto the external argument and accusative case should not be assigned.

The second objection has to do with the observation that the impersonal *se* can occur in constructions in which one cannot argue that a logical subject is being suppressed, either because the argument that is interpreted as a generic or arbitrary human is not a thematic argument of the predicate or because it is not the logical subject. This is arguably the situation with copular sentences, such as (46c), on the assumption that the subject of the copula is not an argument of the copula, but of its predicative complement. And it is definitely the case when impersonal *se* is attached to a participial passive sentence, as in (48). Although such examples are rare and hard to contextualize, they are not ungrammatical.

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[30] See Bentley (2006) for an attempt to capture both the differences and the commonalities between the anaphoric, passive and impersonal uses of the reflexive clitic in Italian, within the framework of Role and Reference Grammar.

(48) Catalan (Institut d'Estudis Catalans 2016: 895)
Passava això quan s' era expulsat del partit.
happened this when REFL was expelled from.the party
'This is what happened when one was expelled from the party.'

The reflexive clitic cannot be the exponent of the suppression of the logical subject of the verb in participial form, because this argument is already suppressed by the participial morphology. If anything is suppressed by the reflexive morphology, it is the subject of the copula, a non-thematic GF of this verb that controls the subject of the participial verb, which is not its logical subject.

Given these two objections to the unified analysis of the reflexive passive and the reflexive impersonal, it seems necessary to assume that they are two different constructions, as concluded in Yang (2019): the reflexive passive is a passive construction, in which the logical subject is suppressed, whereas the reflexive impersonal licenses a null, 3rd person singular subject, with an arbitrary human interpretation. This is also the proposal in Kelling (2006).

The reflexive passive and the reflexive impersonal, although different constructions, are in competition. According to Aranovich (2009), with dyadic predicates, in Spanish, the choice between the two constructions is determined by the animacy features of the internal argument. If this argument is animate, the reflexive impersonal construction is employed, but if it is inanimate the reflexive passive is preferred:[31]

(49) Spanish (Aranovich 2009: 623–624)

a. Ayer se atrapó a los ladrones.
yesterday REFL caught.3SG A the thieves
'The thieves were caught yesterday.'

b. Ayer se atraparon las pelotas.
yesterday REFL caught.3PL the balls
'Yesterday, the balls were caught.'

(50) Spanish (Aranovich 2009: 623–624)

a. * Ayer se atraparon los ladrones.
yesterday REFL caught.3PL the thieves
'The thieves were caught yesterday.'

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[31] While there might be a strong preference for the choice between the two constructions to depend on the animacy of the internal argument, sentences such as (50) are generally not considered to be ungrammatical.

b. * Ayer se atrapó las pelotas.
yesterday REFL caught.3SG the balls
'Yesterday, the balls were caught.'

Aranovich (2009) develops an analysis using Optimality Theory (OT) and Lexical Mapping Theory (LMT). In this analysis, the alternation between the reflexive impersonal and the reflexive passive is the result of a conflict between two constraints, one favoring the assignment of the subject function to the reflexive clitic and another one penalizing inanimate objects. The difference between the two constructions is reflected in the GF assigned to the reflexive clitic, which is a subject in the reflexive impersonal and an oblique in the reflexive passive. The reflexive passive avoids the marked configuration of an inanimate object by allowing the inanimate internal argument to be realized as the subject. See Aranovich (2009) for the details of the analysis.

4 Complex predicates

Complex predicates have been the object of investigation within LFG in a variety of languages since work such as Mohanan (1990, 1994), Matsumoto (1992), Alsina (1993, 1996b), and Butt (1993, 1995). For present purposes we can follow Butt's (1995: 2) definition and take a complex predicate to be a construction whose argument structure is complex, in the sense that two or more semantic heads contribute to it, and whose GF structure is that of a simple predicate. The Romance languages have made a significant contribution to this investigation, as they have several constructions that are analyzed as complex predicates, particularly, the causative construction and restructuring constructions. In Section 4.1 we examine the facts of these constructions and, in Section 4.2, we review some of the analyses that have been proposed for them.

4.1 The causative and restructuring constructions

4.1.1 The causative construction

In contrast with languages where causative verb forms are a single word consisting of a stem and a causative affix (as in Chicheŵa and many Bantu languages), causative constructions in the Romance languages comprise two verb forms (leaving aside the fact that they can also be accompanied by auxiliaries):

the causative verb and an infinitive complement.[32] There are two causative verbs, which behave alike in most respects syntactically: *fare* 'make' and *lasciare* 'let' in Italian, and the corresponding pairs in French (*faire* and *laisser*), Spanish (*hacer* and *dejar*) or Catalan (*fer* and *deixar*);[33] see examples (51)–(54).

What distinguishes the causative construction in Romance from other constructions in which a verb takes an infinitival complement is what we might call the monoclausality of the causative construction, that is, the fact that the causative verb and the infinitive behave as if they were part of one and the same clause from the point of view of the f-structure. As shown in Alsina (1997), the causative verb and the infinitive are a unit at the level of f-structure, very much like causative verbs in Chicheŵa, but are clearly two different units (i.e., two separate verbs) at the level of c-structure, unlike causative verb forms in Chicheŵa, which are a unit at both levels.

Following is some of the evidence in favor of the monoclausality of the causative construction:

4.1.1.1 The case alternation on the causee

(I use the term causee here to refer to the logical subject of the infinitive, or embedded predicate, in the causative construction.) As shown in Section 2.3.1, example (22), repeated here as (51), the case of the causee depends on the transitivity of the embedded predicate: it is dative if the embedded predicate has an accusative object, and it is accusative otherwise.

(51) French (Grimshaw 1990: 153)
a. Il fera boire un peu de vin *(à) son enfant.
he make.FUT.3SG drink.INF a bit of wine A his child
'He will make his child drink a little wine.'

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[32] The Romance languages also include many verbs that are causative in meaning but cannot be considered to be complex predicates in the sense intended here as they are not decomposable into a base predicate and a causative predicate (whether bound morpheme or independent word). This is the case of *romper* 'break' or *abrir* 'open' in Spanish, or *chiudere* 'close' or *raffreddare* 'cool' in Italian. Some of these verbs, including the examples given, undergo the causative-anticausative alternation, which is signaled morphologically by means of the reflexive clitic on the anticausative member of the alternation (e.g. *romperse* or *abrirse* in Spanish and *chiudersi* or *raffreddarsi* in Italian). It is, therefore, an *anticausative* alternation, in Haspelmath's (1993) terms (see also Cennamo 2016: 971), in contrast with the Bantu pattern, where the alternation is causative.

[33] Some of these verbs also admit a biclausal raising-to-object construction, in which both the causative verb and the dependent infinitive head their own clause and the object of the causative verb functionally controls the subject of the infinitival clause. This is the case of a French example such as *Elle a laissé Jean laver la voiture* 'She let John wash the car.' Since these constructions are not complex predicates, they will not be discussed here.

b. Il fera partir {les/*aux} enfants.
he make.FUT.3SG leave.INF the/*A.the children
'He will make the children leave.'

This case alternation would be unexpected if the infinitive were the f-structure head of an embedded clause. By viewing the two verbs in the construction as forming a unit, a PRED, at f-structure, this case alternation can be made to follow from a theory of argument realization in which dative case is assigned only as a marked option, that is, to the more prominent of two internal arguments (as proposed in Alsina 1996b and Alsina & Yang 2018).

4.1.1.2 Clitic climbing

Clitics that correspond to argument roles of the embedded predicate usually appear attached to the causative verb (or to a higher auxiliary or restructuring verb), as in (52):

(52) Catalan

a. Això m' hi ha fet pensar.
that me HI has made think.INF
'That made me think about it.'

b. Aquests documents, els faré enquadernar.
these documents 3PL.M.ACC I.will.make bind.INF
'These documents, I will have them bound.'

The clitic *hi* in (52a) corresponds to the oblique complement of *pensar* 'think' and yet appears attached to the auxiliary of the causative verb; likewise in (52b), where the clitic *els* corresponds to the accusative object of *enquadernar* 'bind'. This property is not found with verbs that take an infinitival clausal complement, such as *semblar* 'seem', *caldre* 'be necessary', *convenir* 'be convenient', *insistir* 'insist, etc., in which case the clitics dependent on the infinitive appear attached to the infinitive.

4.1.1.3 Reflexivization

The reflexive clitic can encode the binding of the logical subject of the causative predicate and an argument of the embedded predicate, as in (53a).

4.1.1.4 Reflexive passive

A reflexive passive of the causative predicate, encoded by the reflexive clitic, can have an argument of the embedded predicate as its nominative argument, agreeing with the causative verb (or a higher auxiliary or restructuring verb), as in (53b).

(53) Catalan

a. S' ha fet criticar durament.
REFL has made criticize.INF hard
'She has got herself criticized severely.'

b. S' han fet arreglar les façanes del carrer principal.
REFL have.3PL made fix.INF the façades of.the street main
'The façades of the main street have been made to be repaired.'

4.1.1.5 Passivization

Some Romance languages allow participial passivization of the causative construction, in which an argument of the embedded predicate is the subject of the passivized causative structure. This possibility is illustrated for Italian in (54a), from Frank (1996), whereas French is a language that does not allow it.

4.1.1.6 Past participle agreement

Among those Romance languages in which the past participle of compound tenses agrees with the accusative object expressed as a clitic (or, depending on the language, in other cases as well), Italian has this phenomenon in causative constructions, as in (54b), although French does not.

(54) Italian

a. Questo libro è stato fatto leggere a Mario da Giovanni.
this book is been made read.INF A Mario by Giovanni
'This book has been made to be read by Mario by Giovanni.'

b. Le tavole, le ho fatte riparare a Gianni.
the.F.PL table.F.PL 3PL.F.ACC have.1SG make.PTCP.F.PL repair.INF A Gianni
'The tables, I have made Gianni repair them.'

Other phenomena that support the monoclausal treatment of the causative construction include *tough* movement, which in Romance is a clause-bound phenomenon: as it can affect the object of the embedded predicate in a causative construction, it shows that the causative predicate and the embedded predicate constitute a single complex predicate. Although the facts are quite compelling in this respect, there are some attempts to explain them adopting a biclausal approach, as in Yates (2002).

4.1.2 The restructuring construction

The restructuring construction, present in many of the Romance languages, but absent in modern French, is similar to the causative construction in that it also involves two verbs (not counting auxiliaries) that form a complex predicate and behave as if they belonged to the same clause, but differs from it in not increasing the valence of the embedded predicate. The list of restructuring verbs varies somewhat from language to language, and even from one speaker to another, but it typically includes verbs such as (using Catalan for the examples) *voler* 'want', *poder* 'can, be able', *saber* 'know', *venir a* 'come to', *anar a* 'go to', *tornar* 'do again', *començar a* 'begin', *acabar de* 'finish', etc. The construction was first described by Aissen & Perlmutter (1976) and Rizzi (1976),[34] who proposed an optional process of clause union or restructuring, respectively, in order to explain that a restructuring verb, such as those just mentioned, and a dependent verb can behave as if they were a single verb from the point of view of their GFs.

As with the causative construction, one of its salient features is the possibility of clitic climbing. Reflexivization and the reflexive passive are also possible with the restructuring construction. Some verbs allow participial passive and languages that have past participle agreement with the object in compound tenses also exhibit this phenomenon in the restructuring construction. In languages that have auxiliary selection, like Italian, the choice of auxiliary is determined by the embedded verb. To illustrate just some of these phenomena in Italian, *dovere* 'have to', as a verb taking an infinitival phrase, allows clitic climbing, as the position of the clitic *gli* illustrates in (55), and also allows, but does not require, the choice of auxiliary to be determined by the infinitive, as shown in (56):

(55) Italian (Rizzi 1982: 4)

a. Gianni ha dovuto parlargli personalmente.
Gianni has had.to speak.3SG.M.DAT personally

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[34] Although these works are better known through later publications, specifically Aissen & Perlmutter (1983) and Rizzi (1982), the fact that the first version of these works has the same date of publication suggests that they were developed independently of each other.

b. Gianni gli ha dovuto parlare personalmente.
Gianni 3sg.m.dat has had.to speak personally
'Gianni has had to speak with him personally.'

(56) Italian (Rizzi 1982: 19)
Piero ha / è dovuto venire con noi.
Piero has / is had.to come with us
'Piero has had to come with us.'

Interestingly, when clitic climbing takes place from an infinitive such as *venire* 'come', which selects *essere*, the option of using the *avere* auxiliary disappears, as shown in (57):

(57) Italian (Rizzi 1982: 21)
a. Maria c' è dovuta venire molte volte.
Maria ci is had.to.f.sg come many times
b. *? Maria ci ha dovuto venire molte volte.
Maria ci has had.to come many times
'Maria has had to come there many times.'

Restructuring is optional, accounting for the options in (55)–(56). When restructuring occurs, clitic climbing is required and auxiliary choice is determined by the dependent infinitive, which accounts for the contrast in (57).

4.2 Analyses of the Romance complex predicates

Alsina (1996b), adapting Alsina's (1992) proposal for the causative predicate in Chicheŵa, assumes that the causative predicate in Romance has a three-place argument structure, in which there is a causer, an affected (or acted-upon) argument, and a caused event. In addition, the affected argument is fused with an argument of the caused event, so that there is a GF that corresponds to two argument roles: the affected argument of the causative predicate and another role of the caused event. The caused event position in the causative argument structure is filled by the predicate of the infinitive in the causative construction.

In this way, the causative complex predicate is formed in the syntax in Romance, whereas it is formed in the lexicon in Chicheŵa. As argued in Alsina (1997), the causative complex predicate is the same in the two languages as far as the argument structure is concerned, but they differ in that it corresponds to a single word in Chicheŵa (containing a verb stem and a causative suffix), but it corresponds to two words in Romance (the causative verb and the infinitive). If the lexicon is the linguistic component in which words are formed, as well as stored, and the syntax operates with fully formed words, the difference between the two languages concerning causative predicates resides in the component in which this complex predicate is formed: the lexicon in Chichewa̓, the syntax in Romance. Given that this proposal implies some departure from classical LFG assumptions (such as the idea that the list of GFs that a predicate requires is fixed in the lexicon and cannot be altered in the syntax), there are alternative proposals that assume that the causative complex predicate is formed in the lexicon, as in Frank (1996), in spite of the fact that it corresponds to two distinct words in the syntax.

The treatment of causatives in Alsina (1996b) can be adapted to handle restructuring constructions. The only difference is that a restructuring verb either takes an event argument as its sole argument, as would be the case of *dovere*, or takes an additional argument role that is fused with the logical subject of the event argument, as would be the case of *volere* 'want' or *venire* 'come'. In either case, the resulting restructuring construction has no more expressed arguments than the base predicate, the infinitive. When restructuring takes place, the auxiliary selection properties of the construction are determined by the base predicate and the highest verb in the sequence of restructured verbs, including auxiliaries, is the one to which clitics are attached.

The idea that predicate formation may take place in the syntax, as opposed to the lexicon, has been met with some resistance by some LFG practitioners. Yet, the alternative, namely, that complex predicate formation with restructuring and causative verbs takes place in the lexicon, is hard to maintain given that the sequence of such verbs is potentially unlimited. Following are two examples with a long sequence of restructuring and causative verbs in Catalan:

(58) Catalan

a. La va haver de tornar a començar a escriure.
3sg.f.acc past.3sg have.inf to repeat.inf to begin.inf to write.inf
'She had to start writing it again.'

b. L' hi he volgut fer acabar de recitar.
3sg.m.acc 3.dat have.1sg want.ptcp make.inf finish.inf of recite.inf
'I wanted to make him finish reciting it.'

In both examples the clitics (*la* in (58a) and *l'hi* in (58b)) are thematically related to the base predicate, but appear attached to the matrix verb (the past tense auxiliary *va* in (58a) and the perfective auxiliary *he* in (58b)), indicating that there is complex predicate formation involving all the verbs from the auxiliary to the base predicate.

An issue that Alsina (1996b, 1997) does not address is how the light verb (the causative, restructuring, or auxiliary verb) in a complex predicate imposes form requirements on the dependent verb. Some verbs, such as the causative verbs and restructuring verbs like *poder* 'can' and *voler* 'want', require a prepositionless infinitive, as seen in (58b) and preceding examples. Other verbs require a specific preposition before the infinitive: *haver* in (58a) and *acabar* in (58b) require the preposition *de* before the infinitive; *tornar* and *començar* in (58a) require the preposition *a* before the infinitive.

The traditional LFG way to capture these dependencies is through the f-structure. However, if the f-structure is "flat" so that there is no feature structure corresponding to the dependent verb that is distinct from that of the embedding verb, this mechanism is no longer available. Andrews & Manning (1999) notice this problem and propose a way to capture the monoclausality of complex predicates, while retaining an embedding relation between the light verb and its dependent verb. The leading idea in Andrews & Manning (1999) is that the features traditionally assumed to be part of f-structure are grouped into three classes: ρ: grammatical relations (SUBJ, OBJ, …); α: argument structure features such as PRED and others; and μ: morphosyntactic features (GEND, NUM, TENSE, etc.). In addition, every node in the c-structure specifies which of these feature classes is shared with its mother node. In this way, it is possible to achieve a flat f-structure as far as GFs are concerned by having the two verbs in the complex predicate share the ρ class with the mother, but having only the light verb share its α and μ features with the mother, whereas the dependent verb would contribute its α and μ features to an ARG attribute. ARG is not a grammatical relation, but one of the features on the α-projection. Having this ARG feature allows the light verb to specify form features on its dependent verb (whether it is an infinitive or a gerund, what preposition it requires, if any, etc.). The embedding at the α-projection allows Andrews & Manning (1999) to capture the fact that the order of the light verbs is reflected in the meaning of the complex predicate, as in the following Catalan examples:

(59) Catalan (Alsina 1997)

a.

Li	acabo	de	fer	llegir	la	carta.
3SG.DAT	I.finish	of	make.INF	read.INF	the	letter

'I finish making him read the letter.' or 'I just made him read the letter.'

b. Li faig acabar de llegir la carta.
3sg.dat I.make finish.inf of read.inf the letter
'I make him finish reading the letter.'

This proposal is not very different from the proposal in Butt et al. (1996), which is designed to account for structures with auxiliaries, but can easily be applied to the analysis of complex predicates. Butt et al. (1996) propose to split the traditional f-structure into two structures, or projections: the grammatical features of verb forms (having to do with whether the form is an infinitive, a gerund, etc.) are removed from the f-structure and placed in the m-structure, which allows the f-structure of an auxiliated structure, and of complex predicates, to be "flat", i.e., not containing an embedding relation between the auxiliary or restructuring verb and its dependent verb. The dependent verbs in auxiliated structures, and by extension in complex predicates, provide their form features to a dep attribute. In this way, the auxiliary, or the light, verb can impose form requirements on their dep (the dependent verb) achieving a similar result to that achieved by Andrews & Manning (1999). More recent LFG developments in the analysis of complex predicates include Andrews (2007), Homola & Coler (2013), and Lowe (2016), which shift the burden of explanation onto the semantics.

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Chapter 33

LFG and Scandinavian languages

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This chapter gives an overview of some of the LFG literature on the Scandinavian languages: Danish, Swedish, Norwegian, Icelandic and Faroese. LFG has been used to investigate these languages ever since the framework was launched in the eighties. Important work has been done by researchers both inside and outside Scandinavia.

1 Introduction to the Scandinavian languages

The North Germanic languages are referred to in English as the Scandinavian languages. The modern languages are usually divided into Mainland Scandinavian: Danish, Swedish[1] and Norwegian, and Insular Scandinavian: Icelandic and Faroese. The literature on Faroese is limited, and Icelandic will usually have to represent Insular Scandinavian in this chapter.

In Danish, Swedish and Norwegian, the term *skandinavisk* is often used in a different way, to denote only Danish, Swedish and Norwegian. The English use will be applied in this chapter.

Danish, Swedish and Norwegian are by and large mutually intelligible. When Danes, Swedes and Norwegians talk to each other, they can come a long way using their own language. Danish, Swedish and Norwegian are grammatically similar in many respects, but there are also differences that can be more or less subtle.

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[1] The variety spoken in Älvdalen in Sweden, known as *älvdalska* in Swedish, and Elfdalian or Övdalian in English, is often considered a separate language (Garbacz 2009). It has hardly been mentioned in the LFG literature, and it is not discussed in this chapter.

Helge Lødrup. 2023. LFG and Scandinavian languages. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1597–1650. Berlin: Language Science Press.
DOI: 10.5281/zenodo.10186018

Mainland Scandinavian and Insular Scandinavian are not mutually intelligible. There are a number of grammatical differences. For example, morphological case on nouns and agreement on finite verbs can be found in Insular Scandinavian, but not in Mainland Scandinavian (except for relics in archaic dialects).

Older forms of the Scandinavian languages will be mentioned occasionally. In medieval times, the most important dividing line was between Eastern Scandinavian: Old Danish and Old Swedish, and Western Scandinavian: Old Norwegian and Old Icelandic. The latter two are sometimes referred to together as Old Norse.

There is an interesting LFG literature on various topics in the Scandinavian languages. For more general overviews of their syntax (independently of LFG), the following can be recommended: Faarlund (2004) on Old Norse, Thráinsson et al. (2004) on Faroese, Thráinsson (2007) on Icelandic, and Faarlund (2019) on Mainland Scandinavian.

2 C-structure phenomena

2.1 Basic sentence structure: V2

The architecture of LFG gives an excellent point of departure for studying c-structure. With parallel levels of representation, insights about c-structure can be obtained without necessarily involving the analysis of phenomena that could be argued to belong to other levels.

The Scandinavian languages have a relatively rigid word order, with the well known V2 requirement: the finite (auxiliary or main) verb must be in second position in main clauses.[2] This is a classical topic within various approaches to syntax.

Examples of V2 are (1) and (2).[3] Example (1) has the subject in the initial position, while example (2) has an adverb in the initial position, and the subject following the finite verb.

(1) Swedish (Sells 2001: 34)
Anna läste bok-en.
Anna read book-DEF
‘Anna read the book.’

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[2] The concept of finiteness is discussed and refined in Sells (2007) and Heinat (2012).

[3] The source of example sentences is indicated when available. Examples that do not indicate a source have been provided by the author.

(2) Swedish (Sells 2001: 34, modified)
Igår läste hon bok-en.
Yesterday read she book-DEF
‘Yesterday she read the book.’

In Mainland Scandinavian, there is no V2 requirement in subordinate clauses. An example is (3).

(3) Swedish
Om Anna inte läser bok-en …
if Anna not reads book-DEF
‘If Anna doesn’t read the book …’

Icelandic usually has V2 in subordinate clauses (Thráinsson 2007: 58–64), while Faroese subordinate clauses are in the process of changing from V2 to non-V2 (Heycock et al. 2012).

V2 was an important motivation for the field grammar that Paul Diderichsen proposed for Danish (Diderichsen 1946). His approach was later taken up by Ahrenberg (1992), who proposed an LFG-like system in which the c-structure is given in the format of a field grammar.

Functional categories were used in LFG from the nineties. They were inspired by work in the Principles and Parameters framework, but the architecture of LFG made a more restricted use possible. A common Principles and Parameters assumption was that all main clauses in Scandinavian have a CP - IP - VP structure, with C as the designated V2 position.

Sells (2001) is an important work on Swedish c-structure in LFG.[4] The account proposed by Sells is based on the general principles that a subject is typically in SpecIP, and a constituent associated with a discourse function typically in SpecCP. He assumes that subject initial sentences are IPs (when the subject does not have a discourse function), while other sentences are CPs. This means that there is no designated V2 position – the finite verb is either in I or in C in main clauses.

This analysis might seem to allow sentences with more than one main verb. This is not the case, however. CP and IP are functional projections, which correspond to the same f-structure as VP, and this f-structure can only have one PRED.

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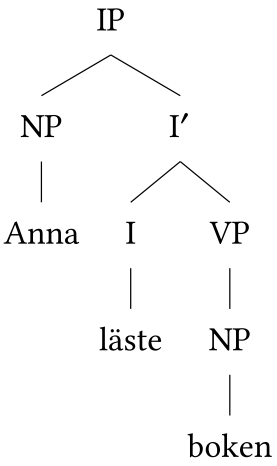
[4] Sells (2001) includes a component with restrictions stated in Optimality Theory, like some of the work that proposes alternatives to his analysis (Börjars et al. 2003, Andréasson 2007, 2010). For simplicity, these aspects of the analyses are put aside here.

The c-structure trees for examples (1)–(2) are from Sells (2001: 34). Note that the tree for (1) is an IP with the finite verb in I, while the tree for (2) is a CP with the finite verb in C.

(4)



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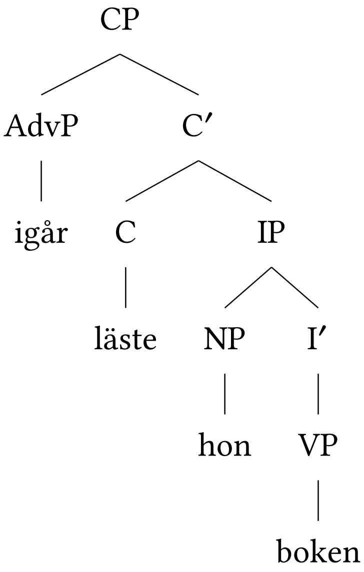

2.2 Object shift

Another c-structure phenomenon that has often been discussed is object shift in Mainland Scandinavian. Examples are (6)–(7).

(6) Swedish (Sells 2001: 54)
Anna såg den inte.
Anna saw it not
‘Anna didn’t see it.’

(7) Swedish (Sells 2001: 54)
Såg Anna den inte?
saw Anna it not
‘Didn’t Anna see it?’

Object shift means that a weak pronominal object is not realized in the regular object position within the VP, but in a position closer to a finite main verb.[5] It can then precede a sentence adverb, as in (6)–(7). Object shift requires that the main verb is not in the VP, but in a higher functional projection. This is often called “Holmberg’s generalization” (Holmberg 1999). When the non-finite main verb is in VP, as in (8), then object shift cannot apply.

(8) Swedish
Anna har inte sett den.
Anna has not seen it
‘Anna has not seen it.’

Sells (2001: 54–56) assumes that a weak pronoun does not project in syntax. He assumes that a shifted pronoun adjoins to the I node. The adjunction is syntactic, and not morphological or phonological incorporation.

Below are the c-structure trees for (6)–(7), from Sells (2001: 62). The finite verb is in I, as in (9), or in the higher C position, as in (10). When the verb is in C, the pronoun is still under I, following the post-verbal subject.[6] Negation and other sentence adverbs are under I′.[7]

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[5] Icelandic also allows object shift with full nominal phrases (Thráinsson 2007: 31–37). This will not be discussed further here.

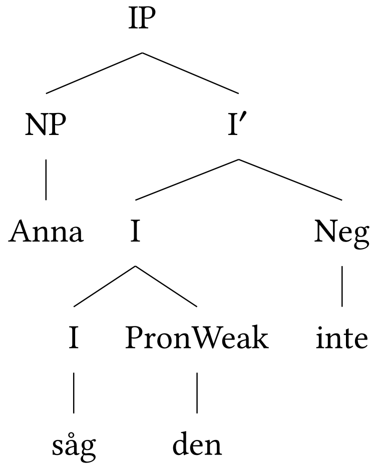
[6] The reader might find it strange that the pronoun is the only element under I when the verb is in C, as in (10). This follows from the adjunction rule X → X Y, combined with the optionality of phrase structure nodes and an economy principle which requires “tree pruning”

[7] Negation is always expressed outside the VP. An interesting effect of this is that an argument with a negative quantifier cannot be inside VP, cf. the contrast (i)–(ii). This is discussed in Sells (2000) and Sells (2001: 93–101).

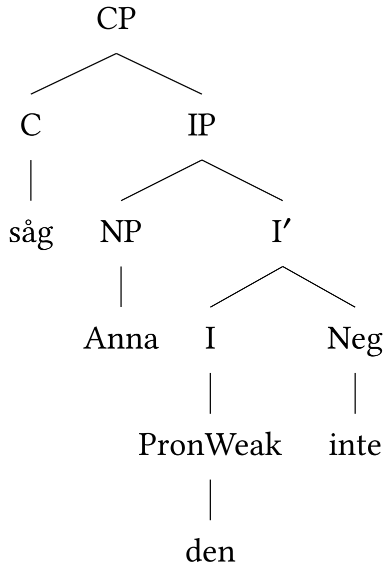
(i) Swedish (Sells 2001: 93)
Jag såg ingen.
I saw nobody
‘I saw nobody.’

(ii) Swedish (Sells 2001: 93)
*Jag har sett ingen.
I have seen nobody
‘I have seen nobody.’ [intended]

(9)



(10)

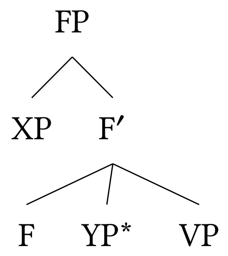


Restrictions on object shift have been discussed several times, see e.g. Andréasson (2008, 2010), Ørsnes (2013), and Engdahl & Zaenen (2020).

2.3 How much hierarchy?

Some researchers have argued that the c-structure proposed by Sells is more hierarchical than necessary, and inconsistent with the principle of Economy of expression (see Bresnan et al. 2016: 90 for this principle). They propose a basic sentence structure with one functional category above VP. The head position of this functional category is then the V2 position. The category is called IP in Dyvik (2000) (on Norwegian), and FP – Finiteness Phrase – in Börjars et al. (2003) and Andréasson (2007, 2010) (on Swedish). The structure they propose is as in (11).

(11)



F is the position of the finite verb. An initial subject has the same position as an initial non-subject, namely SpecFP. In the middle field between F and the VP there can be a subject (when not in SpecFP), one or more sentence adverbs, and pronominal objects.

One motivation for this kind of structure is the relative flexibility of the constituent order in the middle field. Sentence adverbs can precede or follow the subject, conditioned by scope and information structure. Examples are (12), with the subject scoping over the sentence adverb, and (13), with the sentence adverb scoping over the subject.

(12) Swedish (Börjars et al. 2003: 54)
Då skulle alla grod-or-na antagligen dö.
then should all frog-PL-DEF probably die
'All the frogs should probably die then.'

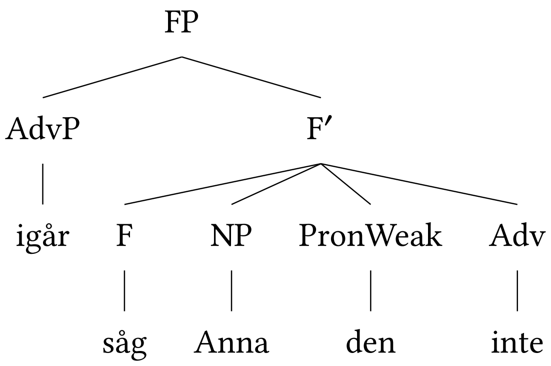
(13) Swedish (Börjars et al. 2003: 54)
Då skulle antagligen alla grod-or-na dö.
then should probably all frog-PL-DEF die
'All the frogs should probably die then.'

Example (12), with the subject preceding the adverb, requires that frogs have been mentioned in the discourse. There is no such requirement in example (13), with the adverb preceding the subject.

With the FP analysis, a sentence with object shift such as (14) would have the c-structure tree (15).

(14) Swedish (Sells 2001: 54)
Igår såg Anna den inte.
yesterday saw Anna it not
'Yesterday, Anna didn't see it.'

(15)



2.4 Is Icelandic different?

While the clausal hierarchy of Mainland Scandinavian has been discussed within LFG, there has been no parallel discussion of Insular Scandinavian. All newer LFG work on Icelandic seems to assume a c-structure that has one functional category above VP, e.g. Sells (2001: 190–92, 2003, 2005), Booth et al. (2017), Booth (2018). This analysis is also given for Old Norse in Kristoffersen (1996: 69). Icelandic then has the same basic structure that is assumed for Mainland Scandinavian in the work discussed in Section 2.3 above (the name of the functional projection aside).

Only Sells (2001: 190–92, 2003, 2005) assumes that Icelandic is different from Mainland Scandinavian concerning its basic sentence structure. His motivation seems to be that Icelandic differs from Mainland Scandinavian in being a "symmetric" V2 language with embedded V2. Sells here follows ideas from Diesing (1990), which cannot be discussed further in this context.

2.5 Expletives

The Scandinavian languages have several constructions that involve expletives. However, Icelandic expletives are very different from those of Mainland Scandinavian. Expletives in Mainland Scandinavian have the c-structure properties of subjects, preceding or following the finite verb in main clauses. Examples (16)–(17) show expletives preceding and following the finite verb.

(16) Norwegian
Det ble danset til midnatt.
EXPL became danced to midnight
'People danced until midnight.'

(17) Norwegian
Ble det danset til midnatt?
became EXPL danced to midnight
'Did people dance until midnight?'

Some Mainland Scandinavian varieties distinguish between expletive *det* 'it' and *der* 'there' in a way comparable to expletive *it* and *there* in English (Larsson 2014). This is the case in Danish and in some dialects of Swedish and Norwegian. Other varieties use only *det* 'it'.

Icelandic also has one expletive only, namely *það* 'it' (see Booth 2018 for an LFG account of Icelandic expletives). This expletive can occur in the first position of the clause, but it cannot follow the finite verb. Examples are (18)–(19).

(18) Icelandic (Thráinsson 2007: 310)
það var dansað til miðnættis.
EXPL was danced to midnight
'People danced until midnight.'

(19) Icelandic (Thráinsson 2007: 312)
Var (*það) dansað til miðnættis?
was (*EXPL) danced to midnight
'Did people dance until midnight?'

The position following the finite verb should be considered the basic subject position in Scandinavian main clauses, in the sense that only this position is reserved for subjects. The fact that the Icelandic expletive cannot occur there motivates the common view – inside and outside LFG – that it is not a subject.

Sells (2005) gives a different analysis in which the expletive is treated as a subject. He shows that the Icelandic expletive is not limited to the first position of a main clause. It can occur in the first position in an embedded clause. Some speakers also allow it as a raised subject in the subject-to-object raising construction, as in (20).

(20) Icelandic (Thráinsson 1979: 481–2)
Jón telur (það) vera mýs í baðker-inu.
Jón believes EXPL be mice in bathtub-DEF
'Jón believes there to be mice in the bathtub.'

In Sells' analysis, the expletive is a subject without a PRED. There can be another subject in the sentence, as in (21).

(21) Icelandic (Thráinsson 2007: 327)
Það höfðu einhverjir stúdentar stolið smjör-inu.
EXPL had some students stolen butter-DEF
'Some students had stolen the butter.'

Both the expletive and the logical subject then map to subject in f-structure, where the expletive is only reflected by a feature such as [EXPL +] (see also Section 3.4).

2.6 Verbal particles

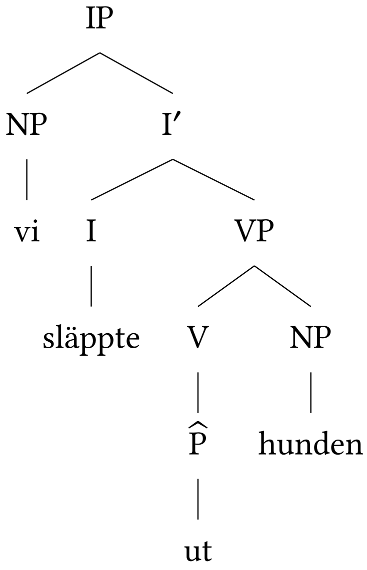
The Scandinavian languages differ as to the placement of verbal particles (Lundquist 2014d). Particles precede the object in Swedish, while they follow the object in Danish. Norwegian and Icelandic allow both word orders. Swedish and Danish examples are (22) and (23).

(22) Swedish (Toivonen 2003: 160)
Vi släppte ut hund-en.
we let out dog-DEF
'We let the dog out.'

(23) Danish (Toivonen 2003: 160)
Vi slap hund-en ud.
we let dog-DEF out
'We let the dog out.'

Toivonen (2003) discusses Swedish verbal particles. They precede the object, as mentioned. To be more exact, they follow the verb, and precede all other VP-internal constituents. Toivonen argues that these particles are non-projecting words in c-structure. They are adjoined to V, which explains the word order. The c-structure for (22) is then as in (24), where the "hat" on P means that it is non-projecting (Toivonen 2003: 21–22). Note that the finite verb is in I in (24).

(24)



It was mentioned above that the other Scandinavian languages are different with respect to the position of the particle. Toivonen proposes that Danish differs from Swedish in that words such as ‘out’ have a different status in Danish. They are prepositions that project a PP, and PPs generally follow objects.

Norwegian and Icelandic would be more difficult to account for within Toivonen’s proposal, since they allow particles to either precede or follow the object. The Norwegian situation is analysed in Dyvik et al. (2019). They consider particles a c-structure category, and particles can precede or follow the object. Particle verbs have lexical entries in which the verb and the particle are represented as one PRED. For example, the particle verb *skrive opp* ‘write up’ has the PRED (25).

(25) PRED ‘skrive*opp ⟨(↑SUBJ) (↑OBJ)⟩’

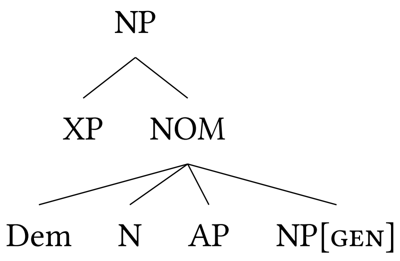
The presence of the relevant particle is secured by a requirement in the lexical entry of the particle verb. A constraining equation requires a feature contributed by the relevant particle. This equation is independent of the position of the particle in c-structure.

2.7 The structure of nominal phrases

Nominal phrases in modern Scandinavian have a rigid word order. Old Norse is very different, with free word order in nominal phrases.

Börjars et al. (2016) study the development of nominal phrases from Old Norse to Modern Faroese. They argue that the Old Norse nominal phrase is a non-configurational NP. There are no syntactic constraints on word order, but the first position is information structurally privileged. The rest of the phrase has a flat structure. They give the schematic c-structure tree (26) (Börjars et al. 2016: e17).

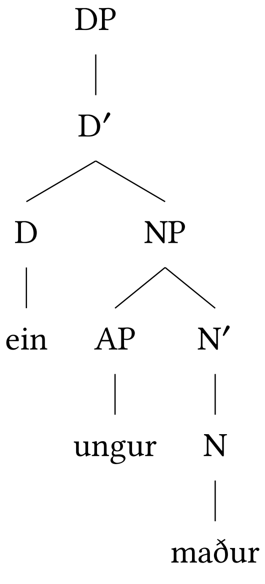
(26)



In Modern Faroese – as in the other modern Scandinavian languages – the word order is no longer free. The first position in a referential nominal phrase contains an element that marks it as ±DEFINITE, such as an indefinite or definite article, a demonstrative, or a noun with the bound definiteness marker.

Börjars et al. (2016) argue that what has happened between Old Norse and Modern Faroese is that a category D has developed, which heads a DP. The c-structure tree for Modern Faroese *ein ungur maður* 'a young man' is then as in (27) (Börjars et al. 2016: e25).

(27)



This is a change from a non-configurational to a configurational nominal phrase.

2.8 Non-projecting possessive pronouns

Standard Swedish and Danish have one position for possessive pronouns in the nominal phrase, preceding the noun and AP (if any). In other Scandinavian varieties, possessive pronouns in addition have the option of immediately following the noun. Examples are (28)–(29).

(28) Norwegian
min ny-e bil
my new-DEF car
'my new car'

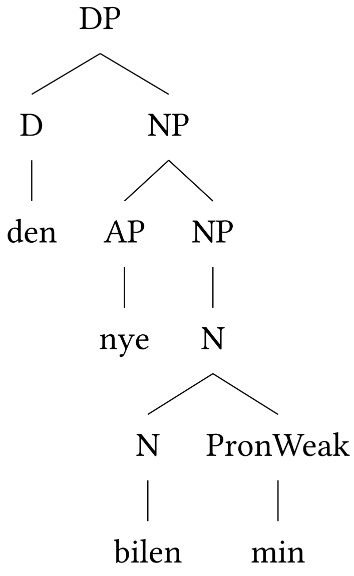
(29) Norwegian
den ny-e bil-en min
the new-DEF car-DEF my
'my new car'

Lødrup (2011) gives a lexicalist analysis of postnominal possessive pronouns in Norwegian, where the main point is that they are non-projecting weak pronouns. They are adjoined to N in syntax, comparable to the weak object pronouns that are adjoined to I in Sells' analysis (see Section 2.2). A noun preceding a possessive pronoun always has the definite form. The noun is either under N, as in (29), or in the higher head position D, as in (30) (following Hankamer & Mikkelsen 2002).

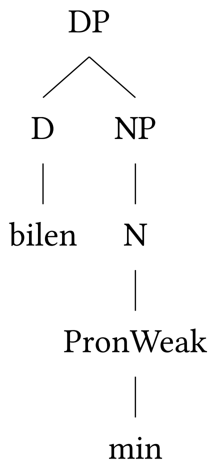
(30) Norwegian
bil-en min
car-DEF my
'my car'

The c-structure trees for (29) and (30) are given in (31) and (32).

(31)



(32)



3 F-structure phenomena

3.1 Oblique subjects in Icelandic

The relation between morphological case and syntactic function is complicated in some languages. The situation in Icelandic has been the object of interesting discussion within different grammatical frameworks. Especially the fact that a number of verbs take an oblique (i.e. non-nominative) subject has been the topic of much attention. Some examples are (33)–(36).

(33) Icelandic (Andrews 1982: 461)
Bát-inn rak á land.
boat-DEF.ACC drifted to land.ACC
'The boat drifted to shore.'

(34) Icelandic (Andrews 1982: 461)
Dreng-ina vantar mat.
boys-DEF.ACC lack food.ACC
'The boys lack food.'

(35) Icelandic (Andrews 1982: 462)
Barn-inu batnaði veik-in.
child-DEF.DAT recovered.from disease-DEF.NOM.
'The child recovered from the disease.'

(36) Icelandic (Zaenen et al. 1985: 100)
Henni hefur alltaf þótt Ólaf-ur leiðinleg-ur.
she.DAT has always thought Ólaf-NOM boring-NOM
'She has always found Ólaf boring.'

The verbs that take an oblique subject are all non-agentive. There are some tendencies concerning the correlation between verb meaning and subject case, but the option of an oblique subject must be seen as idiosyncratic. Important groundwork on oblique subjects was carried out within the framework of LFG. The very first mention of the phenomenon was in Andrews (1976); an LFG analysis was later proposed in Andrews (1982). His proposal is to treat an oblique subject in a way that resembles the treatment of a lexically selected preposition. There is an extra "layer" in their f-structure, in the sense that e.g. a dative subject is the value of the attribute DAT, and this f-structure is the value of SUBJ. Below is the simplified f-structure that Andrews (1982: 472) gives example (35).

(37)
$$\left[\begin{array}{ll}
\text{PRED} & \text{`BATNA}\langle\text{SUBJ DAT,OBJ}\rangle\text{'} \\
\text{SUBJ} & \left[\begin{array}{ll}\text{DAT} & \left[\begin{array}{ll}\text{PRED} & \text{`BARN'}\\ \text{CASE} & \text{DAT}\\ \text{DEF} & +\end{array}\right]\end{array}\right]\\
\text{OBJ} & \left[\begin{array}{ll}\text{PRED} & \text{`VEIK'}\\ \text{DEF} & +\end{array}\right]
\end{array}\right]$$

One argument for this analysis is that an oblique subject doesn't trigger agreement the way a nominative subject does. Regular agreement is blocked by the extra layer. In sentences without a nominative argument, such as (33)–(34) above, the verb occurs in the default third person singular. In sentences with a nominative object, the object can agree with the verb. An example is (38), with a singular oblique subject and a plural nominative object that triggers agreement.

(38) Icelandic (Thráinsson 2007: 156)
Mér hafa alltaf leiðst þessir kjölturakk-ar.
me.DAT have.PL always bored these poodle-NOM.PL
'I have always found these poodles boring.'

Another classic article on non-nominative subjects is Zaenen et al. (1985), who discuss case-preservation in passive sentences. Consider (39)–(40).

(39) Icelandic (Zaenen et al. 1985: 96)
Ég hjálpaði honum.
I helped him.DAT
'I helped him.'

(40) Icelandic (Zaenen et al. 1985: 98)
Honum var hjálpað.
him.DAT was helped
'He was helped.'

Zaenen et al. (1985) show how various syntactic criteria for subjecthood give evidence for non-nominative subjects in passive sentences such as (40). They also compare Icelandic to German. German has superficially similar sentences, but Zaenen et al. (1985) show that the non-nominative arguments in question do not show subject properties.

Zaenen et al. (1985) assume that idiosyncratic case is assigned to arguments at the level of a-structure. One important reason for this assumption is that idiosyncratic case is preserved independently of the syntactic function that realizes the argument position. It is not affected by valency alternations such as passive or raising, as can be seen in (40).

The diachrony of oblique subjects in Icelandic is discussed in Schätzle et al. (2015) and Booth et al. (2017).

3.2 Control and complementation in Icelandic

Control and complementation have been important research topics in LFG since Bresnan (1982a). These topics are intertwined in some ways. LFG distinguishes between two main types of control. One is anaphoric control of a PRO subject (an f-structure subject with a pronominal PRED). The other is functional control, in which the subordinate subject is structure shared with the subject or the object of the governing verb. Functional control is restricted in several ways. It is limited to complements with the function XCOMP and adjuncts with the function XADJ. This means that if an infinitive can be shown to have a syntactic function other than XCOMP or XADJ, control must be anaphoric.

Andrews (1982) assumes that finite *that*- and *wh*-clauses in Icelandic have the external syntactic properties of nominal phrases, realizing nominal syntactic functions such as subject and object (following Thráinsson 1979). Andrews argues that this is also true of infinitival clauses with the infinitival marker *að*. This analysis gives a prediction about how the subject of these infinitival clauses is controlled. Because they are subjects or objects, there must be anaphoric control of a PRO subject.

An interesting question is what case a PRO subject can have. Icelandic verbs can take oblique subjects, as was discussed in Section 3.1. One should expect, then, that PRO can be oblique when required by the infinitival verb. This expectation is true, as can be seen from example (41).

(41) Icelandic (Andrews 1982: 474)
Ég vonast til að vanta ekki ein-an í tím-anum.
I.NOM hope toward to lack not alone-ACC in class-DEF
'I hope not to be the only one missing from class.'

The main verb *vonast* 'hope' takes a regular nominative subject, while the infinitive *vanta* 'lack' requires an accusative subject. In (41), the case of PRO can be seen from the case on *einan* 'alone.ACC', which is an XADJ that agrees with the subject. If control were functional in (41), the accusative subject of *vanta* would have to structure share with the nominative subject of *vonast* 'hope'. This would be impossible, however, because structure sharing shares all grammatical properties, and the values for CASE would be incompatible.

3.3 Control and complementation in Mainland Scandinavian

The function and control of complement clauses have also been discussed for Mainland Scandinavian. Dalrymple & Lødrup (2000) proposed that a finite complement is an object if it shares external syntactic properties with nominal objects, and a COMP if it doesn't. (See Alsina et al. 2005 for criticism.)

Icelandic is a language with finite complements that are objects (see Section 3.2). Examples of languages that have both types of finite complements are English and Swedish (Dalrymple & Lødrup 2000). Norwegian also shows this split, even if object complements represent the dominant option (Lødrup 2004). For example, Norwegian *bevise* 'prove' takes a complement that alternates with a nominal phrase, and corresponds to a subject in the passive. Its complement is then assumed to be an object. The verb *anse* 'consider', on the other hand, takes a complement that lacks these properties, and it is therefore assumed to be a COMP. Examples (42)–(45) show the differences.

(42) Norwegian (Lødrup 2004: 65)
Han har endelig bevist [at jord-en er rund] / dette
he has finally proved that earth-DEF is round / this
'He has finally proved that the earth is round / this.'

(43) Norwegian (Lødrup 2004: 65)
[At jord-en er rund] er endelig blitt bevist.
that earth-DEF is round is finally become proved
'That the earth is round has finally been proved.'

(44) Norwegian
Komitee-en anser [at fordel-ene oppveier
committee-DEF considers that advantage-PL.DEF compensate
ulemp-ene] / *dette
disadvantage-PL.DEF / this
'The committee considers that the advantages compensate for the disadvantages / this.'

(45) Norwegian
*[At fordel-ene oppveier ulemp-ene] blir
that advantage-PL.DEF compensate disadvantage-PL.DEF becomes
ansett.
considered

Lødrup (2004) shows that infinitival complements in Norwegian also show this split, with object complements as the dominant option. For example, the infinitival complement of *akseptere* 'accept' alternates with a nominal object, as shown in (46), and it corresponds to a subject in the passive, as shown in (47).

(46) Norwegian (Lødrup 2004: 70, modified)
De har akseptert [å betale høyere skatt] / dette
they have accepted to pay higher tax / this
'They have accepted to pay higher taxes / this.'

(47) Norwegian (Lødrup 2004: 71)
[Å betale høyere skatt] er blitt akseptert.
to pay higher tax is become accepted
'To pay higher taxes has been accepted.'

As for Icelandic (see Section 3.2), the object analysis implies that the infinitival complements have a PRO subject, and not functional control with structure sharing. In the active (46), the controller of the infinitival subject is the subject of *akseptere* 'accept'. In the passive (47), on the other hand, the infinitive has no controller. This situation rules out functional control, because there is nothing that the subject of the infinitive can structure share with. PRO, on the other hand, can do without a controller, so the infinitive must be assumed to have a PRO subject. A corresponding analysis of the Danish verb *forsøge* 'try' is given in Ørsnes (2006).

3.4 Subject vs object in presentational sentences

All the Scandinavian languages have what could be called a presentational construction, in which a verb takes an expletive and a so-called logical subject. Examples are (48) and (49).

(48) Norwegian
Det kom fire studenter på forelesning-en i går.
EXPL came four students on class-DEF in yesterday
'Four students came to class yesterday.'

(49) Icelandic (Thráinsson 2007: 310)
Það kom-u fjór-ir nemend-ur í tím-ann í gær.
EXPL came-3PLUR four-NOM students-NOM.PL in class-DEF in yesterday
'Four students came to class yesterday.'

The grammatical properties of the presentational construction are rather different in Mainland Scandinavian and Icelandic, and there is some discussion concerning its analysis.

For the Icelandic construction, there seems to be agreement that the logical subject is a grammatical subject. As mentioned in Section 2.5, Icelandic expletives are usually assumed not to be subjects. They can occur in first position, but not in the subject position following the finite verb, as shown in (50).

(50) Icelandic (Thráinsson 2007: 313)
Kom-u (*Það) fjór-ir nemend-ur í tím-ann í gær?
came-3PLUR (EXPL) four-NOM student-NOM.PL in class-DEF in yesterday
'Did four students come to class yesterday?'

However, Sells (2005) assumes that the expletive and the logical subject both map to subject in f-structure. The expletive has no PRED, and no other features that cannot unify with those of the logical subject. Its only reflex in f-structure is then a feature such as [EXPL +].

The Mainland Scandinavian presentational construction is rather different from the Icelandic one. The expletive can occur in all subject positions in c-structure, including the position following the finite verb, as shown in (51).

(51) Norwegian
Kom det fire studenter på forelesning-en i går?
came EXPL four students on class-DEF in yesterday
'Did four students come to class yesterday?'

The logical subject has the same c-structure position as a regular object. The grammatical status of the logical subject has been discussed several times, both inside and outside LFG. Lødrup (1999b, 2020) argues that it is an object in f-structure, following Askedal (1982), Platzack (1983) and others. This view has been criticized by Börjars & Vincent (2005), Zaenen et al. (2017), and Hellan & Beermann (2020). Börjars & Vincent (2005) propose the same kind of analysis for Swedish that Sells (2005) gives for Icelandic: both the expletive and the logical subject correspond to the subject in f-structure. Zaenen et al. (2017) are more agnostic concerning the correct analysis.

Arguments have been given for both subject and object analyses of the logical subject. The presentational construction is not possible with a syntactically realized object role in Mainland Scandinavian, as shown in (52).

(52) Norwegian
Det spiser mange studenter (*pølser) i denne kafe-en.
expl eats many students (sausages) in this cafeteria-def
‘Many students eat (sausages) in this cafeteria.’

This gives an argument for the object analysis, which assumes that the direct object function (LFG’s obj) is taken by the logical subject. Icelandic, on the other hand, allows transitive verbs, see example (21) above.

Another argument for the object analysis is given by subject-to-object raising. Consider (53).

(53) Swedish (Zaenen et al. 2017: 268)
Johan anser det ha varit för många hästar på kyrkogård-en.
Johan considers expl have been too many horses in churchyard-def
‘Johan considers there to have been too many horses in the churchyard.’

Subject-to-object raising leaves the logical subject in the embedded object position, as shown by (53). It is the expletive that raises. This gives an argument that the expletive must be the f-structure subject of ‘to have been’.

Reflexive binding has been used as argument that the logical subject is a grammatical subject. The logical subject not only allows, but seems to require a coreferring proform to be reflexive. An example is (54), in which the reflexive possessive *sin* is acceptable, while the non-reflexive *hans* is not.

(54) Swedish (Börjars & Vincent 2005)
Det kom en man med sin / *hans fru.
expl came a man with refl.poss / his wife
‘There came a man with his (own) wife.’

The arguments that have been given for the competing analyses of presentational sentences are discussed by Lødrup (2020) who concludes that there are no acceptable arguments for the subject analysis.

3.5 Auxiliaries – verbs or functional heads?

The analysis of auxiliary verbs has often been discussed, both outside and inside LFG. In early LFG, they were treated as raising verbs (Falk 1984). In newer LFG, the tendency has been to see them as functional heads without a PRED. With this analysis, they only contribute grammatical features (Butt et al. 2004, Frank & Zaenen 2002). The f-structures (56) and (57) show the different analyses of example (55), with an auxiliary that expresses future tense.

(55) Norwegian
Jeg skal komme.
I shall come
'I will come.'

(56)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{skulle}\langle\textsc{xcomp}\rangle\textsc{subj}\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{pers} & 1 \\ \textsc{numb} & \textsc{sg} \\ \textsc{case} & \textsc{nom} \end{array}\right] \\ \textsc{xcomp} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{komme}\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \underline{\qquad\qquad} \\ \textsc{form} & \textsc{infinitive} \end{array}\right] \\ \textsc{tense} & \textsc{future} \end{array}\right]$$

(57)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{komme}\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{pers} & 1 \\ \textsc{numb} & \textsc{sg} \\ \textsc{case} & \textsc{nom} \end{array}\right] \\ \textsc{tense} & \textsc{future} \end{array}\right]$$

The analysis of auxiliaries raises several difficult questions, and it is not clear that all verbs that are traditionally called auxiliaries should get the same analysis (Falk 2008). Dyvik (1999) discusses Norwegian modals, and criticizes the functional head analysis. His point of departure is the status of f-structure as a grammatical level of representation. He rejects the idea that semantics gives an argument for parallel f-structure representations of morphological and periphrastic expression of, for example, the future.

If one accepts the functional head analysis, there are phenomena that must be accounted for in a different way than in traditional LFG. For example, an auxiliary restricts the form of its dependent verb. When the auxiliary selects an XCOMP, it can restrict the form of the verb heading the XCOMP with the equation (↑XCOMP FORM) = INFINITIVE. To account for this kind of phenomena with the functional head analysis, Butt et al. (2004) propose a separate morphological projection, m-structure, (see also Frank & Zaenen 2002). However, Wedekind & Ørsnes (2003) argue that a simpler description is possible, using the so-called restriction operator. They also use the restriction operator in their account of VP-topicalization (Wedekind & Ørsnes 2004).

3.6 "*do*-support" in Scandinavian

The Scandinavian languages differ from English in not having *do*-support in interrogative and negative sentences. There is, however, a kind of *do*-support that is used in three contexts: When the main verb VP is topicalized, as in (58), elided, as in (59), or pronominalized as in (60). The support verb in these examples is the present form of (Danish) *gøre* 'do'.

(58) Danish (Ørsnes 2011: 410)
Venter gør han ikke.
waits does he not
'He doesn't wait.'

(59) Danish (Ørsnes 2011: 410)
Han venter. Nej, han gør ej.
he waits no he does not
'He'll wait. No he won't.'

(60) Danish (Ørsnes 2011: 410)
Han venter. Nej, det gør han ikke.
he waits no that does he not
'He is waiting. No he is not.'

A VP is pronominalized with the pronoun *det* 'it/that' (Lødrup 1994). This construction often corresponds to VP ellipsis in English, which is a rather restricted option in Scandinavian.

Ørsnes (2011) discusses the use of the non-finite form of the support verb. A non-finite support verb is optional when a VP or a VP anaphor is topicalized. An example of the former is (61).

(61) Danish (Ørsnes 2011: 420)
Hørt efter har han aldrig (gjort).
listened PARTICLE has he never done
'Listen! he never did that.'

Ørsnes (2011) shows that the non-finite support verb in Danish can be obligatory with a post-verbal VP anaphor in some cases, as in (62) (see also Ørsnes 2013).

(62) Danish (Ørsnes 2011: 419)
Peter plejer aldrig ??/*(at gøre) det.
Peter used never to do that
'Peter never used to do that.'

The support verb is considered an auxiliary in Lødrup (1990, 1994). Ørsnes (2011) argues against auxiliary status. A difference from regular auxiliaries is that the support verb cannot take a verbal complement in its complement position. Another difference is that it does not impose restrictions on the shape of its complement. This can be seen in examples (58) and (61) above; a topicalized VP can have its head in the infinitive or in the same form as the support verb (with some variation within Scandinavia). Ørsnes (2011) sees the support verb as a main verb – a subject-to-subject-raising verb that takes an object complement.

3.7 Varieties of raising and control

Raising and control have been importent research topics within LFG. They are related phenomena, and the border between them can be thin (see e.g. Lødrup 2008c). This section will illustrate how raising can be more constrained in Scandinavian as compared to English, and show how the analysis of raising and control has been applied to other constructions in Scandinavian. Note that the discussion of passives in Section 3.8 also covers two constructions that have been given a raising analysis: pseudopassives and complex passives.

3.7.1 Raising to object with *believe* type verbs

Norwegian is traditionally assumed not to have raising to object with *believe* type verbs (sometimes called the ECM construction). Lødrup (2008b) shows that even if sentences such as (63) are possible, sentences such as (64) are not.

(63) Norwegian
Dette antar jeg å være en menneskelig forsvarsmekanisme.
this assume I to be a human defense.mechanism
'This I assume to be a human defense mechanism.'

(64) Norwegian
*Jeg antar dette å være en menneskelig forsvarsmekanisme.
I assume this to be a human defense.mechanism
'I assume this to be a human defense mechanism.' [intended]

The relevant difference between (63) and (64) is that the raised object is in the canonical object position in (64), and in SpecCP in (63). Norwegian requires that the raised object be in a topic or focus position. This constraint was called the Derived Object Constraint in Postal (1974) (see also Kayne 1981). In Lødrup (2008b) the relevant verbs are equipped with a constraint in the lexicon which says that the raised object is realized as a discourse function.

Danish and Swedish are not exactly like Norwegian concerning raising to object with *believe* type verbs. In Danish, it seems to be rather marginal (Brandt 1995: 26). In Swedish, on the other hand, this kind of raising seems to be somewhat less restricted, at least in writing (Teleman et al. 1999: 576–78).

Passive raising sentences with *believe* type verbs, such as (65), are not affected by the Derived Object Constraint.

(65) Swedish (Ramhöj 2016: 583)
Hon säg-s vara en utpräglad målskytt.
she says-PASS be a specialized goal-scorer
'She is said to be a specialized goal scorer.'

However, these passive sentences also raise some questions.

First, there is a restriction on the realization of the passive. Mainland Scandinavian has two ways of realizing the passive – with a suffix or with an auxiliary and a participle. Passive raising sentences with *believe* type verbs differ from other passives in being reluctant to take the periphrastic passive, cf. (66).

(66) Swedish (Ramhöj 2016: 583)
*Hon blir sagd vara en utpräglad målskytt.
she becomes said be a specialized goal-scorer
'She is said to be a specialized goal scorer.'

Second, there are passive *believe* type raising sentences that do not correspond to actives, in the sense that there is no acceptable equivalent active with the passive subject as an object. An example is (65) above. These properties could be taken to indicate that the relevant sentences should not be seen as passives of raising sentences with *believe* type verbs. However, Ramhöj (2016) argues that they should.

3.7.2 Copy raising

Asudeh & Toivonen (2012) discuss so-called copy raising in Swedish and English. An example is (67).

(67) Swedish (Asudeh & Toivonen 2012: 323)
Tina verkar som om hon har hittat choklad-en.
Tina seems as if she has found chocolate-DEF
'Tina seems as if she has found the chocolate.'

Copy-raising differs from regular subject to subject raising in that there is a finite complement clause with a pronominal representation of the raised subject. In the analysis of Asudeh & Toivonen (2012), the *som om* 'as if' complement is an XCOMP whose subject is raised. This raised subject anaphorically binds the copy pronoun in the complement.

3.7.3 Pseudocoordination as control

A favorite topic in both traditional and modern Scandinavian grammar is so-called pseudocoordination (see e.g. Lødrup 2019a and references there). An example is (68).

(68) Norwegian
Da satt han og arbeidet.
then sat he and worked
'Then he sat working.'

A pseudocoordination contains two verbs with the same inflectional form, and the conjunction *og* 'and' between them. The first verb is often a posture verb, as in (68), but some verbs of other types are also possible. A pseudocoordination has grammatical properties that distinguish it from a coordination of two verbs or verb phrases (Lødrup 2019a). Two important properties are the following:

The two verbs cannot occur together in the V2 position in a sentence such as (69).

(69) Norwegian
*Da satt og arbeidet han.
then sat and worked he
'Then he sat working.' [intended]

The first verb in a pseudocoordination allows the presentational construction without involving the second verb, cf. (70).

(70) Norwegian (Lødrup 2019a: 92)
Nå sitter det en mann her og skriver om en ny type maskin.
now sits EXPL a man here and writes about a new type machine
'A man is sitting here now, writing about a new type of machine.'

Lødrup (2002) discusses the analysis of pseudocoordination, and argues that most pseudocoordinations are complement constructions with functional control of the complement headed by the second verb. In Lødrup (2017) this analysis is revised, with anaphoric instead of functional control. When the second verb heads a verbal complement, the properties illustrated in (69) and (70) above follow. In true coordination two verbs can occur in the V2 position, but in pseudocoordination, the first verb cannot 'bring with it' the second verb since it is the head of its complement. In (70), the object *en mann* 'a man' can be understood as the subject of the second verb because it is the controller of its PRO subject.[8] With true coordination, a presentational construction involving the first verb only is not possible. The reason is that a preceding object cannot be understood as a subject of a second coordinated VP – only a preceding subject can.

3.7.4 The preposition *med* 'with' as a control predicate

The preposition *med* 'with' (and to some extent *uten* 'without') has interesting control properties. Lødrup (1999a) showed that it must be assumed to select a subject in one of its uses. His argument was based upon example (71), which requires a subject in the complement of *med* to bind the reflexive.

(71) Norwegian (Lødrup 1999a: 376)
En dame med en hund foran seg kom løpende.
a lady with a dog in.front.of REFL came running
'A lady with a dog in front of her came running.'

---

[8] The observant reader will notice that the author here takes sides in the discussion of the analysis of the presentational construction, calling the controller an object (see Section 3.4).

The preposition *med* 'with' in (71) takes a subject, a non-thematic object and an XCOMP. Haug (2009) argues that *med* can take a subject also when there is no XCOMP. The argument is again based upon binding. Haug gives example (72), in which the object 'car' must be interpreted as the possessor of the prepositional object 'tank'.

(72) Norwegian (Haug 2009: 343)
Han leverte bil-en med full tank.
he returned car-DEF with full tank
'He returned the car with the tank full.'

In Norwegian, this kind of null possessor is generally bound in the same way as a simple reflexive (Lødrup 1999a, 2010, see also Section 3.11). This means that it cannot be bound by an object (Lødrup 2010: 95), so it is necessary to assume that *med* takes a subject.

The subject of *med* is always an anaphorically bound PRO. The controller is often an argument of the matrix verb, but other controllers are also possible – even a participant implied by a verbal noun, as in example (73).

(73) Norwegian (Haug 2009: 340)
Fødsel-en foregår med ski på bein-a.
birth-DEF takes.place with skis on legs-DEF
'The birth takes place with (the mother or the baby) wearing skis.'

Haug (2009) gives a semantic account of *med* using Glue semantics.

3.7.5 "Backward" possessor raising

Lødrup (2009b, 2018) discusses Norwegian sentences such as (74), with a body part noun and a possessor with the preposition *på* 'on'. This construction corresponds to the dative external possessor construction, which is found in e.g. French and German, cf. (75).

(74) Norwegian
Jeg brekker arm-en på ham.
I break arm-DEF on him
'I break his arm.'

(75) French
Je lui casse le bras.
I him.DAT break DEF arm
'I break his arm.'

In the French and German dative external possessor construction, the external possessor is understood to be affected by the verbal action. The external possessor is not included in the verb's basic valency, however. This means that the dative external possessor realizes an "extra" thematic role that must be added by a lexical rule.

The dative external possessor construction is often seen as possessor raising – the dative OBJ$_\theta$ is structure shared with the possessor function in the body part noun phrase. Alternatively, the relation between the possessor and the body part noun could be seen as binding, see e.g. Deal (2017).

Old Norse had the dative external possessor construction. In Modern Norwegian, there is no dative case, and the possessor is expressed as a PP. This construction is rather similar to the dative external possessor construction, but there is one important difference: The PP can be a part of the body part noun phrase, due to reanalysis (Lødrup 2009b, 2018). Example (74) can have 'the arm on him' as one or two constituents.

The two constituent construction can be analyzed in the same way as the dative external possessor construction, when the PP is considered an OBJ$_\theta$. The one constituent construction is more challenging. Lødrup (2018) proposes that the noun phrase-internal possessor should be considered a so-called prominent internal possessor (see e.g. Ritchie 2017). The possessor is structure shared with the verb's OBJ$_\theta$ function. This could be considered a case of "backward" possessor raising. It could be compared to cases of raising and control in which a shared subject is realized in the lower subject position (Polinsky & Potsdam 2006), schematically as in (76).

(76) tried [John to leave]

The structure sharing equation on the main verb accounts for both forward and backward raising. The lexical entry of the verb in example (74) is given in (77).

(77) 'break <(↑SUBJ) (↑OBJ$_{\text{affected}}$) (↑OBJ)>'
(↑OBJ$_{\text{affected}}$) = (↑GF POSS), where GF is a local function

3.7.6 Possessor raising with unergatives

A different type of possessor raising with body part nouns can be found with transitive and unaccusative verbs in many languages. An example is (78).

(78) Norwegian (Lødrup 2019b: 562)
Hun vasket baby-en i ansikt-et.
she washed baby-DEF in face-DEF
'She washed the baby's face.'

The possessor is raised from the prepositional object, and realized as an OBJ with transitive verbs, or as a subject with unaccusatives. This kind of possessor raising can also be seen as structure sharing – the OBJ is structure shared with the possessor function in the prepositional object. (As mentioned in Section 3.7.5, the relation between an external possessor and a body part noun could alternatively be seen as binding. See e.g. Deal 2017.)

Lødrup (2009c, 2019b) shows that sentences seemingly similar to (78) also occur with unergative verbs in Norwegian. An example is (79).

(79) Norwegian (Lødrup 2019b: 563)
Hun spyttet ham i ansikt-et.
she spat him in face-DEF
'She spat in his face.'

This option is completely productive. The only restriction is the same for transitive and unergative verbs: they must denote some form of physical contact. Lødrup (2019b) sees the raised argument with unergatives as a thematic object. It realizes the same role as the PP with *på* 'on' in sentences such as (74) above. Example (79) can alternatively take this PP, cf. (80).

(80) Norwegian (Lødrup 2019b: 563)
Hun spyttet i ansikt-et på ham.
she spat in face-DEF on him
'She spat in his face.'

However, the raised argument shows the syntactic properties of an OBJ, and not of an OBJ$_\theta$ in sentences such as (79) (Lødrup 2019b). We see, then, that the affected role can be realized as either an OBJ$_\theta$ PP or an OBJ DP/NP with unergatives. The OBJ option follows from the syntactic features assigned to arguments by Lexical Mapping Theory. The affected role will usually be treated as a secondary patientlike role by Lexical Mapping Theory. It then gets the syntactic feature [+*o*], and is realized as an OBJ$_\theta$. However, with an unergative verb, the affected role can alternatively be treated as a regular patientlike role. It then gets the syntactic feature [−*r*], and is realized as a direct object. This option does not exist with unaccusatives or transitives. The reason is that their subject is [−*r*], and a verb can only take one [−*r*] argument in Norwegian, as in many other languages (Bresnan & Moshi 1990).

3.8 Varieties of the passive

The passive has been a favorite topic in lexicalist frameworks. Scandinavian has a rich and interesting variety of passives. Mainland Scandinavian has two ways of realizing the passive: a periphrastic passive with an auxiliary and a participle, or a morphological passive with a suffix (see e.g. Engdahl 2006). Icelandic only has periphrastic passives (Thráinsson 2007: 10–11). Icelandic passives with oblique subjects were mentioned in Section 3.1.

3.8.1 Different passives of ditransitives

Norwegian, Swedish and to a lesser extent Danish allow both internal arguments of a ditransitive verb to be realized as the passive subject, as shown in (81)–(83).

(81) Norwegian
De overrakte ham medalj-en.
they presented him medal-DEF
'They presented him with the medal.'

(82) Norwegian
Han ble overrakt medalj-en.
he became presented medal-DEF
'He was presented with the medal.'

(83) Norwegian
Medalj-en ble overrakt ham.
medal-DEF became presented him
'The medal was presented to him.'

These data create problems for theories of the mapping of arguments in passives. It is generally assumed that only one of the internal arguments can correspond to a passive subject. Lexical Mapping Theory assumes that only one internal argument can be classified as an unrestricted function, and thus be realized as a passive subject. Bresnan & Moshi (1990) show that some Bantu languages are "symmetrical" in the sense that either object role can correspond to a passive subject. Lødrup (1995) argues that their analysis cannot be transferred to Mainland Scandinavian, because objects in ditransitives are not symmetrical outside the passive. However, no solution to the problem is presented.

Icelandic is both similar and different from Norwegian and Swedish concerning the passivization of ditransitives (Zaenen et al. 1985). The central group of ditransitives are those that take a dative object and an accusative object, such a *gefa* 'give'. They allow both internal arguments to be realized as the passive subject, as shown in (84) and (85). When the dative is realized as a subject, as in (84), the object gets nominative case and can trigger agreement on the verb (compare example (38) above).

(84) Icelandic (Zaenen et al. 1985: 460)
Konung-inum voru gef-nar ambátt-ir.
king-DEF.DAT were given-PL female.slave-NOM.PL
'The king was given female slaves.'

(85) Icelandic (Zaenen et al. 1985: 460)
Ambátt-in var gef-in konung-inum.
female.slave-DEF.NOM.SG was given.SG king-DEF.DAT
'The female slave was given to the king.'

Zaenen et al. (1985) argue that both internal objects with these verbs can be either object or second object [i.e. OBJ or OBJ$_\theta$]. The option of being an object makes it possible for them to change to subject by the (then current) lexical rule of passive, which replaces OBJ by SUBJ in the linking of roles and functions in the verb's lexical entry.

Ditransitives with other case frames only allow the linearly first internal argument to be realized as a subject.

3.8.2 Pseudopassives

The Mainland Scandinavian languages all have pseudopassives, i.e. passives in which the subject corresponds to the object of a preposition in the active; Engdahl & Laanemets (2015) show that claims to the contrary are not correct. An example is (86).

(86) Norwegian
Skildringer av norsk natur se-es ofte ned på.
depictions of Norwegian nature see-PASS often down on
'People often look down upon depictions of Norwegian nature.'

Bresnan (1982c) pointed out that pseudopassives create a potential problem for a lexical treatment of the passive. She proposed a rule which incorporates the verb and the preposition into one complex verb (Bresnan 1982c: 50–59). This analysis accounts for the fact that the verb and the preposition behave as a unit in English pseudopassives. The preposition must be adjacent to the verb, and it can be a part of a derived participle-based adjective. Examples are (87)–(88).

(87) English (Bresnan 1982c: 54)
*Everything was paid twice for.

(88) English (Bresnan 1982c: 53)
Each unpaid for item will be returned.

Scandinavian pseudopassives are different from the English ones. The preposition does not have to be adjacent to the verb, as (86) shows, and derived adjectives with a preposition following the verb do not exist. Scandinavian grammarians have therefore been skeptical of preposition incorporation (see e.g. Christensen 1986).[9] Lødrup (1991) proposes a raising to subject analysis, in which the subject and the prepositional object are structure shared (see also Alsina 2009).

3.8.3 Complex passives

The so-called complex passive is exemplified in (89).

(89) Danish (Ørsnes 2006)
Bil-en bed-es flyttet.
car-DEF ask-PASS moved
'You are asked to move your car.'

This construction has a passive verb followed by a passive or unaccusative participle. One of its interesting properties is that there is no directly corresponding active sentence. It is impossible to realize the theme argument *bilen* 'car.DEF' as the object of the active verb *bede* 'ask'.

The complex passive is possible with a small number of first verbs in Danish and Norwegian. It is more marginal in Swedish. Ørsnes (2006) gives an LFG account in which the complex passive is a subject-to-subject raising construction.

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[9] These arguments rule out an analysis in which the verb and the preposition are one lexical item. However, given later developments within LFG, one could imagine a different analysis that makes the verb and the preposition one unit. They could be one PRED in f-structure in the same way as complex predicates consisting of two verbs (see the discussion following example (90) below).

3.8.4 Long passives

Another type of passive that involves two verbs is exemplified in (90).

(90) Norwegian
Dette forsøk-es å gjør-e(-s).
this try-PASS to do-INF(-PASS)
'One tries to do this.'

This construction can be found in Norwegian, Swedish and Danish, even if speakers' intuitions vary. It sounds best with a passive second verb (Lødrup 2014). The subject of (90) realizes the internal argument of the second verb. This is a passive of a complex predicate consisting of two verbs (Butt 1995, Alsina 1996, Sells 2004, Andrews 2023 [this volume]), a so-called long passive (Lødrup 2014).

There is independent evidence for the complex predicate analysis. Verbs that take the long passive also allow verbal feature agreement in the active, in the sense that a second verb takes on the form of the preceding verb, instead of the expected infinitive. Verbal feature agreement is a complex predicate phenomenon, for reasons discussed in Niño (1997) and Sells (2004). Mainland Scandinavian can (to varying degrees) have this kind of agreement with imperatives and participles, as in (91)–(92) (Havnelid 2015, Aagaard 2016).

(91) Norwegian
Forsøk å gjør ditt beste.
try.IMP to do.IMP your best
'Try to do your best.'

(92) Norwegian
Hadde forsøk-t å gjor-t samtal-en kort.
had try-PTCP to do-PTCP conversation-DEF short
'(I) would have tried to make the conversation short.'

3.8.5 The new passive/impersonal construction

Icelandic has a construction that has been called the new passive construction or the new impersonal construction (see Maling & Sigurjónsdóttir 2002). An example is (93).

(93) Icelandic (Kibort & Maling 2015)
Loks var fund-ið stelp-una eftir mikla leit.
finally was found-N.SG girl.(F)-DEF.ACC after great search
'They finally found the girl after a long search.'

This construction seems to have passive morphology. There is no realized subject. (There can be an expletive in first position, but these are usually not considered subjects, see Section 2.5.) The external role cannot be realized as a subject, and there is no "promotion to subject" of an internal role.

The analysis of this construction has been discussed several times, but the only LFG discussion is in Kibort & Maling (2015). Some authors see it as a real passive (e.g. Eythórsson 2008). Maling and her co-authors argue that despite its morphology, the construction is not a passive. They see it as an impersonal active construction, comparable to the Irish autonomous form and the Polish -*no/to* construction. This means that the verbal morphology introduces a PRO subject with an unspecified, typically human interpretation. This PRO is argued to behave like other subjects syntactically. For example, it can control a subject-oriented adjunct, as shown in (94).

(94) Icelandic (Maling & Sigurjónsdóttir 2002: 125)
Það var kom-ið skellihlæjandi í tím-ann.
EXPL was come-N.SG laughing.out.loud into class-DEF
'People came into class laughing out loud.'

3.9 Directed motion – rules or constructions

Toivonen (2002) and Asudeh et al. (2013) discuss the Swedish directed motion construction, in which a verb takes a reflexive and a directional PP. An example is (95).

(95) Swedish (Asudeh et al. 2013: 13)
Sarah armbågade sig genom mängd-en.
Sarah elbowed REFL through crowd-DEF
'Sarah elbowed her way through the crowd.'

Toivonen (2002) discusses how this kind of sentence should be described, with a construction or with a lexical rule. An argument for using a construction is that "it is difficult to pin its meaning to any one of its individual parts" (Toivonen 2002: 342). The relevant sentences denote traversal, but the verb does not need to be a motion verb. There is no special word or morpheme that is uniquely associated with the construction.

Asudeh et al. (2013) discuss this and similar expressions further. They point out that assuming a directed motion construction would violate the Lexical Integrity Principle:

> "Morphologically complete words are leaves of the c-structure tree and each leaf corresponds to one and only one c-structure node." (Bresnan et al. 2016: 92)

This principle entails that units smaller or bigger than words cannot be inserted in c-structure. Asudeh et al. (2013) propose templates to factor out grammatical information that can be invoked by words or construction-specific phrase structure rules. This makes it possible to capture the constructional effects, without giving up the Lexical Integrity Principle.

3.10 Definiteness and pronouns

3.10.1 Double definiteness

So-called double definiteness can be found in Norwegian, Swedish and Faroese, but not in Danish and Icelandic. Examples are (96)–(97).

(96) Norwegian
denne hest-en / ??hest
this horse-DEF / horse
'this horse'

(97) Norwegian
den hvit-e hest-en / ??hest
the white-DEF horse-DEF / horse
'the white horse'

Double definiteness means that the definiteness of the nominal phrase is expressed by two elements: both the determiner and the definite suffix on the noun.[10] In (97), the adjective makes the determiner *den* obligatory. When there is no adjective, a definite noun such as *hesten* 'horse.DEF' can be a nominal phrase on its own.

Double definiteness is usually obligatory in the colloquial language. There are, however, certain options for semantic differences with and without double definiteness, especially in literary style. Some researchers assume that the two definite elements give different semantic contributions to the phrase (e.g. Julien 2005: 35–44).

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[10] The definite (or "weak") form of the adjective in (98) is conditioned by the definiteness of the nominal phrase. This will not be discussed further here.

The LFG formalism makes it easy to account for double definiteness by letting both definite elements introduce [DEF +]. A problem is then how to avoid double definiteness in languages where it is ungrammatical, such as Danish. Cf. example (98).

(98) Danish
den hvid-e hest / *hest-en
the white-DEF horse / horse-DEF
'the white horse'

One way of accounting for Danish is to use so-called instantiated values (Strahan 2008: 213–14). The Danish determiner *den* 'the' is then specified as [↑ DEF = +_], where the underscore indicates that this specification cannot unify with anything else. The Danish definite noun *hesten* 'horse.DEF' also has this specification, so (98) is ruled out with a definite noun.

A different analysis of double definiteness can be found in Romero (2015). He assumes that the determiner is the only element that has definiteness as an inherent property, while the noun simply agrees with it. The definite form of the noun then carries a constraining equation [↑ DEF $=_c$ +]. This analysis gives raise to a problem with nominal phrases such as *hesten* 'horse.DEF', which can be used in all argument positions. Romero's solution is that *hesten* is really *den hesten* 'the horse.DEF', where the elements undergo lexical sharing (in the sense of Wescoat 2002).

Börjars & Harries (2008) discuss the history of double definiteness, and make the following remark on its analysis:

> All analyses of the difference between double and single definiteness appear to be somewhat stipulative […] This may be because it is a relatively superficial phenomenon, not associated with deep semantic properties, and hence there may not be any fundamental principled explanation. (Börjars & Harries 2008: 341)

3.10.2 Pronominal demonstratives

Norwegian and Danish can use a pronoun as a demonstrative in sentences such as (99)–(100).

(99) Norwegian (Strahan 2008: 193)
Se på han mann-en!
look at he.NOM man-DEF
'Look at that man!'

(100) Danish (Strahan 2008: 193)
Se på ham mand-en!
look at he.acc man-def
‘Look at that man!’

Johannessen (2008) says that the use of the demonstrative is linked to what she calls psychological distance, and names it the pronominal psychological demonstrative. The form of the pronoun is invariable in each language, not depending upon the function of the nominal phrase. Norwegian always uses the nominative, while Danish uses the accusative. It is striking that Danish can have the definite form of the noun in this construction when double definiteness is not allowed otherwise.

A nominal phrase with a pronominal demonstrative always has specific reference (while the regular distal demonstrative *den* is neutral in this respect). Strahan (2008) sees the relation between the specificity of the pronominal demonstrative and the definiteness of the noun as a kind of agreement.

A difference between Norwegian and Danish is that Danish needs a determiner following the pronominal demonstrative when there is an adjective preceding the noun, as in (101). The noun is then indefinite. The Norwegian equivalent cannot have this determiner following the pronominal demonstrative, as shown in (102).

(101) Danish (Strahan 2008: 213)
Det er ham den store mand.
it is he.acc the big-def man
‘It is that big man.’

(102) Norwegian
Det er han (*den) store mann-en.
it is he.nom the big-def man-def
‘It is that big man.’

This difference between Norwegian and Danish shows that the pronominal demonstrative must be at different levels in c-structure in the two languages. Strahan (2008) assumes that it is under NP in Norwegian, and under DP in Danish.

Varieties of Swedish are similar to Danish in allowing sentences parallel to (101). On the other hand, Swedish is like Norwegian in using the nominative form of the pronoun.

3.10.3 Nominative and accusative of Danish pronouns

Personal pronouns in Danish have, like English, the accusative form as the default form, while the nominative is reserved for subjects. Ørsnes (2002) discusses a special feature of Danish: The nominative is only used for local subjects, as in (103). A non-local subject is realized in the accusative form, as in (104).

(103) Danish (Ørsnes 2002)
Peter tror han vinder.
Peter thinks he.NOM wins
'Peter thinks he is going to win.'

(104) Danish (Ørsnes 2002)
Ham / *han tror Peter vinder.
he.ACC / he.NOM thinks Peter wins
'Peter thinks he is going to win.'

Ørsnes (2002) gives the following conditions for nominative and accusative pronouns:

Nominative The DP is the subject of the immediately containing f-structure.

Accusative The DP is *not* the subject of the immediately containing f-structure (but possibly the subject of an embedded f-structure).

The constructive case formalism (Nordlinger 1998) makes it possible to state these conditions in a simple way. Ørsnes (2002) proposes that the accusative *ham* is equipped with the restriction (105), and the nominative *han* with (106).

(105) *ham* $\{\neg\ (\textsc{subj}\uparrow) \vee$
$((\textsc{comp}^{+}\ \textsc{subj}\uparrow)\ \textsc{df}) = \uparrow\}$

(106) *han* $(\textsc{subj}\uparrow)$
$((\textsc{comp}^{+}\ \textsc{subj}\uparrow)\ \textsc{df}) \neq \uparrow$

3.11 Reflexive binding

3.11.1 The classical LFG approach

The basic facts about binding of reflexives are rather similar in the Mainland Scandinavian languages (but see Lundquist 2014a for some nuances).

Norwegian data has played an important role in the development of binding theory in LFG. Dalrymple (1993) was influenced by the pioneer work of Hellan (1988) (see also Hestvik 1991). Her work is followed up in Bresnan et al. (2016: 227–85). Two general introductions to LFG also discuss binding in Norwegian and Swedish: Falk (2001: 173–91) and Börjars et al. (2019: 152–175).

Anaphoric elements in Norwegian give a nice illustration of different kinds of binding requirements. Their properties are shown in table 1 (from Dalrymple 1993: 34). A nucleus is a PRED and the functions that it selects. A complete nucleus is a nucleus that contains a SUBJ.

Table 1: Anaphoric elements in Norwegian

	Bound to:	Disjoint from:
seg selv	subject in coargument domain	–
ham selv	argument in minimal complete nucleus	subject in minimal complete nucleus
seg	subject in minimal finite domain	subject in minimal complete nucleus
sin	subject in minimal finite domain	–

Examples are (107)–(110).

(107) Norwegian (Dalrymple 1993: 29, from Hellan 1988: 67)
Jon fortalte meg om seg selv.
Jon told me about REFL SELF
'Jon told me about himself.'

(108) Norwegian (Dalrymple 1993: 29, from Hellan 1988: 104)
Vi fortalte Jon om ham selv.
We told Jon about him SELF
'We told Jon about himself.'

(109) Norwegian (Dalrymple 1993: 31, from Hellan 1988: 73)
Jon hørte oss snakke om seg.
Jon heard us talk about REFL
'Jon heard us talk about him.'

(110) Norwegian (Dalrymple 1993: 33, from Hellan 1988: 75)
Jon ble arrestert i sin kjøkkenhave.
Jon became arrested in REFL.POSS kitchen-garden
'Jon was arrested in his kitchen garden.'

Dalrymple shows how anaphoric elements can be equipped with binding requirements in their lexical entries. Binding is described as an inside-out phenomenon in f-structure. Intuitively, we start at the anaphoric element, and go outwards to find a possible binder to co-index with. The path outward is restricted in different ways for different elements. For example, *seg selv* is bound to the subject in its coargument domain, which means that the path cannot go through an f-structure that contains a subject. Possessive *sin* is bound to a subject in a minimal finite domain, which means that the path cannot go through an f-structure that contains TENSE.

The relation between the anaphoric element and the binder can be non-local, as shown by the long distance use of the simple reflexive *seg* (example (109)). This is a case of functional uncertainty.

3.11.2 Some questions of data and interpretation

The Norwegian binding data used by Dalrymple have been the basis of theoretical discussion within different frameworks. They are not without their problems, however. The Hellan/Dalrymple assumptions were criticized in Lødrup (1999a, 2007, 2008a). Three problems for the Hellan/Dalrymple assumptions will be mentioned here: object binders, the status of the simple reflexive *seg*, and binding into a finite clause.

3.11.2.1 Object binders

Hellan and Dalrymple assume that only subjects are possible binders. This might be considered a somewhat brutal idealization of the data, because speakers accept object binders as well in some cases, such as (111) (Lødrup 2008a).

(111) Norwegian
Regl-ene er til for å beskytte dem mot seg selv.
rules-DEF are PARTICLE for to protect them against REFL SELF
'The rules exist to protect them against themselves.'

3.11.2.2 The status of the simple reflexive *seg*

Hellan and Dalrymple assume that the simple reflexive *seg* is not used in local binding, only in long distance binding as in example (109) above. A difficult question concerns the status of the simple reflexive when it is not long distance bound. It is uncontroversial that it can be a non-argument, e.g. with inherently reflexive verbs (such as *skynde seg* 'hurry'). The problem concerns sentences such as (112), in which the simple reflexive seems to be locally bound.

(112) Norwegian
Jon vasker seg.
Jon washes REFL
'Jon is washing himself.'

In the Hellan/Dalrymple approach, one has to say that this is not an argument reflexive, but a lexical reflexive that is used to detransitivize the verb. Lødrup (1999a, 2007) argues that the simple reflexive is a thematic object in sentences such as (112). He claims that a locally bound simple reflexive is possible in what he calls a physical contexts (see also Bresnan et al. 2016: 279–282). This means that the reflexive is the object of a verb that denotes an action directed towards the body of the subject, or the object of a locational preposition.

Physical contexts are also the contexts that allow body part nouns and other nouns in the "personal domain" to occur in the definite form without a possessive pronoun, as in (113) (Lødrup 1999a, 2010). The subject is then understood as the possessor. This use of the definite form is independent of the regular conditions on definiteness, such as being previously known or mentioned.

(113) Norwegian
Jon vasker ansikt-et.
Jon washes face-DEF
'Jon is washing his face.'

Lødrup assumes that both simple reflexives and the relevant group of definite nouns can be bound in physical contexts. Outside physical contexts, the complex reflexive is required – and a body part noun needs a possessive pronoun (or a definite form that satisfies the regular conditions on definiteness). This is shown in (114)-(115).

(114) Norwegian
Jon elsker seg *(selv).
Jon loves REFL (SELF)
'Jon loves himself.'

(115) Norwegian
Jon elsker ansikt-et *(sitt).
Jon loves face-DEF (REFL.POSS)
‘Jon loves his face.’

3.11.2.3 Binding into a finite clause

Mainland Scandinavian allows non-local binding into a non-finite clause, as in example (109) above. Varieties of Mainland Scandinavian also allow binding into a finite clause to some extent. Lødrup (2009a) shows that this can be acceptable when the subject of the embedded clause is low prominent: expletive, non-animate or non-specific. Examples are (116)-(117). Note that the complex reflexive is used in (117).

(116) Norwegian (Lødrup 2009b: 116)
Alle kan føle det er en del av seg…
all can feel it is a part of REFL
‘Everybody can feel that it is a part of them.’

(117) Norwegian (Lundquist 2014b)
Folk leser vel bare de brev-ene som er til seg selv.
people read presumably only the letters-DEF that are to REFL SELF
‘People presumably only read the letters which are for them.’

The Norwegian (117) is accepted by a majority of informants, and the same is true of its Swedish equivalent (Lundquist 2014b).

The conditions on binding into a finite clause in Mainland Scandinavian seem to be complicated, and there has been some discussion about their nature (Strahan 2009, 2011, Lødrup 2009a, Lundquist 2014b,c, Julien 2020).

3.11.3 Long distance binding in Insular Scandinavian

Icelandic allows binding into a finite clause when the subordinate verb is subjunctive (Thráinsson 1976). Icelandic long distance reflexives are usually considered logophoric (see e.g. Maling 1984). An example is (118).

(118) Icelandic (Thráinsson 1976)
Jón segir að María elsk-i sig.
Jón says that María loves-SBJV REFL
‘Jón says that María loves him.’

Sentences corresponding to (118) are also possible in Faroese (Strahan 2011), even though this language does not have a subjunctive mood.

Strahan (2009, 2011) compares long distance binding in Mainland and Insular Scandinavian, and discusses the formalization of relevant binding conditions. An original idea is the use of outside-in (in addition to inside-out) functional uncertainty, to account for the role of the binder as a perspective-holder

3.12 Binding of distributive possessors

The Scandinavian languages can use prenominal distributive possessors to express distance distributivity. Examples are (119)–(120).

(119) Swedish
Vi har ätit varsitt äpple.
we have eaten each.3.REFL.POSS.NEUT apple
'We have eaten one apple each.'

(120) Eastern Norwegian
Vi har spist hver-t vår-t eple.
we have eaten each-NEUT 1.REFL.POSS-NEUT apple
'We have eaten one apple each.'

These distributive elements are composed of a distributive quantifier and a reflexive possessor (at least from a historical point of view). Lødrup et al. (2019) compare the grammar of these expressions in Standard Swedish and Eastern Norwegian, and find a number of differences. Eastern Norwegian has agreement that is lacking in Standard Swedish: The distributive quantifier agrees with the following noun in number and gender, and the possessor agrees with the subject in person and number. Another difference is that the Eastern Norwegian expression follows standard binding requirements, while this is not always necessary in Swedish.

Lødrup et al. (2019) give an analysis which is based upon an idea from Vangsnes (2002): The Swedish *varsitt* 'each.3.REFL.POSS.NEUT' is a single lexical unit, while its Eastern Norwegian correspondent is syntactically complex. They also give a semantic analysis in which the distributive possessor has the semantics of a Skolemized Choice Function.

4 Computational work

Computational approaches to Scandinavian grammar are not covered in this chapter. It could be mentioned, however, that seminal work on Norwegian grammar within LFG has been conducted in several computational linguistics projects at the University of Bergen. NorGram is a broad-coverage LFG grammar for Norwegian implemented on the XLE platform (Dyvik 2000, see also Forst & King 2023 [this volume]). Extensive online documentation of NorGram covers inter alia basic clause structure, lexical categories, phrase structure categories, and f-structure features.[11] NorGram has been used in the construction of the LFG treebank NorGramBank (Dyvik et al. 2016, see also Rosén 2023 [this volume]). For the treebank there is detailed documentation (in Norwegian) on how to search for various grammatical phenomena; it provides not only c- and f-structures, but also comments on the analyses.[12]

5 Conclusion

There is a rich LFG literature on various aspects of the Scandinavian languages, and it was impossible to do justice to it all in this chapter. Scandinavian data have played a role in the development of LFG, for example when it comes to binding conditions and functional categories. Chomskyan approaches have had a dominating position in Scandinavian syntax, and research in LFG has given alternative perspectives. It has produced results that are important both for Scandinavian and international linguistics.

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Chapter 34

LFG and Semitic languages

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This chapter surveys the work in LFG on the Semitic languages of Arabic, Hebrew and Maltese. The overview is structured around a number of themes and topics where there is LFG work on one or more of the Semitic languages. Successive sections look at basic clause structure, verbal complementation (including temporal and aspectual auxiliaries, phasal verbs, and perceptual report verbs), copula constructions, construct state nominals, mixed categories, negation and unbounded dependency constructions.

1 Introduction

The Semitic languages are part of the Afro-Asiatic family and the genus includes Arabic, Amharic, Tigrinya, Hebrew, Tigré, Maltese, Mehri and Jibbali *inter alia*. Of these, Arabic (including its many modern vernaculars, and the codified, formal variety Modern Standard Arabic (MSA)) is spoken over a very extensive geographical area with in the order of 250–300 million native language speakers, while Amharic, Tigrinya, Hebrew and Tigré all have numbers of speakers in excess of 1 million. Most work in LFG on this family is on (Modern) Hebrew, Arabic (Modern Standard (MSA) and the modern vernaculars) and Maltese (a mixed language with a Maghrebi/Siculo-Arabic stratum). Kifle (2007) and Kifle (2011) are concerned respectively with differential object marking and the applicative construction in Tigrinya, a Semitic language of Eritrea and Ethiopia; see Bodomo & Che 2023 [this volume] for further discussion of Tigrinya.[1]

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[1] Example sentences in this chapter have been taken from a number of different sources. In each case, the examples are given using the author's own transcription, with the exception of long vowels, where the notation has been standardised. On the other hand, some standardisation of glossing has been adopted to increase transparency.

Louisa Sadler. 2023. LFG and Semitic languages. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1651–1702. Berlin: Language Science Press. DOI: 10.5281/zenodo.10186020

2 Basic clause structure

Word order is relatively free in Arabic: there are two basic word orders generally claimed for msa (svo and vso), while svo structures predominate in the spoken vernaculars. Beyond LFG, a considerable literature has addressed the question of whether the preverbal position in svo structures is a genuine subject position or alternatively a dislocated or topicalised position, in particular in connection with msa which exhibits full agreement in the svo order and partial agreement in the vso order. While none of the LFG work on Arabic has a primary focus on matters of constituent structure (unlike quite a considerable volume of the theoretical work in other frameworks), basic clause structure for Arabic is covered to some extent in the theses by Alsharif (2014) (msa), Alotaibi (2014) (Hijazi), ElSadek (2016) (Egyptian), Alruwaili (2019) (Turaif) and Camilleri (2016) (Maltese). This work generally reflects the view that Arabic has two structural subject positions, [Spec, IP] and a lower position, and places the tensed verb in I.

Alsharif (2014) adopts an I+S (subject-predicate) analysis for the two basic word orders of msa, in which the subject appears in a different position in each word order, as shown in (2) (Alsharif 2014: 49–50),[2] and a similar position is adopted for vso and svo structures in Hijazi Arabic in Alotaibi (2014).

(1) msa (Alsharif 2014: 49;50)

a. ya-šrab-u Ali-un al-qahwat-a
3m-drink.ipfv-sg.ind Ali-nom def-coffee-acc
'Ali drinks the coffee.'

b. Ali-un ya-šrab-u al-qahwat-a
Ali-nom 3m-drink.ipfv-sg.ind def-coffee-acc
'Ali drinks the coffee.'

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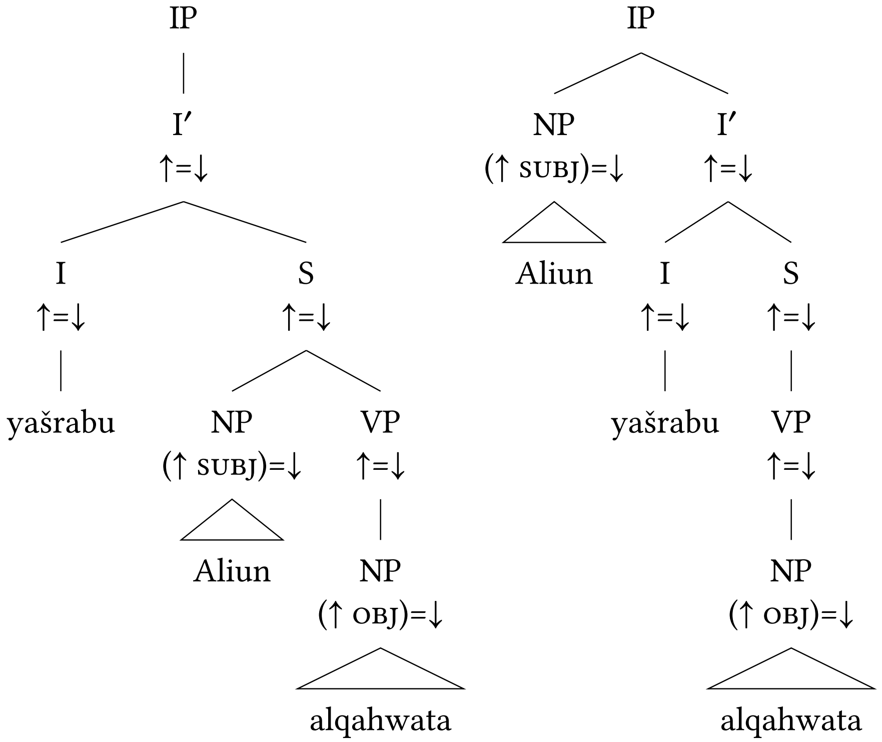
[2] Alsharif (2014) claims that for msa the subject in Spec of IP is associated with additional pragmatic information, but this is not explored further. The agreement asymmetry between SVO and VSO structures in msa where we find full agreement in SVO structures and partial agreement (person and gender) in VSO structures is not discussed but see Fassi Fehri (1988) for an early discussion of this issue. Many vernacular varieties lack this agreement asymmetry, but this is not the place to discuss this somewhat complex issue.

(2)



In a slight variant, both ElSadek (2016) and Alruwaili (2019) assume an I+VP structure for the basic neutral SVO word order in Egyptian Arabic and Turaif Arabic respectively.[3]

(3) Egyptian Arabic (ElSadek 2016: 90)
ʔel-walad katab el-gawāb
DEF-boy write.PFV.3M.SG DEF-letter
'The boy wrote the letter.'

(4) Turaif Arabic (Alruwaili 2019: 100)
ʕali kitɛb l-wāǧib
Ali write.PFV.3M.SG DEF-homework
'Ali wrote the homework.'

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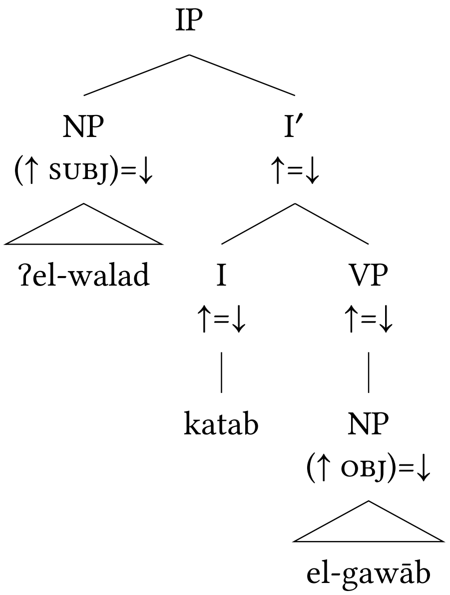
[3] As with many other vernaculars, VSO is a possible but less common variant in Turaif Arabic.

(5) (ElSadek 2016: 91)



In all of this work, an important motivation for the assumption that the verb expressing tense is in I is the fact that the very same (perfective and imperfective) forms express aspectual information when they occur in a lower position, in the compound tenses of Arabic (the examples (1a) and (6) provide a simple illustration of this property). There is some discussion of compound tenses in Arabic (involving forms of the ‘be’ verb as a temporal auxiliary) in a number of LFG sources and this literature includes both Aux-feature and Aux-PRED analyses for broadly comparable data across the dialects.

Alsharif (2014) adopts a single-tier or Aux-feature analysis for MSA examples such as (6), and a fuller development of this approach to compound tense formation in MSA is given in Alsharif & Sadler (2009).[4]

(6) MSA (Alsharif 2014: 52)

kāna	Ali-un	ya-šrab-u	al-qahwat-a
be.PFV.3M.SG	Ali-NOM	3M-drink.IPFV-SG.IND	DEF-coffee-ACC

‘Ali was drinking the coffee.’

---

[4] In the simple tenses of Arabic, the imperfective and perfective forms of the lexical verb are associated with TENSE. The compound tenses of Arabic and Maltese are formed by combining imperfective and perfective verb forms of the auxiliary ‘be’ (associated with TENSE) with perfective and imperfective forms of the lexical verb, which are then associated with ASPECT. Note that these forms still show subject agreement in their (embedded) aspectual use.

(7) MSA (Alsharif & Sadler 2009: 18)
kun-tu ʔaktub-u t-taqrīr-a
be.PFV-1SG write-IPFV.1SG the-report-ACC
'I was writing the report.'

(8)
$$\begin{bmatrix} \text{PRED} & \text{`WRITE}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{ASP} & \text{PROG} \\ \text{TENSE} & \begin{bmatrix} \text{PAST} & + \end{bmatrix} \\ \text{SUBJ} & \begin{bmatrix} \text{PERS} & 1 \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix}$$

(Alsharif & Sadler 2009: 18)

The Aux-feature account is also adopted by Alotaibi (2014) for Hijazi (Taif) Arabic and Alruwaili (2019) for Turaif Arabic, and by Camilleri (2016) for Maltese. In (10) the auxiliary elements *kont* 'be.PFV.1SG' and *qed* respectively contribute TENSE=PAST and ASPECT=PROG to the f-structure of the predicate *wash*.

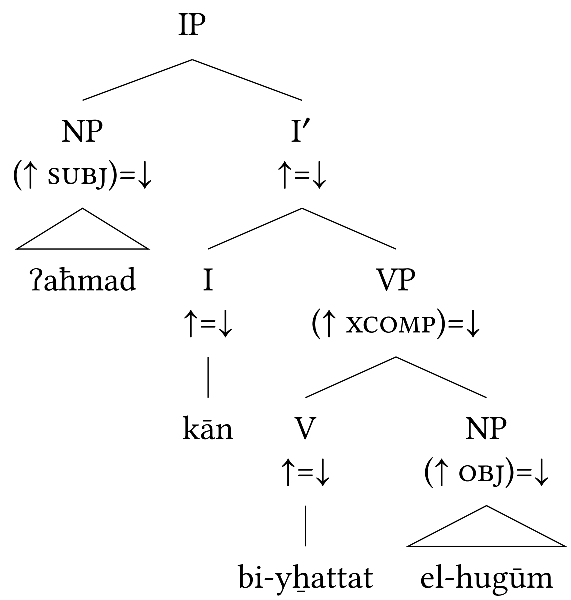
(9) Hijazi (Taif) Arabic (Alotaibi 2014: 37)
ʔaħmad kān yiğri fī al-ħadīqah ʔams
Ahmad be.PFV.3M.SG run.IPFV.3M.SG in DEF-garden yesterday
'Ahmad was running in the garden yesterday.'

(10) Maltese (Camilleri 2016: 19)
Kon-t qed n-a-ħsel il-karozza
be.PFV-1SG PROG 1-FRM.VWL-wash.IPFV.SG DEF-car
'I was washing the car.'

On the other hand, ElSadek (2016) presents some arguments in favour of the Aux-PRED analysis for Egyptian Arabic, in which the tense-aspect auxiliary *kān* is treated as a raising verb taking a VP XCOMP complement. The c-structure for (11) and f-structure for (13) below illustrate this approach. In work on the aspectual system of Libyan Arabic, Börjars et al. (2016) also provide arguments in support of an Aux-PRED approach to the facts which they discuss.

(11) Egyptian Arabic (ElSadek 2016: 91)
ʔaħmad kān bi-yẖattat el-hugūm
Ahmed be.PFV.3M.SG BI-plan.IPFV.3M.SG DEF-attack
'Ahmed was planning the attack.'

(12) (ElSadek 2016: 91)

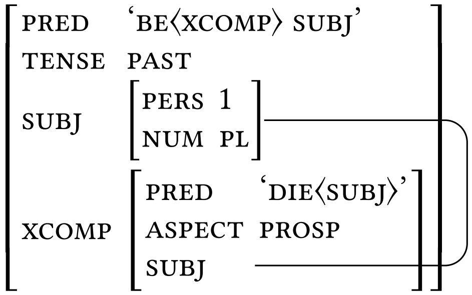


(13) Egyptian Arabic (ElSadek 2016: 90)

konna	ħa-nmūt
be.pfv.1pl	fut-die.ipfv.1pl

‘We were going to die.’

(14) (ElSadek 2016: 90)



3 Aspects of verbal complementation

Various further aspects of verbal complementation in the Arabic vernaculars are discussed in the LFG literature. Camilleri (2016) provides a detailed exploration of temporal and aspectual auxiliation in Maltese, articulating an unusually large set of features and values for this domain at f-structure. She also explores the use of the pseudo-verbs *għodd-* ‘almost’ *il-* ‘to’ and *għad-* ‘still’ as aspectual auxiliaries expressing the perfect aspect. The term pseudo-verb is used descriptively in work on the Arabic vernaculars to refer to a form which plays the role of a finite verb in the syntax but which is derived from a participle, preposition or nominal stem and usually retains many aspects of morphosyntactic realization reflecting this origin, such as exhibiting non-canonical forms of subject agreement. These forms raise many interesting issues for analysis, not least regarding their synchronic categorial identity. Camilleri argues that the universal perfect and the perfect of recent past are expressed syntactically in Maltese by the pseudo-verbs *il-* and *għad-* respectively (see (15) and (16)), while *għodd* provides an avertive construction. Applying a range of standard tests, she argues for an Aux-pred, raising analysis of these forms, along the lines shown in (18) and (19) for (16) and (17) respectively. Note that Maltese, like Arabic, lacks an infinitival form, and makes use of the imperfective form of the verb in these non-finite complements.

(15) Maltese (Camilleri 2016: 205)

Il-ni	n-i-kteb	mis-7
to-1sg.acc	1-frm.vwl-write.ipfv.sg	from.def-7

'I have been writing since 7 o'clock.'

(16) Maltese (Camilleri 2016: 213)

Kon-t	għad-ni	qed	n-i-kteb
be.pfv-1sg	still-1sg.acc	prog	1-frm.vwl-write.ipfv.sg

'I was still writing.'

(17) Maltese (Camilleri 2016: 213)

Kon-t	għodd-ni	xtraj-t	il-libsa
be.pfv-1sg	almost-1sg	buy.pfv-1sg	def-dress

'I had almost bought the dress.'

(18)

$$\left[\begin{array}{ll}
\textsc{pred} & \text{`}\textsc{għadni}\langle\textsc{xcomp}\rangle\textsc{subj}\text{'} \\
\textsc{tense} & \textsc{past} \\
\textsc{aspect} & \textsc{perfect} \\
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \end{array}\right] \\
\textsc{xcomp} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{nikteb}\langle\textsc{subj}\rangle\text{'} \\ \textsc{subj} & \rule{5em}{0.4pt} \\ \textsc{aspect} & \textsc{prog} \end{array}\right]
\end{array}\right]$$

(Camilleri 2016: 214)

(19)

$$\begin{bmatrix} \text{PRED} & \text{`GĦODDNI}\langle\text{XCOMP}\rangle\text{SUBJ'} \\ \text{CL-TYPE} & \text{AVERTIVE} \\ \text{TENSE} & \text{PAST} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PERS} & 1 \\ \text{NUM} & \text{SG} \end{bmatrix} \\ \text{XCOMP} & \begin{bmatrix} \text{PRED} & \text{`XTRAJT}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{SUBJ} & \underline{\qquad\qquad} \\ \text{ASPECT} & \text{PERFECTIVE} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`LIBSA'} \\ \text{DEF} & + \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(Camilleri 2016: 214)

The syntax and morphosyntax of phasal verbs, that is verbs which denote the inception, duration, continuation, completion or termination of a state or event (such as (20)), in the Arabic vernaculars is addressed in Alotaibi et al. (2013) (see also Camilleri 2016 and ElSadek 2016 for more extensive discussion of Maltese and Egyptian respectively). These verbs take verbal complements (or, particularly in Modern Standard Arabic, nominalised verbal complements) and typically disallow intervening material between the aspectual verb and its verbal complement (which generally lacks a complementising particle). The aspectual verb and the embedded verb have the same subject, which is not expressed as an NP in the lower clause. The embedded verb shows subject agreement and is usually an imperfective form (Arabic lacks an infinitive form). Using standard tests, Alotaibi et al. (2013) show that a raising analysis is motivated for these verbs in examples such as (20) and (21) below.[5]

(20) Egyptian Arabic (Alotaibi et al. 2013: 17)

a.

el-walad	ma-badaʔ-š	ya-kul
def-boy	neg-start.pfv.3m.sg.neg	3-eat.ipfv.m.sg

‘The boy didn’t start to eat.’

b.

el-walad	badaʔ	ma-ya-kul-š
def-boy	start.pfv.3m.sg	neg-3-eat.ipfv.3m.sg.neg

‘The boy started to not eat.’

---

[5] In addition to occurring in a raising structure, some of the class of phasal verbs also occur in a ‘subjectless’ variant with a default 3m.sg phasal verb and a subject expressed within the embedded complement, a structure which provides an expletive subject counterpart to the raising structure.

(21) a. Hijazi Arabic (Alotaibi et al. 2013: 20)
al-maḥṣūl bada ya-n-ğimʕ
DEF-harvest start.PFV.3M.SG 3-PASS-gather.IPFV.M.SG
'The harvest started being gathered.'

b. Maltese (Alotaibi et al. 2013: 20)
L-iltiema bde-w j-i-n-ġabr-u
DEF-orphans begin.PFV.3-PL 3-FRM.VWL-PASS-gather.IPFV-PL
'The orphans started being gathered (together).'

Camilleri et al. (2014b) discuss perceptual report predicates in MSA and in Maltese. The MSA verb *yabdū* 'seem, appear' occurs in an expletive subject (or 'subjectless') construction taking a complement introduced by the declarative complementising particle *ʔanna*. While it does not permit subject raising (SSR) they argue that it does permit copy raising (CR) with the complementising particle *kaʔanna* 'as if'. In the CR construction, the copy pronoun is not restricted to the embedded SUBJ role and may occur in a wide range of nominal GFS in the embedded complement.

In Maltese the perceptual report predicates include the verb *deher* 'seem/appear' and the pseudo-verbs *donn*+PRN (diachronically the imperative of 'believe/think') and *qis*+PRN, both meaning 'seem/appear/taste/sound as.though/as.if'. (22) exemplifies the expletive construction with the verb *deher*, in which the verb appears in the default 3M.SG form and the subject is expressed only in the embedded COMP. In (23) the subject is in the matrix clause and both matrix and embedded verbs agree with it. Camilleri et al. (2014b) argue that evidence from standard tests for raising (idiom chunks, meaning preservation under passivisation, expletives, etc) suggests that (23) and similar examples are SSR.

(22) Maltese (Camilleri et al. 2014b: 191)
J-i-dher t-tfal sejr-in tajjeb
3-FRM.VWL-appear.IPFV.M.SG DEF-children going.ACT.PTCP-PL good.M.SG
'It seems the children are doing well.'

(23) Maltese (Camilleri et al. 2014b: 191)
It-tfal dehr-u qed j-ieħd-u gost
DEF-children appear.PFV.3-PL PROG 3-take.IPFV-PL pleasure
'The children seem (as though) they are enjoying themselves (lit: taking pleasure).'

However, Maltese *deher* also occurs in what looks like a copy raising (cr) construction, in which a pronominal coreferential with the subj of the raising predicate *deher* occurs as an argument within the embedded complement. This is illustrated in (24) where the obj pronominal inflection *-ha* in the form *weġġagħ-ha* 'hurt.caus.pfv.3m.sg-3f.sg.acc' is coreferential with the (inflectionally-expressed) matrix subj (indicated by the dashed line between anaphor and antecedent in (25)).

(24) Maltese (Camilleri et al. 2014b: 195)

Marija	t-i-dher	weġġagħ-ha	sew,	Mario
Mary	3-frm.vwl-appears.f.sg	hurt.caus.pfv.3m.sg-3f.sg.acc	well	Mario

'Mary seems as though Mario hurt her a lot.'

(25)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{seem}\langle\textsc{comp}\rangle\textsc{subj}\text{'} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{`Marija'} \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{fem} \\ \textsc{pers} & 3 \end{bmatrix} \\ \textsc{comp} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{hurt}\langle\textsc{subj,obj}\rangle\text{'} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{mario}\text{'} \end{bmatrix} \\ \textsc{obj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{pro}\text{'} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(Camilleri et al. 2014b: 196)

The analysis which Camilleri et al. (2014b) develop of the syntax and semantics of these perceptual report predicates builds on Asudeh & Toivonen's (2012) work on English and Swedish. Because Maltese (and Arabic in general) is both a pro-drop language and uses the imperfective form of the verb in non-finite complement clauses (lacking an infinitive form), examples such as (23) could in principle involve either raising or copy raising. They argue that there is a clear contrast between ssr examples such as (23), in which any aspect of the eventuality can be the perceptual source, and cr examples such as (26) in which it is the raised subj itself that is necessarily the individual psource. In the Maltese cr construction, the pronominal copy can correspond to a very wide range of embedded functions. It is also not limited to the immediately embedded comp but within the topmost embedded comp it is restricted to non-subject functions.

(26) Maltese (Camilleri et al. 2014b: 192)
T-i-dher ġa ta-w-ha xebgħa
3-FRM.VWL-seem.IPFV.F.SG already give.PFV.3-PL-3F.SG.ACC smacking
xogħol x't-a-għmel!
work what.3-FRM.VWL-do.IPFV.F.SG
'She$_i$ seems like they already gave her$_i$ a whole load of work to do!'

While Camilleri et al. (2014b) are concerned with canonical verbal perceptual report predicates in MSA and Maltese, ElSadek & Sadler (2015) look at the expression of perceptual reports in Egyptian Arabic using the active participle *bāyen* 'show, appear' and in particular at the use of the (noun-derived) pseudo-verb *šakl* (>'form, shape') as a perceptual report predicate. *bāyen* can occur in a construction in which the active participle is followed by a PP which expresses the (visible) individual PSOURCE with either the standard sentential complementiser *ʔin* (corresponding to the MSA complementiser *ʔanna*) or the 'evidential' complementiser *kaʔin* (cognate with MSA *kaʔanna*). The active participle must be in the default form but a temporal auxiliary may agree with the nominal PSOURCE in the PP, as illustrated in (27), in what may be a case of parasitic or miscreant agreement.

(27) Egyptian Arabic (ElSadek & Sadler 2015: 92)
konti bāyen ʕalē-ki ʔinn-ik
be.PFV.2F.SG show.ACT.PCTP.M.SG on-2F.SG that-2F.SG
mabsūt-a
happy.PASS.PTCP.SG-F
'You seemed happy.'

With *šakl*, there is rather clearer evidence of raising. (28) illustrates a very common means of expressing a perceptual report. It involves what appears morphosyntactically to be a nominal form *šakl* 'form, shape' with a dependent 'possessor' corresponding to the individual about whom the report is made. Notice in (28) that it is the dependent 'possessor' (the pronominal affix) which controls agreement on the ACT.PTCP, and similarly in an example such as (29). Synchronically, this form appears to operate as a pseudo-verb here, in a raising structure.

(28) Egyptian Arabic (ElSadek & Sadler 2015: 95)
šakl-ohom mestaney-īn ħāga mohemma
form-3PL wait.ACT.PTCP-PL thing important
'They seem to be waiting for an important thing.'
'It seems they're waiting for an important thing.'

(29) Egyptian Arabic (ElSadek & Sadler 2015: 98)
šakl el-welād kānu biyitderbo
form DEF-boys be.PFV.3PL beat.BI.IPFV.PASS.3PL
'The boys seem to have been (being) beaten.'

In structures such as (28) and (29) the dependent NP or pronoun is not obligatorily interpreted as the individual PSOURCE. In a different structure, illustrated in (30), we find a sentential complement introduced by the complementising particle *kaʔin*, with no requirement that the dependent NP/pronoun be co-referential with the subject of the (embedded) predication, and these structures *are* associated with a clear individual PSOURCE interpretation.

(30) Egyptian Arabic (ElSadek & Sadler 2015: 98)
šakl el-welād kaʔenn-aha darabet-hom
form DEF-boys as.if-3F.SG beat.PFV.3F.SG-3PL
'The boys seem as if she's beaten them.'

Other work on aspects of complementation includes the following. ElSadek (2016) discusses the causative *χalla* 'make', aspectual/phasal verbs and modal verbs, proposing analyses involving functional and anaphoric control. Alotaibi et al. (2013) concerns the description and analysis of experiencer-object psychological predicates (*frighten* or *please* class – EOPVS) in Hijazi Arabic, Egyptian Arabic and Maltese and proposes that the interaction of EOPVS with aspectual raising predicates involves copy raising (CR). An analysis of aspectual object marking in Libyan Arabic is provided in Börjars et al. (2016). In Libyan Arabic, the presence of the preposition *fi* before the direct object of a transitive verb in the imperfective form provides a continuous or habitual aspectual value to the clause (see (31)), which Börjars et al. (2016) model by means of a clause feature INTERIOR=+.

(31) Libyan Arabic (Börjars et al. 2016: 126)

a. aħmed kle el-koski
Ahmed eat.PST.3M.SG DEF-couscous
'Ahmed ate couscous.'

b. aħmed yākil fi el-koski
Ahmed eat.IPFV.3M.SG FI DEF-couscous
'Ahmed eats/is eating couscous.'

4 Copula sentences

Both Hebrew and Arabic have copula sentences without an overt copula head, as well as copula sentences with a 'pronominal copula', and a variety of copula-type elements which mark existential constructions of various sorts. Predicative (copula) sentences with no copula receive present tense interpretations, while an appropriate form of *be* signals other temporal interpretations. The examples in (32) illustrate this alternation between the 'null' and overt copula in Hebrew with adjectival, nominal and prepositional predicates.

(32) a. Hebrew (Falk 2004: 227)
Pnina nora xamuda/ tinoket/ b-a-bayit
Pnina awfully cute.f/ baby.f/ in-def-house
'Pnina is awfully cute/a baby/in the house.'

b. Pnina hayta nora xamuda/ tinoket/ b-a-bayit
Pnina be.pst.3f.sg awfully cute.f/ baby.f in-def-house
'Pnina was awfully cute/a baby/in the house.'

As well as the zero realisation in the predicative clauses in (32), the so-called pronominal copula also occurs with predicative complements in Hebrew, as well as with a definite NP complement in an equative copula construction, in paradigmatic opposition with forms of *be* giving temporal interpretations other than the present.[6]

(33) a. Hebrew (Falk 2004: 227)
Pnina hi nora xamuda/ ha-tinoket
Pnina pron.3f.sg awfully cute.f/ def-baby.f
'Pnina is awfully cute/the baby.'

b. Pnina hayta nora xamuda/ ha-tinoket
Pnina be.pst.3f.sg awfully cute.f/ def-baby.f
'Pnina was awfully cute/the baby.'

---

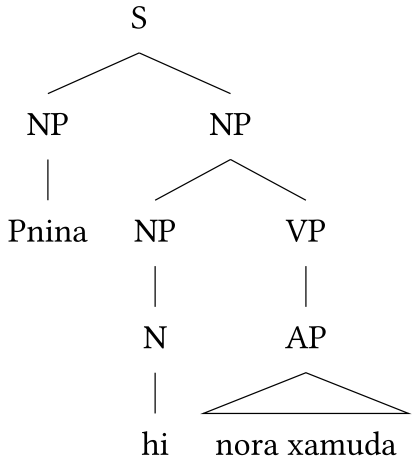
[6] The distribution of the null copula and the pronominal copula strategy in Arabic is similar, but not identical. For example, in Hebrew examples with predicative nominals and PPs are well-formed in the complement of the pronominal copula, but these structures are not found in (most) Arabic vernaculars.

(i) Hebrew (Sichel 1997: 296)
Rina hi talmid-a/xaxam-a/b-a-bayit
Rina pron.3f.sg student-f/intelligent-f/in-def-house
'Rina is a student/intelligent/at home.'

The pronominal copula forms of Hebrew and Arabic have received considerable analytic attention outside LFG. Within LFG, Falk (2004) develops a mixed category analysis of the pronominal copula *hi* and its inflectional counterparts in Hebrew, taking it to be categorially nominal but functionally verbal. It is argued to have categorially mixed properties in taking 'verbal' complements (e.g. accusative objects) and heading a constituent with a clausal distribution, but occurring in an N position.[7] (34) is the lexical entry for the copula use of *hi*; the c-structure and f-structure for (33) are shown in (35) and (36) respectively.[8] The final line in (34) is satisfied if the category VP is a member of the set of c-structure nodes mapping to the f-structure denoted by ↑. This requirement is satisfied in the c-structure shown in (35).

(34) *hi* N (↑ PRED)='BE⟨SUBJ,PREDLINK'⟩ (Falk 2004: 233)
(↑ TENSE)=PRES
(↑ SUBJ GEND)=F
(↑ SUBJ NUM)=SG
VP ∈ CAT(↑)

(35)



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[7] In Hebrew, the sentential negator *lo* appears before a verb but between the pronominal copula and the following predicative element, which is taken to support the conclusion that the pronominal copula is not a V in c-structure.

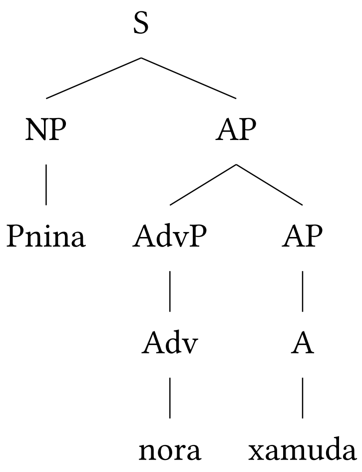
[8] Note that although this is a mixed category analysis, because Falk (2004) assumes an NP node dominating the N *hi*, the N is not the extended head of VP and AP, according to the standard definition of extended head (Bresnan et al. 2016: 136).

(36)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{be}\langle\textsc{subj}, \textsc{predlink}\ \rangle\text{'} \\ \textsc{tense} & \textsc{pres} \\ \textsc{subj} & \left[\begin{array}{ll}\textsc{pred} & \text{`Pnina'} \\ \textsc{gend} & \textsc{f} \\ \textsc{num} & \textsc{sg}\end{array}\right] \\ \textsc{predlink} & \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{cute}\text{'} \\ \textsc{adj} & \left\{\left[\text{“}\textsc{awfully}\text{”}\right]\right\}\end{array}\right]\end{array}\right]$$

(Falk 2004: 234)

While the pronominal copula is treated as a PRED-bearing element with a PREDLINK complement (see (34) above), giving a closed, two-tier analysis of these copula sentences, those with no copula are treated as simple single-tier predications (“such sentences are most naturally analysed as involving an exocentric S, with direct predication by the non-verbal element” (Falk 2004: 235)). The analysis of an example such as (32a) which lacks the pronominal copula is along the lines shown in (37–38). On this analysis, non-verbal predicational elements which appear in both the null copula and the pronominal copula constructions must be associated with two lexical entries, the predicational (i.e. SUBJ-subcategorising) PRED value (for the null copula construction) being a lexical extension of the non-predicational one (as can be seen by comparing the relevant PRED values in (36) and (38) respectively).

(37)



(38)
$$\left[\begin{array}{ll} \textsc{tense} & \textsc{pres} \\ \textsc{subj} & \left[\begin{array}{ll}\textsc{pred} & \text{`Pnina'} \\ \textsc{gend} & \textsc{f} \\ \textsc{num} & \textsc{sg}\end{array}\right] \\ \textsc{pred} & \text{`}\textsc{cute}\langle\textsc{subj}\rangle\text{'} \\ \textsc{adj} & \left\{\left[\text{“}\textsc{awfully}\text{”}\right]\right\}\end{array}\right]$$

(Falk 2004: 235)

An interesting consequence of this analysis is that the distinction between individual level predication and stage-level predication is reflected in f-structure. Individual level predication uses the pronominal copula and therefore is associated with a two-tier analysis, while stage-level predication (with no copula) is associated with a single simple f-structure (Falk 2004: 236). This contrast in interpretation is illustrated in (39).

(39) Hebrew (Falk 2004: 236–237)

a. ha-dinozaur hu vsikor
def-dinosaur pron.m.sg drunk.m.sg
'The dinosaur is a drunkard.'

b. ha-dinozaur vsikor
def-dinosaur drunk.m.sg
'The dinosaur is drunk.'

Copula clauses with forms of the verb *haya* 'be' are functionally equivalent to both the zero and the pronominal copula constructions, as shown in (32b) and (33b) above. This means that the lexical entry for *haya* must have an optional pred value (see (40)). As a consequence, a sentence such as (41) will be associated with one c-structure and the two f-structure analyses shown in (42) and (43), that is, it will be analysed as functional ambiguous.

(40) *hayta* N ((↑ pred)='be⟨subj, predlink⟩')
(↑ tense)=past
(↑ subj gend)=f
(↑ subj num)=sg

(41) Hebrew (Falk 2004: 227)
Pnina hayta nora xamuda
Pnina be.pst.3f.sg awfully cute.f
'Pnina was awfully cute.'

(42)
$$\left[\begin{array}{ll} \textsc{tense} & \textsc{past} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{Pnina}\text{'} \\ \textsc{gend} & \textsc{f} \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \textsc{pred} & \text{`}\textsc{cute}\langle\textsc{subj}\rangle\text{'} \\ \textsc{adj} & \left\{\left[\text{``}\textsc{awfully}\text{''}\right]\right\} \end{array}\right]$$

(Falk 2004: 237)

(43)
$$\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{be}\langle\textsc{subj, predlink}\ \rangle\text{’} \\ \textsc{tense} & \textsc{past} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{Pnina}\text{’} \\ \textsc{gend} & \textsc{f} \\ \textsc{num} & \textsc{sg} \end{array}\right] \\ \textsc{predlink} & \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{cute}\text{’} \\ \textsc{adj} & \left\{\left[\text{“}\textsc{awfully}\text{”}\right]\right\} \end{array}\right] \end{array}\right]$$

(Falk 2004: 237)

For MSA, Attia (2008) discusses predicative and locational copula clauses lacking an overt copula form and associates a *be* PRED with the absence of a copula, treating the predicative complement as a PREDLINK. His contention is that the adjective cannot be the head because the subject and the adjective both take what is considered to be default nominative case, while in the presence of an overt copula the adjective will have accusative case. (44) and (45) show this contrast.

(44) MSA (Attia 2008: 94)
al-marʔat-u karīmat-un
DEF-woman.F.SG-NOM generous.F.SG-NOM
‘The woman is generous.’

(45) MSA (Attia 2008: 100)
kāna ar-rağul-u karīm-an
was DEF-man.M.SG-NOM generous.M.SG-ACC
‘The man was generous.’

While agreement between the adjective and the clausal subject could be captured simply and transparently by a local SUBJ agreement statement on a two-tier analysis with an open predicational complement (that is, an XCOMP analysis along the lines of a raising predicate) this mechanism is not available on the (closed complement) PREDLINK analysis, since the PREDLINK does not contain a SUBJ. Attia (2008) suggests that agreement specifications should be associated with the c-structure rules, as in (46), adapted from Attia (2008: 104).

(46)
$$\text{S} \longrightarrow \begin{array}{c} \text{NP} \\ (\uparrow \textsc{subj}){=}\downarrow \end{array} \left\{ \begin{array}{c} \text{VCop} \\ \uparrow{=}\downarrow \\ \end{array} \middle| \begin{array}{c} \epsilon \\ (\uparrow \textsc{pred}){=}\text{‘}\textsc{null-be}\langle\textsc{subj, predlink}\rangle\text{’} \\ (\uparrow\textsc{tense}){=}\textsc{pres} \end{array} \right\} \begin{array}{c} \{\ \text{NP} \mid \text{AP}\ \} \\ (\uparrow \textsc{predlink}){=}\downarrow \\ (\downarrow \textsc{gend}){=}(\uparrow \textsc{subj gend}) \\ (\downarrow \textsc{num}){=}(\uparrow \textsc{subj num}) \end{array}$$

The f-structure of a simple predicative copula sentence such as (47) is (48) on this analysis.

(47) MSA (Attia 2008: 107)
huwa ṭālib-un
he student.NOM
‘He is a student.’

(48)
$$\begin{bmatrix} \text{PRED} & \text{`NULL-BE}\langle\text{SUBJ, PREDLINK }\rangle\text{'} \\ \text{TENSE} & \text{PRES} \\ \text{SUBJ} & \begin{bmatrix}\text{PRED `HE'}\end{bmatrix} \\ \text{PREDLINK} & \begin{bmatrix}\text{PRED `STUDENT'}\end{bmatrix} \end{bmatrix}$$
(Attia 2008: 107)

The ‘null-be⟨SUBJ, PREDLINK⟩’ analysis is not adopted across the board for the Arabic copula clause. Alsharif (2014) treats verbless predication in MSA with a single-tier analysis and no ‘null-be’ PRED, as does Alruwaili (2019) for Turaif Arabic. In these analyses the lack of an overt verb is associated simply with TENSE=PRES. Alruwaili (2019) treats the Arabic pronominal copula of equational sentences, illustrated in (49), as an element in I with the PRED value ‘hi⟨SUBJ,OBJ⟩’, though without providing much discussion of this analytic choice.

(49) Turaif Arabic (Alruwaili 2019: 109)
huda hī l-mudīr-a
Huda COP.3F.SG DEF-director-F.SG
‘Huda is the director.’

5 Construct state nominals

A considerable theoretical literature addresses the syntax of the *construct state nominal* (or *construct*) (CSN) in Modern Hebrew and Arabic, a construction of central importance in the grammar of these languages. This construction, illustrated in (50)–(52), has a range of distinctive properties: it is left-headed, the head cannot be inflected for definiteness and may occur in a bound form, the *construct state*, depending on language and inflectional class. In MSA the dependent is genitive. A further key property is lack of interruptibility of the head-dependent construction, so that any adjectival modifiers of the head noun follow the entire construct (including any modifiers of the non-head dependent itself), as in example (53). A range of different relations may hold between the head and the non-head or dependent, including possession, partitivity, kinship, identity, measurement and composition, though the range of the construction differs between languages and dialects.[9]

(50) Hebrew (Falk 2007: 106)
mamlexet norvegia
kingdom.CONSTR Norway
‘the kingdom of Norway’

(51) Lebanese Arabic (Ouwayda 2012: 77)
sayyaret l-estez
car.F.SG.CONSTR DEF-teacher
‘the teacher’s car’

(52) Syrian Arabic (Hallman 2018: 258)
ʕamm l-ʕrāus
uncle DEF-bride
‘the uncle of the bride’

(53) Hebrew (Falk 2007: 106)
dodat ha-balšan ha-generativi ha-zkena
aunt.CONSTR DEF-linguist DEF-generative.M DEF-old.F
‘the generative linguist’s old aunt’

(54) Jordanian Arabic (Alhailawani 2018: 152)
bait il-mara il-jdīd
mouse.M.SG DEF-woman.F.SG DEF-new.M.SG
‘the woman’s new house’

As well as the CSN, Hebrew and the Arabic vernaculars have an analytic or free state genitive construction with a distribution which partially overlaps that of the CSN. The following examples illustrate (note that a variety of different “linking elements” are found in the various Arabic vernaculars).

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[9] There are also modificational constructs which get a kind reading as in (i). These are not discussed in any detail in the LFG literature.

(i) Lebanese Arabic (Ouwayda 2012: 77)
abbouʕet sherti
hat cop
‘a cop’s type of hat’

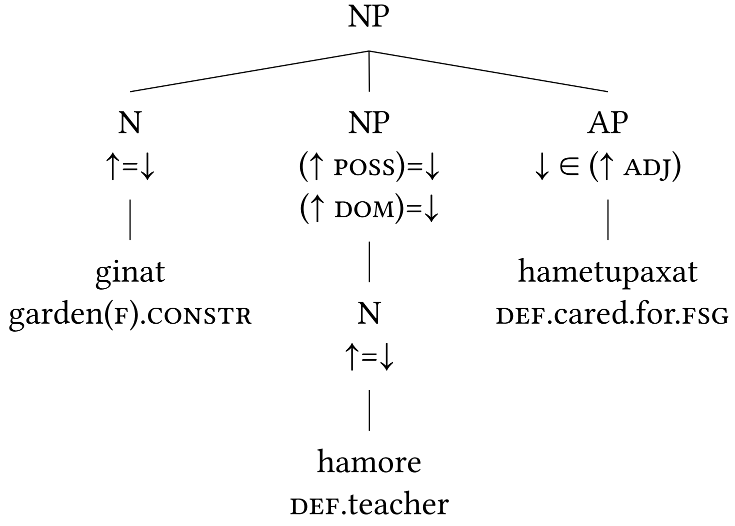
(55) Lebanese Arabic (Ouwayda 2012: 77)
l-sayyara tabaʔ l-estez
DEF-car of DEF-teacher
‘the teacher’s car’

(56) Hebrew (Falk 2007: 104)
ha-doda ha-zkena šel ha-balšan
DEF-aunt DEF-old of DEF-linguist
‘the old aunt of the linguist’

Falk (2001) provides a detailed examination of the constituent structure of NPs containing a *construct* in Hebrew, concluding that despite the closely bound nature of the CSN[10] the N+possessor/dependent does not form a constituent to the exclusion of the head-modifying AP; the c-structure proposed for (57) is thus (58).[11] The c-structure rule is shown in (59): the ↓ ∈(↑ ADJ) annotation is for the sort of modificational example noted in footnote 9 above which also occur in Hebrew e.g. *bigdey yeladim* ‘clothing.CONSTR children’ (children’s clothing), and is not directly relevant to our discussion below.

(57) Hebrew (Falk 2001: 85)
ginat ha-more ha-metupax-at
garden(F).CONSTR DEF-teacher(M) DEF-cared.for-F.SG
‘the teacher’s tended garden’

(58) (Falk 2001: 85)



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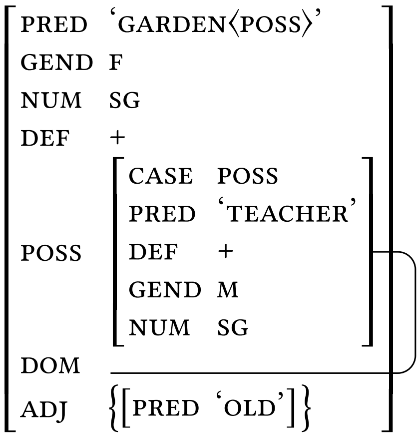
[10] The construct state (of the head noun) is a morphophonological form limited to occurrence within this construction, and within compounds.

[11] Falk (2007) assumes that any PP modifiers or arguments of the head N are adjoined to the NP, citing a similar proposal developed for Welsh NP structure in Sadler (2000).

(59) $$\begin{array}{llll} \text{NP} \longrightarrow & \text{N} & \text{NP} & \text{AP*} \\ & \uparrow=\downarrow & (\uparrow \textsc{dom})=\downarrow & \downarrow \in (\uparrow \textsc{adj}) \\ & & \{\, (\uparrow \textsc{poss})=\downarrow \mid & \\ & & \downarrow \in (\uparrow \textsc{adj}) \,\} & \end{array}$$ (Falk 2001: 91)

The c-structure rule annotations state that the dependent NP is the value of both a POSS function and a DOM attribute. Nouns are treated as optionally subcategorising for a POSS, which may be expressed by means of the dependent NP in a CSN, or by means of the alternative free genitive construction. The basic property of the construct form is the tight bond it forms with the dependent (reflected in the choice of a particular variant form of the head noun). Modelling his analysis in part on Wintner's (2000) use of a DEP attribute in his HPSG analysis, Falk introduces a DOM attribute associated with the immediately post-head constituent. The dependency between the head in the construct state and the dependent NP is thus captured in the f-structure – the construct form (and only this form) selects a DOM attribute, which is also the value of the POSS feature (the f-description (↑ DOM) is an existential constraint, requiring the presence of a DOM attribute in the satisfying f-structure). Construct forms cannot occur in other syntactic environments. In a CSN the definiteness value of the construction as a whole is "inherited" from the dependent nominal. This is captured in the lexical entry shown in (60) for the construct form of the noun *gina* 'garden', i.e. *ginat* by the f-description (↑ DEF)=(↑ DOM DEF). The f-structure is shown in (61). In contrast to nouns in construct form, free form nouns are specified as ¬(↑ DOM).

(60) *ginat* (↑ PRED)='GARDEN⟨(POSS)⟩' (Falk 2001: 92)
(↑ NUM)=SG
(↑ GEND)=F
(↑ DOM)
(↑ DEF)=(↑ DOM DEF)

(61)


(Falk 2001: 92)

Adjectival modifiers in Hebrew and Arabic show definiteness agreement, in addition to agreement in more canonical agreement features such as num and gend. In a csn the definiteness value of the construction as a whole is determined by that of the poss or dependent NP, as illustrated in (53), (54) and (57) above. Definiteness agreement is simply captured by associating the relevant inside-out statement (e.g. ((adj ↑) def=+) with the attributive adjective.

Simply put, the essence of Falk's (2001) analysis is a lexical distinction between construct forms of nouns, which are specified as (↑ dom) and free forms, which are ¬(↑ dom) by default, a special ps rule which takes care of the adjacency requirement, and the association of the dependent NP with the poss function. Notice that the occurrence of a poss function and the use of the construct form are not co-extensive: some dependent NPs are adj, rather than poss functions, as noted above, and some poss functions are realised by means of the free genitive construction illustrated in (56) above. It is for this reason that Falk's account separates the requirement for a dependent (dom) from the function of the dependent (normally poss).

Falk (2007) further develops the analysis of the csn presented in Falk (2001), providing more extensive discussion of the distribution of the 'short' (i.e csn-internal) and 'long' (i.e. *šel*-PP) possessor constructions (i.e. examples such as (56) above). For example, while both constructions are available for relational nouns, true possession in Hebrew is normally expressed by using the *šel* construction (use of the csn being limited to more formal registers). By contrast, for naming places and periods of time, Hebrew uses only the short construction (see (50)). There are two main theoretical developments, concerning the identification of grammatical functions and the treatment of definiteness and definiteness inheritance.

While Falk (2001) calls the grammatical function of the dependent NP poss, Falk (2007) offers a more articulated account, replacing this function by $\widehat{\text{GF}}$. The notation $\widehat{\text{GF}}$ stands for the most prominent argument in an f-structure (typically the subj in a clausal f-structure); Falk (2006) introduces this notation, arguing that the grammatical function subj should be deconstructed into the most prominent function, notated $\widehat{\text{GF}}$ and an 'overlay' function, pivot, a function of cross-clausal connection. The dependent in examples such as (62) involving a relational noun then is treated as the $\widehat{\text{GF}}$ (rather than poss), and the overlay function is argued to be def (replacing the dom of the earlier account), licensed through structure-sharing (with $\widehat{\text{GF}}$) as stated in (65). As noted above, the head noun in a construct nominal cannot itself be inflected for definiteness and it is the possessor, or $\widehat{\text{GF}}$ dependent which determines the definiteness of the construction as a whole. (59) is replaced by (63), but expresses essentially the same analysis.[12]

(62) Hebrew (Falk 2007: 104)
dodat ha-balšan ha-zkena
aunt.CONSTR DEF-linguist DEF-old.F
'the linguist's old aunt'

(63) $$\begin{array}{lllll} \text{NP} \longrightarrow & \text{N} & \text{NP} & \text{AP}^* & \text{Falk (2007: 113)} \\ & \uparrow{=}\downarrow & (\uparrow \text{DEF}){=}\downarrow & \downarrow \in (\uparrow \text{ADJ}) & \\ & & (w\ (\lessdot)\ \text{MORPHTYPE}){=}\text{BND} & & \end{array}$$

(64) $$\begin{bmatrix} \text{PRED} & \text{'AUNT}\langle\widehat{\text{GF}}\rangle\text{'} \\ \text{GEND} & \text{F} \\ \text{NUM} & \text{SG} \\ \widehat{\text{GF}} & \\ \text{DEF} & \begin{bmatrix} \text{PRED} & \text{'TEACHER'} \\ \text{DEF} & + \\ \text{NUM} & \text{SG} \end{bmatrix} \\ \text{ADJ} & \left\{ \begin{bmatrix} \text{PRED} & \text{'OLD'} \end{bmatrix} \right\} \end{bmatrix}$$ (Falk 2001: 92)

(65) $(\uparrow\text{DEF}){=}(\uparrow \widehat{\text{GF}}) \mid (\uparrow \text{OBL}_{\text{CON}}) \mid (\uparrow \text{OBL}_{\text{THEME}}) \mid (\uparrow \text{OBL}_{\text{NAME}})$ (Falk 2007: 120)

The re-entrancy stated in (65) takes account of the range of functions which can be expressed within the CSN (replacing the POSS of the previous analysis). An example such as (66) is associated with an OBL_{CON} function (as well as being the value of DEF): other functions which can be expressed by the dependent nominal in a CSN are OBL_{NAME} and $\text{OBL}_{\text{THEME}}$ – the latter for concrete nouns with a Theme argument as in (67).

(66) Hebrew (Falk 2007: 117)
kos kafe
cup coffee
'a cup of coffee'

(67) Hebrew (Falk 2007: 122)
targumey ha-odisea šel ha-sifriya
translation.CONSTR DEF-Odyssey of DEF-library
'the library's translation of the Odyssey'

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[12] The annotation (w ($\lessdot$) MORPHTYPE)=BND on the dependent NP specifies that the left sister of the NP's word structure is a bound form.

6 Mixed categories

An analysis of the Hebrew action nominal (and NP structure more generally) is offered in Falk (2001) and further developed in Falk (2007). These papers treat action nominals such as (68) as displaying a ‘verbal’ mapping to arguments, signalled by the existence of the ACC-marked OBJ, while others display a purely nominal mapping. In the ‘verbal’ action nominal, the agent argument is realized within the CSN (i.e. as a ‘short’ possessor) or in a *šel*-PP (‘long’ possessor). In each case, it is argued that the c-structure of the action nominal is mixed.

(68) Hebrew (Falk 2007: 117)

a. sgirat ha-mankal [et ha-misrad]
closure.CONSTR DEF-director ACC DET-office
‘the director’s closure of the office’

b. ha-sgira šel ha-mankal [et ha-misrad]
DEF-closure of DEF-director ACC DET-office
‘the director’s closure of the office’

The analysis of an example such as (68a) in Falk (2001) is as follows. The nominal has a mixed c-structure captured in (69), where λ is the category labelling function. A c-structure with both NP and VP projections is required to satisfy this set of constraints, motivating the c-structure rule in (70). Alongside this is the assumption that Hebrew actional nominals have the specification (↑ POSS)=(↑ SUBJ) and hence the f-structure in (71) arises for the accusative Hebrew actional nominal such as (68a) (given the treatment of dependent NP within the CSN developed in Falk 2001). The fundamental insight concerning the f-structure of ‘verbal’ action nominals is that they have a verbal argument structure mapping (e.g. to SUBJ and OBJ) but realise their SUBJ as a POSS.[13] The c-structure proposed by Falk for the ‘verbal’ action nominal is shown in (72).[14]

(69) (↑PRED)=‘close$< < x, y >_v >_n$ (Falk 2001: 96)
v: VP $\in \lambda\ (\phi^{-1}\ (\uparrow)\ )$
n: NP $\in \lambda\ (\phi^{-1}\ (\uparrow)\ )$

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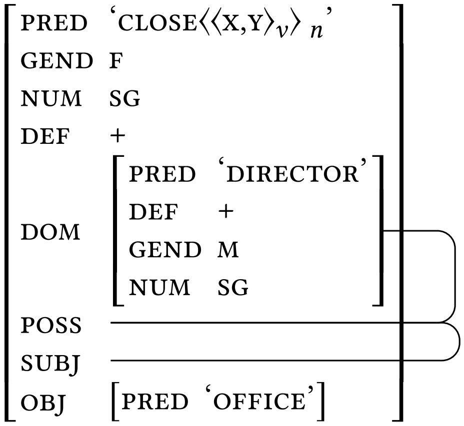
[13] The argument mapping for (68b) will be similar although there will be no DOM feature because the POSS is not realized within a CSN.

[14] As a technical aside, note that although this is a mixed category analysis, according to the standard definition of extended head (Bresnan et al. 2016: 136) the N is not the extended head of the VP, because of the intervening NP node which dominates the CSN, a matter which is not discussed in Falk (2001, 2007).

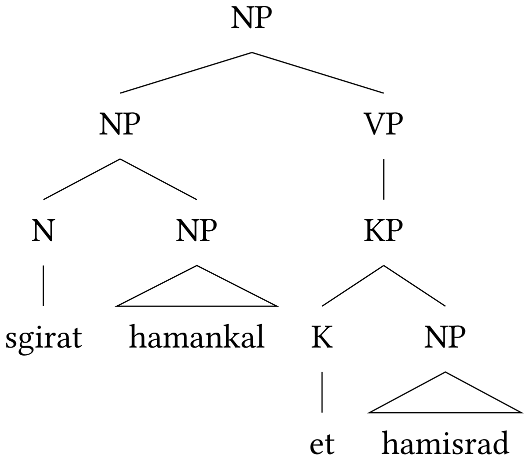
(70) $\text{NP} \longrightarrow \underset{\uparrow=\downarrow}{\text{NP}} \quad \underset{\uparrow=\downarrow}{\text{VP}}$ (Falk 2001: 94)

(71)



(Falk 2001: 96)

(72)



As well as the 'verbal' mapping (with an ACC-marked OBJ), Hebrew action nominals may realize their arguments as shown in (73). In (73a) the arg2 or theme is the dependent NP in the construct state nominal, and hence corresponds to a POSS (on the analysis of Falk 2001). This variant has a purely nominal mapping in which the other argument (if present) is an OBL. Hence the PRED value is as shown in (74).

(73) Hebrew (Falk 2001: 94, 118)

a. sgirat	ha-misrad	(alyedey	ha-mankal)
closure.CONSTR	DEF-office	by	DET-director

b. ha-sgira šel ha-misrad (alyedey ha-mankal)
DEF-closure of DEF-office by DET-director
'the closure of the office by the director'

(74) (↑PRED)='close⟨(OBL_{AG}), POSS⟩ (Falk 2001: 97)

Evidence that the purely nominal variant also has a mixed c-structure comes from the observation that it can be modified by AdvP as well as by AP, as shown in (75).[15]

(75) Hebrew (Falk 2001: 98)

a. ibud ha-kolot yadanit alyedey ha-mumxim
processing DEF-votes manually by DEF-experts

b. ibud ha-kolot ha-yadani alyedey ha-mumxim
processing DEF-votes DEF-manual by DEF-experts
'the manual processing of the votes by the experts'

In summary, Falk argues that both "verbal" and "nominal" action nominals in Hebrew have a mixed c-structure. In Falk (2001) the NP realized as the dependent within a CSN nominal (or as a *šel* phrase in the case of 'long' possession) is analysed as a POSS, leading to the mappings shown in (76) for the action nominal. Falk (2007) develops a more articulated view of the range of GFs associated with the CSN, as discussed in the previous section, leading to the mappings show in (77) for the action nominals.

(76)

	subcategorisation lexical description	additional functions (in CSN) from the PS rules
verbal mapping	⟨SUBJ, OBJ⟩ SUBJ=POSS	POSS=DOM
nominal mapping	⟨OBL_{AG}, POSS⟩	POSS=DOM

(77)

	subcategorisation lexical description	additional functions from the PS rules
verbal mapping	⟨ $\widehat{\text{GF}}$, OBJ⟩	$\widehat{\text{GF}}$=DEF
nominal mapping	⟨OBL_{AG}, $\widehat{\text{GF}}$ ⟩	$\widehat{\text{GF}}$=DEF

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[15] Although there is less discussion, Falk (2001) also provides examples showing AP modification of the verbal variant (with the POSS/SUBJ expressed as a *šel* PP), as well as modification by AdvP.

There is relatively little detailed discussion in the LFG literature of the corresponding Arabic NPs, which are headed by maṣdars. The msa examples (78) and (79) illustrate the ‘verbal’ and ‘nominal’ mappings respectively.[16]

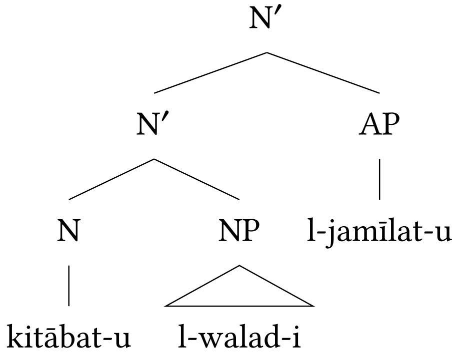
(78) msa (Börjars et al. 2015: 49)
ʔakl-u l-walad-i it-tufāhat-a
eat.msd-nom def-boy-gen def-apple-acc
‘the boy’s eating the apple’

(79) msa (Börjars et al. 2015: 55)
ʔakl-u l-walad-i as-sarīʕ-u li-t-tufāhat-i
eat.msd-nom def-boy-gen def-fast-nom of-def-apple-gen
‘the boy’s fast eating of the apple’

In connection with his treatment of negation in maṣdar-headed structures in msa, Alsharif (2014) adopts Falk’s (2001) analysis of the csn dependent as a poss (re-entrant with the dom feature) and using the additional functional equation poss=subj for cases in which the head N is a maṣdar, and a mixed category c-structure (at least for the ‘verbal’ maṣdar structures). However he argues for a structure in which the csn is recognised as a constituent to the exclusion of any adjectival modifiers, as shown in (81) (in contrast to Falk’s (59) above). Börjars et al. (2015) provide agreement data from msa in support of the same conclusion.

(80) msa (Alsharif 2014: 291)
kitābat-u l-walad-i l-jamīlat-u
write.msd-nom def-boy-gen def-beautiful-nom
‘the boy’s beautiful writing’

(81)



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[16] The occurrence of acc case in (78) is often taken to indicate a mixed categorial status for this construction, with the ‘verbally-marked’ dependent(s) appearing within a VP node.

In contrast to the mixed category analysis of Hebrew action nominals developed in Falk (2001, 2007), Börjars et al. (2015) propose a purely nominal c-structure, reflecting the fact that the maṣdar has nominal morphosyntax and may have the external distribution of a NP. The gen and acc NPs in the transitive 'verbal' maṣdar are both sisters of N – the idea is essentially that of extending the constituent containing the cs to include acc objects in the case of the 'verbal' mapping (all rhs categories are to be interpreted as optional in this rule).[17] The nominal structure in (79) is more hierarchical, with the *li*-PP (corresponding to the second argument of the verb 'eat') adjoined at a higher level NP constituent in the structure as an obl, and the AP also licensed as an adjunct by a recursive NP → NP XP rule.

(82)
$$\text{NP} \longrightarrow \begin{array}{cccc} \text{N} & \text{NP} & \text{NP} & \text{NP} \\ \uparrow=\downarrow & (\downarrow \textsc{case})=\textsc{gen} & (\downarrow \textsc{case})=\textsc{acc} & (\downarrow \textsc{case})=\textsc{acc} \\ & (\uparrow \textsc{subj})=\downarrow & (\uparrow \textsc{obj})=\downarrow & (\uparrow \textsc{obj}_{\theta})=\downarrow \end{array}$$

(Börjars et al. 2015: 53)

Lowe (2020) points out a number of empirical problems with this analysis, notably in relation to ensuring the correct ordering of any AP and AdvP modifiers in the nominal maṣdar constructions and in ruling out the occurrence of adjectival modifiers in the 'verbal' maṣdar structures; and also takes issue with it on theoretical grounds. He argues for an approach to mixed category constructions in which internal syntax, rather than morphosyntax or external distribution, is taken to be a sufficient criterion for syntactic categorisation. This leads to a mixed projection (VP over NP) analysis for both types of maṣdar construction (the VP node is motivated by the presence of an obj under the 'verbal' mapping and the possibility of adverbial modifiers under both 'nominal' and 'verbal' mappings). The structures which he proposes, (84) and (86), are rooted in a VP node, despite the nominal nature of the external distribution of these structures.[18]

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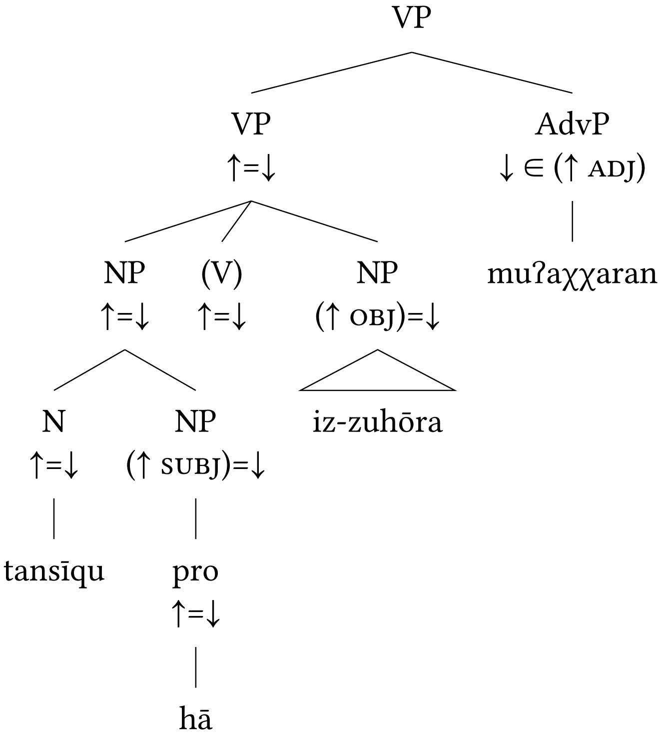
[17] Börjars et al. (2015) do not provide an analysis of definiteness inheritance (from the genitive dependent) for the general case of construct state nominals. For the maṣdar-headed structures of msa which they are concerned with in this paper they assume the equation (↑ def)=(↑ subj def) in the lexical entry of the maṣdar.

[18] To address this issue, Lowe (2020: 333) proposes the use of a complex category $\text{V}_{[msd]}$ and a metacategory in the phrase structure rules to capture the distributional similarity between NPs and maṣdar-headed VPs. Recall that the meta-category label does not itself give rise to a node in the tree representation, being merely an abbreviatory device.

(i) $\text{NomP} \equiv \{\text{NP} \mid \text{VP}_{[msd]}\}$ (Lowe 2020: 333)

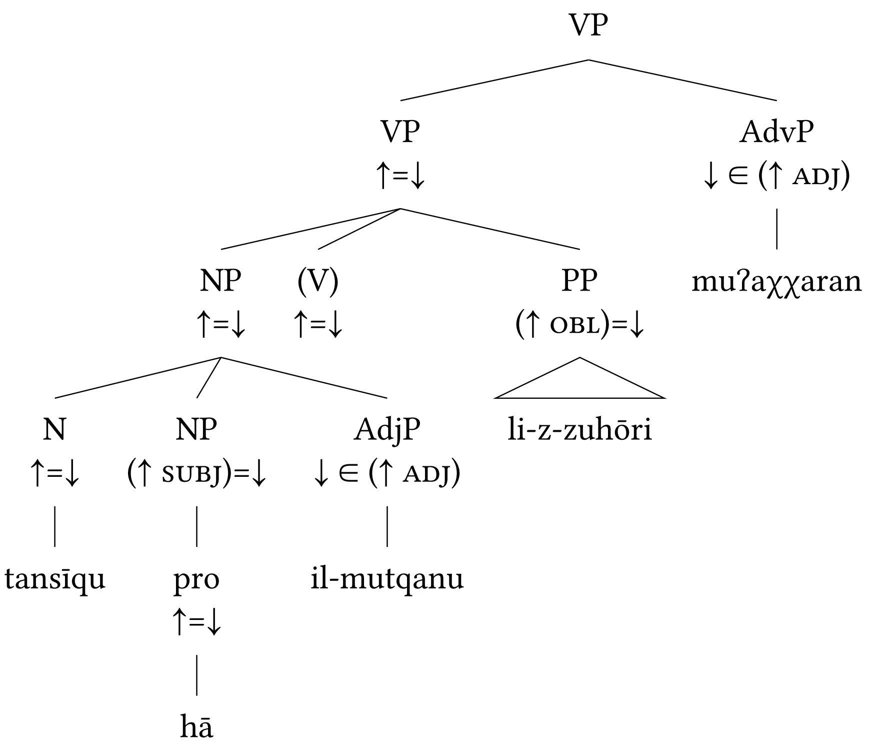
(83) MSA (Börjars et al. 2015: 49)
tansīq-u =hā iz-zuhōr-a muʔaχχaran
arrange.MSD-NOM her DEF-flowers-ACC recently
‘her arranging the flowers recently’

(84)



(85) MSA (Börjars et al. 2015: 55)
tansīq-u =hā il-mutqan-u li-z-zuhōr-i muʔaχχaran
arrange.MSD-NOM her DEF-perfect-NOM of-DEF-flowers-GEN recently
‘her perfect arranging of the flowers recently’

(86)



7 Negation

Sentential negation in MSA is expressed by means of the particles *mā*, *lā*, *lan* and *lam* and the inflecting form *laysa* which occurs with both verbal and non-verbal predicates (see (87) and (88)). *laysa* (and its inflectional variants) gives rise to present tense interpretations and shows partial agreement when it precedes the subject and full agreement with a preceding subject, typical verbal behaviour. Accordingly, Alsharif & Sadler (2009) treat *laysa* as a negative (present) tensed verbal element in I.

(87) MSA (Alsharif & Sadler 2009: 10)

a. al-awlad-u lays-ū ya-ktub-ūn
the-boys-NOM NEG-3M.PL 3M-write.IPFV-3M.PL-IND
‘The boys do not write.’

b. lays-a al-awlad-u ya-ktub-ūn
NEG-3M.SG the-boys-NOM 3M-write.IPFV-3M.PL-IND
‘The boys do not write.’

(88) MSA (Benmamoun 2000: 53)
laysa ʔaḫii muʕallim-an.
NEG.3M.SG brother.my teacher-ACC
‘My brother is not a teacher.’

The particles *lā*, *lam* and *lan* are strictly verb-adjacent, and do not exhibit agreement with the subject. While *lā* occurs with a verb in the indicative imperfective, *lam* occurs with the jussive imperfective expressing negation in the past, and *lan* with the subjunctive imperfective, expressing negation in the future: thus *lam* and *lan* are negative particles which carry temporal information.

(89) MSA (Benmamoun 2000: 95)
a. ṭ-ṭullāb-u laa ya-drus-uu-n
the-students NEG 3M-study.IPFV-3M.PL-IND
‘The students do not study/are not studying.’
b. lan ya-ḏhab-a ṭ-ṭullāb-u
NEG.FUT 3M-go.IPFV-M.SG.SBJV the-students-NOM
‘The students will not go.’
c. ṭ-ṭullāb-u lam ya-ḏhab-uu
the-students-NOM NEG.PST 3M-go.IPFV-M.PL.JUSS
‘The students did not go.’

Alsharif & Sadler (2009) analyse these negative particles as non-projecting words of category I (notated $\widehat{\mathrm{I}}$) in the sense of Toivonen (2003), forming a small construction with the immediately following verbal element. The notion of non-projecting word captures the uninterruptibility of the Neg+V sequence, but still treats the negative marker and the verb as separate morphological words. The particles *lam* and *lan* contribute PAST and FUT tense values respectively (and select (tenseless) forms of the verb in a dependent mood), while *lā* cannot co-occur with PAST tense. The negative particle *lan* can also occur as a non-projecting word under V where it contributes not FUT but PROSP aspect. They consider the interaction of these negative particles with both simple and compound tenses in MSA.[19]

(90) $\mathrm{I} \longrightarrow \begin{array}{cc} \hat{\mathrm{I}} & \mathrm{I} \\ \uparrow=\downarrow & \uparrow=\downarrow \end{array}$ (Alsharif & Sadler 2009: 14)

(91) *lam* $\hat{\mathrm{I}}$ $(\uparrow \text{TENSE PAST})=+$ (Alsharif & Sadler 2009: 16)
$(\uparrow \text{POL})=\text{NEG}$
$(\uparrow \text{MOOD}) =_c \text{JUSS}$

As for MSA *mā*, this marker of sentential negation occurs in sentences with both verbal and non-verbal predicates. It always precedes the predicate but is not required to be immediately adjacent to it. Alsharif (2014) argues that it is a negative complementiser (Arabic has a reasonably extensive range of complementising particles), so that (92) is associated with the c-structure shown in (94).

(92) MSA (Alsharif 2014: 169)
mā qal-a maher-un l-ħaqq-a
NEG say.PFV-3M Maher-NOM DEF-truth-ACC
'Maher did not say the truth.'

(93) MSA (Alsharif 2014: 132)
mā mohammad-un kātib-un
NEG Mohammad-NOM writer-NOM
'Mohammad is not a writer.'

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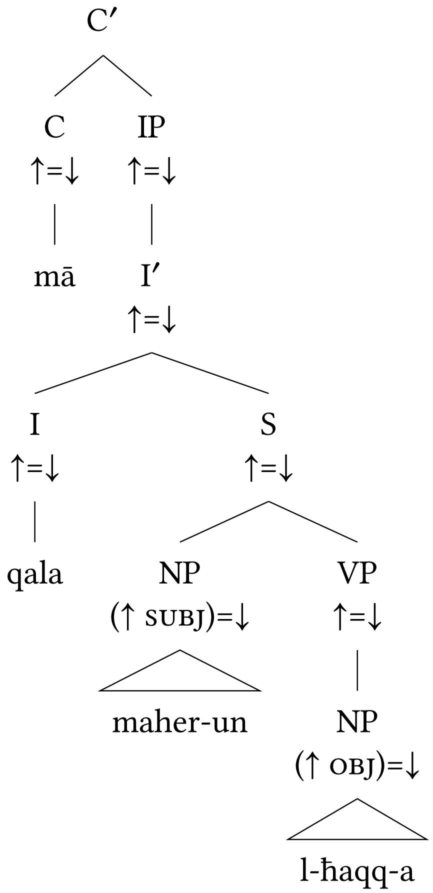
[19] A complex TENSE feature with boolean-valued attributes PAST and FUT is adopted in this approach because of the compositional nature of certain periphrastic verb forms. For example, a future tense may be formed periphrastically by combining the imperfective indicative form (which otherwise received a present tense interpretation), with the preverbal particle *sawfa* as in (i), and hence the imperfective indicative is associated with the (underspecified) TENSE PAST=−.

(i) MSA (Fassi Fehri 1993: 82)
sawfa lā y-aḥdur-u
FUT NEG 3M-present.IPFV-3M.SG.IND
'He will not come.'

(94) msa (Alsharif 2014: 170)



Adopting the idea that it may mark some sort of contrastive focus as well as negation, (see Ouhalla 1993 and Benmamoun 2000, *inter alia*)), Alsharif (2014) also argues that in examples such as (95), the focussed element immediately following the negative complementiser, is in [Spec,IP] (in (95) this is the PP *bi-s-sikkīn-i*) (hence this position must host various discourse functions, including that of subj).

(95) msa (Alsharif 2014: 173)

mā	bi-s-sikkīn-i	jaraħ-a	χālid-un	bakr-an
neg	p-def-knife-gen	wound.pfv-3m.sg	Khalid-nom	Bakr-acc

‘It is not with a knife that Khalid wounded Bakr.’

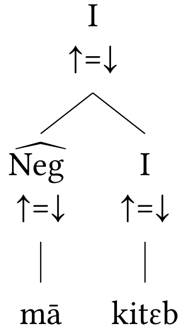
The Arabic vernaculars typically use *mā* for negation in verbally-headed sentences, and a set of forms which combine *m-* with pronominal affixes for sentential negation in non-verbal sentences.[20]

A major split is found across the dialects (roughly between Eastern and Western) according to whether they use a single negative element or bipartite negation, combining an *m-* form with a second marker *-š/-x* which results from grammaticalisation of an earlier form corresponding to *šayʔ* 'thing' in Classical Arabic.

The vernacular verbal negative marker *mā* illustrated in (96) is treated as a non-projecting word in Alsharif (2014) (for Hijazi) and Alruwaili (2019) (for Turaif Arabic), that is, as a syntactic element appearing strictly adjacent to a verbal element.[21]

(96) Turaif Arabic (Alruwaili 2019: 162)
ʕali mā kitɛb l-wāǧib
Ali NEG write.PFV.3M.SG DEF-homework
'Ali did not write the homework.'

(97) Turaif Arabic (Alruwaili 2019: 162)



Alruwaili (2019) shows that *mā* can occur before either the the auxiliary (*kān* 'be.PFV') or the lexical verb in compound tenses (and hence can form a small

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[20] The occurrence of verbal negation with many pseudo-verb forms, as in (i), where the literal, prepositional meaning of *l-* is 'to', shows that their reanalysis from their original category into a verbal category is well advanced.

(i) Turaif Arabic (Alruwaili 2019: 121)
ṭ-ṭullāb mā l-hum χaṣam
DEF-student.PLM NEG have-3M.PL.GEN discount
'The students do not have a discount.'

[21] Clearly, an affixal analysis of the negative markers might be argued to be appropriate for some other dialects.

construction with either I or V), and argues in favour of the ternary branching rule (99) as the negator must precede the tense/aspect particle *rāħ* when they co-occur. As a marker of sentential negation, *mā* specifies ENEG=+ (eventuality negation, see Przepiórkowski & Patejuk 2015).

(98) Turaif Arabic (Alruwaili 2019: 166)
huda mā rāħ t-sāfar bukra
Huda NEG FUT 3F.SG-travel.IPFV tomorrow
'Huda will not travel tomorrow.'

(99)
$$\begin{array}{lclll} \mathrm{I}' & \longrightarrow & \widehat{\mathrm{Neg}} & \widehat{\mathrm{I}} & \mathrm{I} \\ & & \uparrow=\downarrow & \uparrow=\downarrow & \uparrow=\downarrow \end{array}$$

The example in (100) illustrates the marker of sentential negation for non-verbal predicates (and in equational sentences). Both Alsharif (2014) and Alruwaili (2019) treat this marker (and its inflectional variants) as a negative copula (the lexical entry in (101) is from Alruwaili (2019: 170)).

(100) Turaif Arabic (Alruwaili 2019: 169)
huda mū/mahi fi l-bēt
Huda NEG.COP/NEG.COP.3F.SG in DEF-house
'Huda is not in the house.'

(101) *mū* I (↑ ENEG) = + Turaif Arabic (Alruwaili 2019: 170)
VP ∉ CAT(↑)
(↑ TENSE)=PRES

Camilleri & Sadler (2017a) look at sentential negation in Maltese and the syntactic behaviour of a group of negative sensitive indefinite items (n-words, NSI) in Maltese. In common with many Western dialects of Arabic, Maltese is a language with bipartite negation, as can be seen in the double marking *ma ...-x* in (102). Synchronically, they argue for Maltese that it is *m-/ma* which realizes negation in Maltese, while the *-x* is essentially some sort of NSI. The strategies for sentential negation of clauses with verbal and non-verbal predicates (including the active participle) respectively are shown in (102) and (103) respectively.

(102) Maltese (Camilleri & Sadler 2017a: 147)
Ma qraj-t-x il-ktieb.
NEG read.PFV-1SG-NEG DEF-book
'I didn't read the book.'

(103) Maltese (Camilleri & Sadler 2017a: 147)
Mhux ~ mhumiex sejr-in.
NEG.3M.SG.NEG ~ NEG.3PL.NEG go.ACT.PTCP-PL
'They are not going.'

The paper proposes an analysis of the *xejn* 'nothing' series of negative indefinites (including *ħadd* 'no one', *ebda* 'no(ne)' and *imkien* 'nowhere') which occur in negative sentences. As the examples in (104) show, the negative marker *ma* is required to express sentential negation, irrespective of the linear order of the n-word vis-à-vis the predicate. This behaviour, and the fact that these n-words may provide negative fragment answers, supports the view that Maltese is a strict negative concord language and the classification of these indefinites as simple NCIs. However, although Maltese uses the bi-partite (*ma …-x*) strategy for negation, as shown in (102) above, *-x* is in fact incompatible with these n-words in the same clause, as shown in (105).

(104) Maltese (Camilleri & Sadler 2017a: 150)

a. Ilbieraħ ħadd *(ma) ġie.
yesterday no.one NEG come.PFV.3M.SG
'No one came yesterday.'

b. Ilbieraħ *(ma) ġie ħadd.
yesterday NEG come.PFV.3M.SG no.one
'No one came yesterday.'

(105) Maltese (Camilleri & Sadler 2017a: 151)
It-tifla ma ra-t(*-x) xejn.
DEF-girl NEG see.PFV-3F.SG-x nothing
'The girl saw nothing.'

Long-distance licensing of n-words is felicitous in Maltese (depending on the nature of the subordinate clauses), as in (106), and the same incompatibility with the suffix *-x* is observed.[22]

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[22] As an alternative to (106), bi-partite negation and a positive proform (replacing *xejn* 'nothing' by *xi ħaġa* 'something' in (106)), is also grammatical, retaining the same interpretation.

(106) Maltese (Camilleri & Sadler 2017a: 153)
Ma smaj-t [li qal-u [li
NEG hear.PFV-1SG COMP say.PFV.3-PL COMP
qal-t-i-l-hom [li għand-hom
say.PFV-3F.SG-EPENT.VWL-DAT-3PL COMP have-3PL.GEN
j-i-xtr-u xejn.]]]
3-FRM.VWL-buy.IPFV-PL nothing
'I didn't hear that they said she told them they have to buy anything.'

Camilleri & Sadler (2017a) argue that the n-word proforms like *xejn* are not in fact simply NCIs but have the broader distribution of weak NPIs, a view supported by the fact that they occur in a range of non-veridical contexts, as shown in (107), and unlike NCIs are not limited to negative or anti-veridical contexts. Equally, the *-x* of bipartite negation shares the wider distribution of an NPI, occurring in a range of contexts including conditionals, interrogatives, rhetorical interrogatives, embedded interrogatives and counterfactuals.

(107) Maltese (Camilleri & Sadler 2017a: 154)
Kil-t xejn ċikkulata?
eat.PFV-2SG nothing chocolate
'Did you eat any chocolate?'

As part of the analysis they provide an approach to bi-partite negation in Arabic dialects (primarily found in the dialects westward from the Levant to Morocco). There is both a dependency and an essential asymmetry in the distribution of *ma* and *-x*: *ma* realizes sentential negation but requires the presence of either *-x* or one or more NCI items within an appropriate domain, while *-x* itself is incompatible with the presence of (other) NCI items within that domain. Following Przepiórkowski & Patejuk (2015), Camilleri & Sadler (2017a) propose that *ma* introduces an ENEG feature. Because *ma* cannot stand alone it also introduces a constraining equation requiring a positive value of a NVM (for non-veridical marker) feature within an appropriate domain, which can be satisfied by a strictly local *-x* or by NC items in the N-series, within a certain domain.[23] The lexical entry for the sentential negation marker *ma* is in (108). The first line provides a value for the sentential negation feature ENEG, treating it as a feature with

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[23] Because both *-x* and the N-series proforms occur in the wider set of non-veridical contexts they cannot simply be associated with an inside-out statement limiting them to contexts containing ENEG=+.

instantiated values, with the consequence that it is required to be uniquely contributed, so expressed only once. The somewhat complicated uncertainty statement requires that there either be a feature NVM=+ in the local f-structure (which will be introduced by *-x*, see example (102) and the entry for *-x* in (109)) or that some dependent within the domain specified by the functional uncertainty path be specified as NVM=+ (e.g. examples (104a), (106), where NVM=+ is associated with an n-word dependent, see the entry for *xejn* in (110)). This path rules out *ma* satisfying its requirement for a NVM=+ dependent in a subordinate negative domain, ruling out (111). The non-veridicality affix *-x* defines NVM=+ and is incompatible with NVM=+ on any local dependent or any more deeply embedded dependent which is not itself inside an f-structure marked as ENEG=+, thus ruling out (112). The entry for an N-series word simply defines the NVM feature in the local f-structure, as in (110).

(108) *ma* ENEG $(\uparrow \textsc{eneg})=+$
$\{ (\uparrow \{\textsc{xcomp}|\textsc{comp}|\textsc{adj}\}^{*}\ \textsc{gf}^{+}\ \textsc{nvm}) \mid (\uparrow \textsc{nvm}) \} =_{c} +$
$\neg(\rightarrow \textsc{eneg})$
(Camilleri & Sadler 2017a: 159)

(109) -X $(\uparrow \textsc{nvm})=+$
$\neg(\uparrow \{ \textsc{xcomp}|\textsc{comp}|\textsc{adj}\}^{*}\ \textsc{gf}^{+}\ \textsc{nvm})=+$
$\neg(\rightarrow \textsc{eneg})$
(Camilleri & Sadler 2017a: 159)

(110) *xejn* N $(\uparrow \textsc{nvm})=+$ (Camilleri & Sadler 2017a: 159)

(111) Maltese (Camilleri & Sadler 2017a: 159)

*Ma	semma	[li	**ma**	ra-x	[li	darb-u
NEG	say.PFV.3M.SG	COMP	NEG	see.PFV.3M.SG-X	COMP	injure.PFV.3-PL

lil	ebda	raġel.]]
ACC	some	man

‘He didn’t say that he didn’t see that they injured any man.’

(112) Maltese (Camilleri & Sadler 2017a: 159)

*It-tifla	ma	ra-t-x	xejn.
DEF-girl	NEG	see.PFV-3F.SG-X	nothing

Intended: ‘The girl saw nothing.’

An example such as (106) will have the f-structure shown schematically in (113) (Camilleri & Sadler 2017a: 161).

(113)
$$\begin{bmatrix} \text{ENEG} & + \\ \text{PRED} & \text{`HEAR}\langle\text{SUBJ,COMP}\rangle\text{'} \\ \text{COMP} & \begin{bmatrix} \ldots \\ \begin{bmatrix} \text{COMP} & \begin{bmatrix} \text{PRED} & \text{`BUY}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`NOTHING'} \\ \text{NVM} & + \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Alruwaili & Sadler (2018) look at negation, n-words and the combination of negation and coordination in a construction similar to the English *neither … nor* construction in the vernacular Arabic of Turaif in the Northern region of Saudi Arabia. Turaif Arabic does not use the bipartite negation illustrated above for Maltese. Also unlike Maltese, the n-words which can occur as fragment answers, including the negative proform *māhad* 'no one' and the scalar focus particle *wala* 'not even one' can occur (*preverbally*) without the negation marker, giving rise to a negative interpretation, as shown in (114a). Hence a preverbal n-word in combination with the sentential negation marker *mā* results in a double negation reading, as in (115). Alruwaili & Sadler (2018) treat these negative arguments as contributing CNEG adopting the distinction between ENEG and CNEG introduced by Przepiórkowski & Patejuk (2015), and proposing the f-structure in (116) for (115).[24]

(114) Turaif Arabic (Alruwaili & Sadler 2018: 30)

a. māħad ǧa l-yōm
no.one come.PFV.3M.SG DEF-today.M.SG
'No one came today.'

b. mā ǧa ʔaħad l-yōm
NEG come.PFV.3M.SG one DEF-today
'No one came today.'

(115) Turaif Arabic (Alruwaili & Sadler 2018: 30)
wala ṭālib mā ǧ-a l-yōm
NEG.SFP student.M.SG NEG come.PFV-3M.SG DEF-today
'Every student came today.'
(= Not even a single student didn't come today.)

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[24] The feature SFOC is associated with the scalar focus determiner *wala*.

(116)

$$\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{come}\langle\textsc{subj}\rangle\text{’}\\ \textsc{eneg} & +\\ \textsc{subj} & \left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{student}\text{’}\\ \textsc{cneg} & +\\ \textsc{num} & \textsc{sg}\\ \textsc{sfoc} & +\end{array}\right]\\ \textsc{adj} & \left\{\left[\textsc{pred}\ \ \text{‘}\textsc{today}\text{’}\right]\right\}\end{array}\right]$$

(Alruwaili & Sadler 2018: 31)

The main focus of this paper is on the bipartite negative coordination marker *lā … wala* illustrated in (117b) (and found across many dialects of Arabic).

(117) Turaif Arabic (Alruwaili & Sadler 2018: 32–33)

a. mansōr mā gaʕad min n-nōm, w ʕali mā ǧa min d-dawām
Mansour NEG wake.PFV.3M.SG from DEF-sleep, CONJ Ali NEG come.PFV.3M.SG from DEF-work
‘Mansour did not wake up and Ali didn’t come (back) from work.’

b. lā mansōr gaʕad min n-nōm, wala ʕali ǧa min d-dawām
NEG Mansour wake.PFV.3M.SG from DEF-sleep, NEG.CONJ Ali come.PFV.3M.SG from DEF-work
‘Mansour did not wake up and nor did Ali come (back) from work.’

Alruwaili & Sadler (2018) analyse both the negative conjunction *wala* (which rather transparently combines the conjunction *wa* and a negative formative) and the negative marker *lā* as elements which adjoin to (and mark) a conjunct, postulating special coordination schema for *neither … nor* coordination – the rules in (118) and (119) (Alruwaili & Sadler 2018: 38) illustrate for sentential coordination.

(118) *Negative Coordination Schema*

$$\begin{array}{lccc}\text{XP} & \longrightarrow & \text{XP} & \text{XP}^{+}\\ & & \downarrow\in\uparrow & \downarrow\in\uparrow\\ & & (\downarrow\textsc{eneg}) =_c +\_ & (\downarrow\textsc{conjform}) =_c \textsc{wala}\\ & & (\downarrow\textsc{conjform}\ ) \neq \textsc{wala} & \end{array}$$

(119)

$$\begin{array}{lccc}\text{XP} & \longrightarrow & \text{Neg} & \text{XP}\\ & & \uparrow=\downarrow & \uparrow=\downarrow\\ & & (\in\uparrow) & \end{array}$$

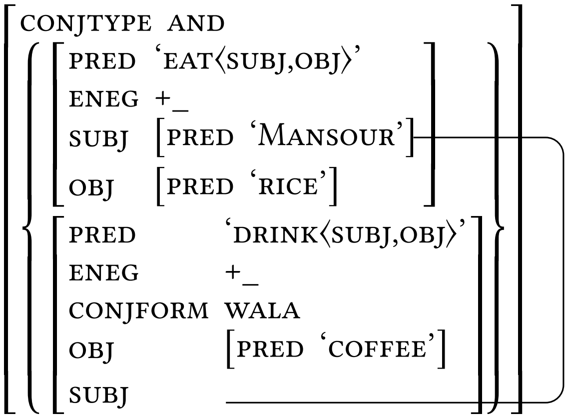
(120) *wala* Neg (↑CONJFORM)=WALA (Alruwaili & Sadler 2018: 38)
(↑ENEG)=+_
((∈ ↑) CONJTYPE)=AND

(121) *lā* Neg (↑CONJFORM)=LĀ (Alruwaili & Sadler 2018: 39)
(↑ENEG)=+_
((∈ ↑) CONJTYPE)=AND

The f-structure for (122) on this analysis is shown in (123), from Alruwaili & Sadler (2018: 38).

(122) Turaif Arabic (Alruwaili & Sadler 2018: 32)
mansōr **mā** akal l-ruz **wala** šarab l-gahwa
Mansour.M NEG eat.PFV.3M.SG DEF-rice NEG.CONJ drink.PFV.3M.SG DEF-coffee
'Mansour neither ate the rice nor drank the coffee.'

(123)



The *neither … nor* construction may also be used to coordinate arguments, where it shows the weak NCI behaviour noted above for negative elements such as *maħad* 'no one' and determiner *wala*. That is, occurring preverbally, it expresses negation (and hence can give rise to double negation readings) while postverbally, it behaves like a NCI.

(124) Turaif Arabic (Alruwaili & Sadler 2018: 34,40)

a. lā ʔaħmad wala mhammad ǧ-aw
NEG Ahmad NEG.CONJ Mohamamd come.PFV-3M.PL
'Neither Ahmad nor Mohammad came.'

b. lā ʔaħmad wala mhammad **mā** ǧ-aw
NEG Ahmad NEG.CONJ Mohammad NEG come.PFV-3M.PL
'Both Ahmad and Mohammad came.'

c. mā ǧ-aw lā ʔaħmad wala ʕali
neg come.pfv-3m.pl neg Ahmad.m neg.conj Ali.m
‘Neither Ahmad nor Ali came.’

In previous work, Przepiórkowski & Patejuk (2015) associate the Polish strict nci *nikt* ‘nobody’ with an inside-out constraint requiring eneg=+ to be defined in the appropriate containing f-structure. Building on this approach, Alruwaili & Sadler (2018) formulate a complex lexical constraint to capture the dependency between the cneg/nci alternation and the existence and linear position of a eneg marker.

8 Unbounded dependency constructions

Hebrew and Arabic both make extensive use of resumptive strategies as well as gap strategies in unbounded dependency constructions, and formalisation of the resumptive strategy for Hebrew is a major concern of Asudeh (2012), the most important reference for this section (see also Asudeh 2011). Falk (2002) also discusses the resumptive strategy for Hebrew udcs. Camilleri & Sadler (2011) looks at restrictive relative clauses and resumption in Maltese (see also Camilleri & Sadler 2012a), building on Asudeh’s approach to resumption. Further work on Maltese is descriptively oriented (Camilleri & Sadler 2016, Sadler & Camilleri 2017).

Hebrew resumptives occur in all NP positions except that of the highest subject. (125) illustrates an optional obj resumptive and (126) illustrates a resumptive within a complex NP island (note that there is no *wh*-item in these Hebrew relative clauses).

(125) Hebrew (Borer 1984: 220)
raʔiti ʔet ha-yeled she/ʔasher rina ʔohevet (ʔoto)
saw.1sg acc def-boy comp Rina love.3f.sg him
‘I saw the boy that Rina loves.’

(126) Hebrew (Borer 1984: 221)
raʔiti ʔet ha-yeled she-/asher dalya makira ʔet ha-ʔisha
saw-I acc def-boy comp Dalya knows acc def-woman
she-ʔohevet ʔoto
comp-loves him
‘I saw the boy that Dalya knows the woman who loves him.’

It is well established in the literature beyond LFG that the resumptives of Hebrew have the interpretational properties of pronouns rather than those of gap. The diagnostics distinguishing those which are interpretationally identical to gaps from those which behave semantically as pronouns include differences in behaviour with respect to island phenomena, weak crossover, across-the-board extraction, parasitic gaps and reconstruction (McCloskey 2017: 106). In line with this work, Asudeh (2011, 2012) distinguishes two types of true resumptives, which he refers to as *syntactically active resumptives* (SARS) and *syntactically inactive resumptive* (SIRS). Both types of resumptive receive the same treatment in the syntax-semantics interface, that is, they are removed by a manager resource. SARS do not display gap-like properties in the syntax and are simply anaphorically bound pronouns in the syntax: the RPS of Hebrew are of this type, as shown in (128). On the other hand, SIRS are syntactically gap-like (i.e. they are functionally controlled): the RP is treated as the bottom of a filler-gap dependency by restricting out the pronominal PRED, so that syntactically, the RP is equivalent to a gap (this analysis is given for Swedish in Asudeh 2012).

On the view that Asudeh develops, Hebrew resumptives are pronouns at f-structure, and are licensed in the complementiser system of Hebrew.[25]

That is, members of the class of C elements are lexically associated with the (optional) information shown in (127).

(127) *C* % RP=(↑GF^{+}) (Asudeh 2012: 221)
(↑UDF)$_{\sigma}$=(%RP$_{\sigma}$ ANTECEDENT)
@MR(%RP)
@RELABEL(%RP)

Abstracting away from many technical details, (127) states an equality between the semantics of a discourse function (↑UDF) in the f-structure which contains the complementiser and the value of the ANTECEDENT attribute of some grammatical function within the structure (identified by means of the local name %RP). The template call in the third line introduces the semantic resource which removes the surplus pronominal resource in the course of semantic composition, using the Resource Management Theory of Resumption developed in Asudeh (2012).

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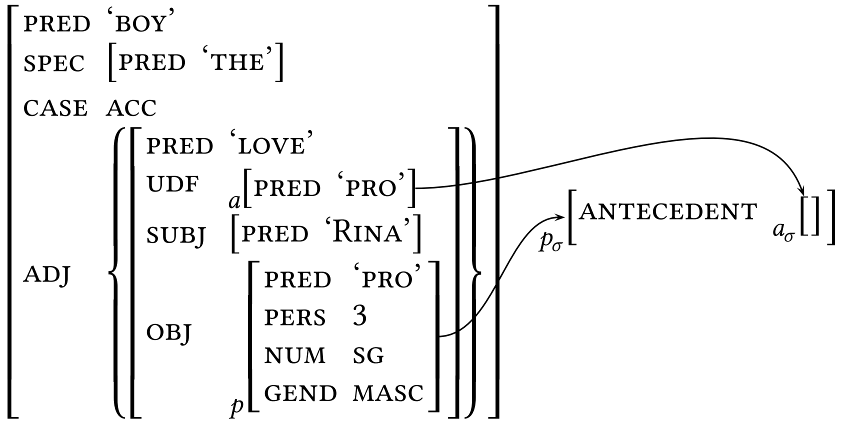
[25] An alternative view of the resumptive pronouns is taken in Falk (2002), namely that pronouns may lack a PRED value just in case they are functionally identified with a discourse function: functional identification is introduced lexically (by the pronoun itself) and mediated by reference to a *p* projection containing the referential elements in the discourse as shown in (i).

(i) $f \in p^{-1}(\uparrow_{p}) \wedge (\textsc{df}\ f) \Rightarrow \uparrow = f$ (Falk 2002: 163)

The example in (125) with the resumptive has the f-structure in (128) (Asudeh 2012: 227).[26] The (standard) CP rule is shown in (129) (Asudeh 2012: 224) where ϵ is not an empty node in the c-structure but the absence of a node associated with the collection of constraints specified.

(128)



(129)

$$\mathrm{CP} \longrightarrow \left\{ \begin{array}{c} \mathrm{XP} \\ (\uparrow \textsc{udf}){=}\downarrow \end{array} \middle| \begin{array}{c} \epsilon \\ (\uparrow \textsc{udf pred}){=}\text{`}\textsc{pro}\text{'} \\ (\textsc{adjunct} \in \uparrow) \\ REL_\sigma \end{array} \right\} \begin{array}{c} \mathrm{C}' \\ \uparrow{=}\downarrow \end{array}$$

Asudeh (2012) provides detailed coverage of many aspects of the syntax of Hebrew UDCs. For example (130) contains a fronted resumptive and no complementiser. The former is treated as an adjunction to C and the latter by means of a lexical entry for a null complementiser. *ʔašer* is a complementiser which can only appear in relative clauses, a restriction which is captured by an inside-out constraint in the lexical entry (132)

(130) Hebrew (Borer 1984: 220)

raʔiti	ʔet	ha-yeled	ʔoto	rina	ʔohevet
saw.1SG	ACC	DEF-boy	him	Rina	love.3F.SG

'I saw the boy that Rina loves.'

(131) (Asudeh 2012: 223)

$$\mathrm{C} \longrightarrow \begin{array}{c} \mathrm{C} \\ \uparrow{=}\downarrow \end{array} \quad \begin{array}{c} \widehat{\mathrm{D}} \\ (\uparrow \textsc{gf}){=}\downarrow \end{array}$$

(132) *ʔasher* C (ADJUNCT ∈ ↑) (Asudeh 2012: 223)

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[26] Asudeh does not represent the subcategorised arguments within the PRED value, which is a simple, argument-less semantic form.

Camilleri & Sadler (2011) provide an analysis of Maltese restrictive relative clauses. In Maltese a resumptive is not permitted in the highest subject function or, in relative clauses with definite or quantified heads, the highest object position. They suggest the underlying distribution of resumptive and gap is essentially free but subject to some additional restrictions (for example, only a resumptive is possible as the argument of a preposition).

(133) Maltese (Camilleri & Sadler 2011: 113)
Ir-raġel li bgħatt-(lu) l-ittra
def-man comp send.pfv.1sg.(-dat.3m.sg) def-letter
weġib-ni
respond.pfv.3m.sg-1sg.acc
'The man that I sent (him) the letter responded.'

As well as complementiser-introduced relatives such as (133), Maltese also has *wh*-relatives, which involve a gap rather than a resumptive pronoun, although these are subject to quite severe restrictions. (134) is an example.

(134) Maltese (Camilleri & Sadler 2011: 114)
It-tifel 'l min n(a)-ħseb j-għallem-*u
def-boy acc.who 1sg-think.ipfv 3-teach.ipfv.3m.sg-3sg.acc
'the boy who I think he teaches'

Building on standard assumptions, Camilleri & Sadler (2011) provide a syntactic analysis of both complementiser and *wh*- relatives. The example in (135) with either a complementiser or a *wh*-item is associated with the f-structure in (136) (assuming the pred value of *'l min* is 'pro').

(135) Maltese (Camilleri & Sadler 2011: 116)
Rajt lit-tifel li /'l min j-af Pawlu
see.pfv.1sg acc.def-boy comp /who 3m.sg-know.ipfv Paul
'I saw the boy that Paul knows.'

(136)
$$\left[\begin{array}{ll}
\textsc{pred} & \text{`BOY'} \\
\textsc{def} & + \\
\textsc{adj} & \left\{\left[\begin{array}{ll}
\textsc{pred} & \text{`KNOW}\langle\textsc{subj,obj}\rangle\text{'} \\
\textsc{compform} & \textsc{decl} \\
\textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`Paul'} \\ \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{masc} \end{array}\right] \\
\textsc{topic} & \left[\textsc{pred}\ \text{`PRO'}\right] \\
\textsc{obj} &
\end{array}\right]\right\}
\end{array}\right]$$

(Camilleri & Sadler 2011: 116)

Camilleri & Sadler (2011) show that Maltese also has true resumptives (as opposed to intrusive pronouns), and that the available tests indicate that (in the terminology of Asudeh 2012) they are SARs and hence anaphorically bound pronouns in the syntax. For example, they can be used felicitously in circumstances which would induce weak crossover violations. In (137) the dependency between the antecedent (*ir-raġel*) (or the TOPIC) and the RP 'crosses over' the possessive in *martu* ('his wife'), but the sentence is completely grammatical, while the corresponding sentence with a gap would be ungrammatical, despite the fact that RPs are normally excluded in wh-relatives in Maltese. Note that the POSS function is not accessible to relativisation by the wh-strategy and so it is clear that (137) involves relativisation on the OBJ, and therefore constitutes a case of crossover. (138) provides a similar example using the less restricted complementiser strategy for relativisation.

(137) Maltese (Camilleri & Sadler 2011: 19)
Ir-raġel 'l min n-af li t-elq-it-u
DEF-man ACC.who 1SG-know.IPFV COMP 3F.SG-leave.PFV-3M.SG.ACC
l-mara/mart-*(u)
DEF-woman/woman-3M.SG.ACC
'the man who I know that his wife left him'

(138) Maltese (Camilleri & Sadler 2011: 19)
Ir-raġel li n-af li ħallie-t-u
DEF-man COMP 1SG-know.IPFV COMP leave.PFV-3F.SG-3M.SG.ACC
mart-*(u) baqa' ma hariġ-x mid-dar
wife-3M.SG.ACC stay.PFV.3M.SG NEG go out.3M.SG-NEG from.DEF-house
'The man who I know that his wife left him, has not left the house since.'

(139) illustrates the Complex Noun Phrase Constraint, with a (second) relative dependency into a CNP created by relativisation: although the relativised position is one which is normally accessible to the gap strategy, the resumptive is obligatory here as a gap would cause a syntactic constraint violation.[27]

(139) Maltese (Camilleri & Sadler 2011: 120)
Raj-t ir-raġel li n-af mara li
see.PFV-1SG DEF-man COMP 1SG-know.IPFV woman COMP
t-af-u u għid-t-l-u
3F.SG-know.IPFV-3M.SG.ACC and tell.PFV-1SG-DAT-3M.SG
j-selli-l-i għali-ha
3M.SG-send regards.IPFV-DAT-1SG for-3F.SG.ACC
'I saw the man who I know a woman that knows him, and told him to send her my regards.'

9 Other work

Alotaibi (2014) looks at conditional sentences in Hijazi Arabic and provides an LFG analysis of the syntax of these constructions. Camilleri et al. (2014a) discusses the dative alternation in Hijazi Arabic, ECA and Maltese and develops an account of the mapping to GFs using the mapping approach of Kibort (2008). Camilleri & Sadler (2012b) looks at non-selected datives in Maltese. Alzaidi (2010) on gapping constructions in Hijazi (Taif) Arabic. Sadler (2019) provides an analysis of mixed agreement in adjectival relatives in MSA. Clausal possession in Hebrew is discussed in Falk (2004). For an early discussion of agreement in MSA see Fassi Fehri (1988). Camilleri & Sadler (2017b) discusses the grammaticalisation of a progressive construction in the Arabic vernaculars from a posture verb ACT.PTCP and also provides a synchronic account of the progressive construction. Camilleri & Sadler (2018) concerns the grammaticalisation of both the universal perfect (see also Camilleri 2016) and the progressive in Arabic.

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[27] The distribution of resumptives in Maltese does raise some potentially puzzling issues. Camilleri & Sadler (2011) show that there may be evidence from the distribution of gaps and RPs in across-the-board constructions that Maltese also has *syntactically inactive resumptives* (SIRs) (functionally controlled RPs or 'audible' gaps) since gaps and resumptives occur together in ATB constructions, but that simply assuming that ATB constructions in Maltese (and in Arabic more widely) involve SIRs rather than SARs is also problematic.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

CONJ	conjunction	JUSS	jussive
CONSTR	construct form	MSD	maṣdar
EPENT.VWL	epenthetic vowel	PRN	pronoun
FRM.VWL	formative vowel	SFP	scalar focus particle

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Chapter 35

LFG and Sinitic languages

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The assumptions of LFG have been applied to the research on a number of grammatical phenomena in Chinese languages. In this chapter, we present an overview of some of the studies devoted to investigating the syntactic patterns of two varieties of Chinese: Mandarin and Cantonese. This chapter includes a discussion on the expression and identification of grammatical functions, *ba*, *bei* and related constructions, the dative alternation, compounds (VO compounds and resultative compounds), the locative inversion, and classifiers and measure words. The chapter concludes with a brief overview of the applications of LFG in Chinese language processing.

1 Introduction: Chinese or Sinitic Languages

LFG is a lexicon-driven, unification-based linguistic theory aiming to account for both variations and universals found in human languages. The well-known parsimony of morpho-syntactic markings in Chinese poses an interesting challenge to the theory, but at the same time provides an opportunity to showcase

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the explanatory adequacy of LFG. The term ‘Chinese’ is commonly replaced by ‘Sinitic languages’ or ‘Chinese languages’ in the linguistics literature. These two terms refer to a family of varieties which are genetically related but are, very often, not mutually intelligible (Handel 2015, Huang & Shi 2016). Wurm & Liu (1987) list 10 varieties under ‘Chinese’ in the *Language Atlas of China*, while the *Ethnologue* lists 16 (Eberhard et al. 2020). The more prominent varieties are traditionally known as *fangyan* 方言 (literally ‘regional speech’ or ‘dialect’), and are classified into 7 groups: Mandarin, Xiang, Gan, Wu, Yue, Hakka and Min. Drawing data from both Mandarin and Cantonese (a Yue dialect), we will be using the term ‘Chinese’ to loosely refer to the Sinitic family, and reserve the terms ‘Mandarin’ and ‘Cantonese’ for these two individual varieties.

LFG has been adopted to study Chinese since 1985. Earlier studies, such as Huang (1985, 1986, 1987, 1988, 1989b,a, 1990) and Huang & Mangione (1985), present LFG accounts of a wide range of grammatical structures in Mandarin Chinese, including the internal structure of NPs, the subcategorized topic, and lexical discontinuity. Her (1990) investigates the grammatical functions in Mandarin, while Tan (1991) focuses on the subject in Mandarin. Bodomo & Luke (2003), the monograph resulting from the first LFG Workshop dedicated to the analysis of Chinese languages in 2001, contains studies on Mandarin, Cantonese, and other Sinitic languages.

It is important to note that, although this chapter focuses on Cantonese and Mandarin, LFG has in fact been successfully applied to a wide range of varieties in China. For instance, Huang (1991) provides an account of adjectival reduplication in Taiwan Southern Min. Studies on Zhuang, a Tai-Kadai language spoken in southern China, include Pan (2010), Bodomo (2011), and Burusphat & Qin (2012).

There is also a well-established collection of LFG literature written in Chinese, with most of them providing an introduction to the framework. These include Huang (1988, 1989b), Fu (1990a,b), Fu (1993), Feng (2004), Gao & Li (2009) and Wei (2014).

In the following sections, we first outline the prominent grammatical properties of Chinese from an LFG perspective (Section 2). Section 3 discusses the encoding of grammatical functions in Chinese, while Sections 4–10 provide an overview of the major grammatical phenomena which have been analyzed in LFG. Section 11 concludes the chapter by highlighting LFG analyses which have contributed to the understanding of Sinitic languages, and how the studies on Sinitic languages have contributed to the development of LFG.

2 Grammatical properties: An LFG Perspective

This section introduces important grammatical features of Chinese from an LFG perspective, including the morpho-syntactic encoding of grammatical functions (Section 2.1); the classifier system (Section 2.2); and the canonical word order and the role of information structure (Section 2.3). For more in-depth and recent discussions on issues in Chinese linguistics, see Huang et al. (2009), Wang & Sun (2015), Huang & Shi (2016), and Huang et al. (2022), among others.

2.1 Morpho-syntactic encoding

Chinese has been described in the literature as being 'morphologically impoverished' (e.g. Packard 2000, Hsieh et al. 2022). This, however, does not mean that there is no morpho-syntactic encoding. In (1a), TENSE is not encoded on the verb, but in (2), aspect is.[1,2]

(1) a. Cantonese
Zoengsaam kam jat/ gam jat/ ting jat faangung.
Zoengsaam yesterday/ today/ tomorrow work
'Zoengsaam went to work yesterday/ is going to work today/ will go to work tomorrow.'

b. Mandarin
Zhangsan zuotian/ jintian/ mingtian shangban.
Zhangsan yesterday/ today/ tomorrow work.
'Zhangsan went to work yesterday/ goes to work today/will go to work tomorrow.'

(2) a. Cantonese
Zoengsaam tai-zo/ -gan/ -gwo bun syu.
Zoengsaam read-PFV/ -PROG/ -EXP CLF book
'Zoengsaam has read/is reading/read the book.'

b. Mandarin
Zhangsan du-le/ zhengzai du/ du-guo (yi) ben shu.
Zhangsan du-PRF/ ZAI read/ read-EXP (NUM) CLF book.
'Zhangsan has read/is reading/read a book.'[3]

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[1] Tones are omitted unless they are relevant to the discussion.

[2] Examples in Cantonese are romanized using the scheme developed by LSHK (2002).

[3] The marker *-gwo*, and the Mandarin equivalent *-guo*, express the 'experiential aspect' in Chinese.

There is no person, number or gender agreement between a verb and its arguments.

(3) Cantonese

a. Zoengsaam gin-dou keoidei.
Zoengsaam see-dou 3pl
'Zoengsaam saw them.'

b. ngo gin-dou Zoengsaam.
I see-dou Zoengsaam
'I saw Zoengsaam.'

Note that the changes in person and number do not affect the verb forms in (3). Note also that *-dou* (到; *-dao* in Mandarin) is not a tense marker – it marks accomplishment and is part of a verb-result compound.

There is no case-marking in Chinese. Pronouns are not case-marked, either:

(4) Cantonese

a. ngo gin-dou keoi.
1sg see-dou 3sg
'I saw him/her.'

b. keoi gin-dou ngo.
3sg see-dou 1sg
'S/he saw me.'

2.2 Number-marking, classifiers and the expression of quantities

Most nouns are not number-marked. The only marker which codes number in Mandarin is the plural marker *-men* (Hsieh et al. 2022). Yet, even for human nouns, a bare noun is unspecified for number, allowing both a singular and a plural reading, as exemplified in (5).

(5) Mandarin
Gebi de xuesheng hen chao.
next.door de student very noisy
'The student(s) next door is/are very noisy.'

Classifiers are a significant feature of the Chinese languages. As number is not explicitly encoded in Chinese, nouns can only be enumerated when they are individuated by classifiers in the [num clf n] structure. Some scholars believe that classifiers ‘serve to profile an essential or inherent feature of the head noun...and contribute no additional meaning to the head noun’ (Her 2012a; see also Cheng & Sybesma 1999). Others (e.g. Huang & Ahrens 2003, Chen et al. 2022), however, argue that classifiers make a crucial contribution to the meaning through coercion.

(6) Mandarin

a. san ben shu
three CLF book
‘three (volumes/copies of) books’

b. san xiang shu
three CLF book
‘3 boxes of books’

Cantonese, among other varieties of Chinese and unlike Mandarin, allows the omission of the numeral one. Whether ‘one’ is expressed depends on the information structure and the grammatical function of the noun. The structure [CLF N] receives a definite, or contextually retrievable, interpretation when it serves as the SUBJ, but when it is an OBJ, either a definite or an indefinite reading is possible:

(7) Cantonese

a. [CLF N] as SUBJ
(Context: What happened to the book?)
[bun syu] laan-zo.
CLF book damage-PFV
‘The book is damaged.’

b. [CLF N] as OBJ

i. With a definite reading
(Context: Where is the book?)
ngo m gin-zo [bun syu].
1SG not see-PFV CLF book
‘I have lost the book.’

ii. With an indefinite reading
ngo kam jat maai-zo [bun syu].
1SG yesterday buy-PFV CLF book
‘I bought a book yesterday.’

2.3 Canonical word order

Different views can be found in the literature regarding the canonical word order in Chinese languages. While there is a long tradition of analyzing Chinese as having a canonical SVO word order (e.g. Light 1979, Mei 1980, Sun & Givón 1985, Dryer 2005), there are also arguments for treating the SOV order as the canonical word order (see, for instance, Tai 1973, Li & Thompson 1974). The empirical and theoretical arguments for both the SVO and SOV accounts can be found in Liu (2022) and Xu & Dong (2022) respectively. In some Wu varieties, it has also been observed that the SOV or OSV orders occur more frequently than the SVO order, especially in cases where obj expresses the patient role (Yue 2003).

Despite the ongoing debate on the canonical word order, it is generally accepted that word order variations in Chinese can be accounted for in terms of information structure (Shyu 2016). Chinese has been well-established as a topic-prominent language since Li & Thompson (1976). Constituents bearing almost any grammatical function can be easily placed in the sentence-initial position as long as they are topics. Kroeger (2004) provides a clear overview on the grammatical functions which can be topicalized in Chinese, including the possessor (Xu & Langendoen 1985). Identifying grammatical functions in Chinese is thus far from being straight-forward – grammatical functions may be expressed in various syntactic positions depending on the discourse context, and they are not morphologically encoded. The obj *pingguo* can appear in the canonical object position (8a), sentence-initially if it is topical (8b), and between the subj and the V, where the marker *ba* is optional:[4]

(8) Mandarin
    a. ta chi le [pingguo].
       3sg eat pfv apple
       'S/he ate the apple/apples.'
    b. [pingguo] ta chi le.
       apple 3sg eat pfv
       'S/he ate the apple/apples.'

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[4] Whether the marker *ba* is required depends on the semantic features of the displaced NP. A displaced human NP must be marked:

(i) Ta *(ba) laoshi tuidao le.
    3sg.m ba teacher push.over pfv
    'He pushed over the teacher.' (Yang & van Bergen 2007: 1622)

c. ta (ba) [pingguo] chi le.
3SG BA apple eat PFV
'He ate the apple/apples.' (Yang & van Bergen 2007: 1622)

Other word order variations are found in Chinese. These will be discussed in Section 4.

Chinese is also well-known for having 'Chinese-style topics' (Chafe 1976), or 'dangling topics'. These topics are unique in that they are not subcategorized for by the predicate in the comment (Pan & Hu 2008). In (9), the predicate in the comment is *lai* 'come', which is intransitive and only subcategorizes for a subject, *xiaofangdui* 'fire-brigade'. The topic [*nei chang huo*] 'that fire' is not related to the predicate-argument structure of *lai* 'come', and is thus considered a 'dangling' topic.

(9) Mandarin
[nei chang huo], xingkui xiaofangdui lai de kuai.
that CLF fire fortunately fire-brigade come DE quick
'As for that fire, fortunately the fire-brigade came quickly.'
(Li & Thompson 1976)

It is also possible and entirely natural to have more than one topic at the beginning of a sentence in Chinese, i.e. 'topic-chain constructions':

(10) Mandarin
[zhei jian shi], (Zhangsan), ta mei you cuo.
this CLF matter Zhangsan 3SG not have fault
'Regarding this matter, Zhangsan is not at fault.'
(Her 1990; glosses modified)

We provide a more detailed discussion on the TOPIC as a grammatical function in Section 3.

3 Grammatical functions and word order variations in Chinese

We provide a synopsis of the state-of-the-art LFG research on Chinese in this section and Sections 4–10. We begin with the fundamental issue of encoding grammatical functions in Chinese.

Identifying grammatical functions in Chinese can be challenging due to the lack of morphological encoding of grammatical functions, and to the fact that Chinese has relatively free word order. We offer an overview of the grammatical functions in Mandarin (Section 3.1), and in Cantonese (Section 3.2).

3.1 Mandarin

Almost all early LFG studies on Chinese have included a classification of grammatical functions. Interestingly, although there are no obligatory morphological encodings of GFs, there is general consensus as to the grammatical functions which can be identified for Chinese. Huang (1989b, 1993a), adopting the assumptions of classical LFG (Bresnan 1982b, Bresnan & Kanerva 1989), shows that GFs in Mandarin can be identified by their unambiguous syntactic positions at the surface level, and can be classified into four types based on two features: [±*r*estricted] and [±*o*bjective]. Her (1990, 2008) presents an expanded set of GFs in Mandarin, and recognizes SUBJ, OBJ, OBJ2, OBL_θ (oblique function which includes subtypes $\text{OBL}_{\text{THEME}}$ (theme), OBL_{GOAL} (goal), OBL_{BEN} (beneficiary), OBL_{LOC} (location), and COMP (complement function that includes subtypes XCOMP, SCOMP, and NCOMP) as subcategorizable GFs, while TOPIC, ADJunct (adjunct function that has two subtypes ADJ and XADJ), and POSS are identified as non-subcategorizable, as shown in Figure 1. It should be noted that, in the current LFG literature, the restricted object function OBJ_θ has replaced OBJ2, while grammatical function labels such as SCOMP and NCOMP, which make reference to c-structure categories, are no longer adopted.

The syntactic encoding of GFs is via both the c-structure and the predicate argument structure (AS). Take the lexical verb *da* 'hit', for example: it has a predicate argument structure of ⟨AGENT, THEME⟩, and subcategorizes for ⟨SUBJ, OBJ⟩, where the linking between the argument roles and the grammatical functions is constrained by the Lexical Mapping Theory (LMT; Bresnan & Kanerva 1989).

(11) Mandarin
Lisi da Zhangsan.
Lisi hit Zhangsan
'Lisi hit Zhangsan.'

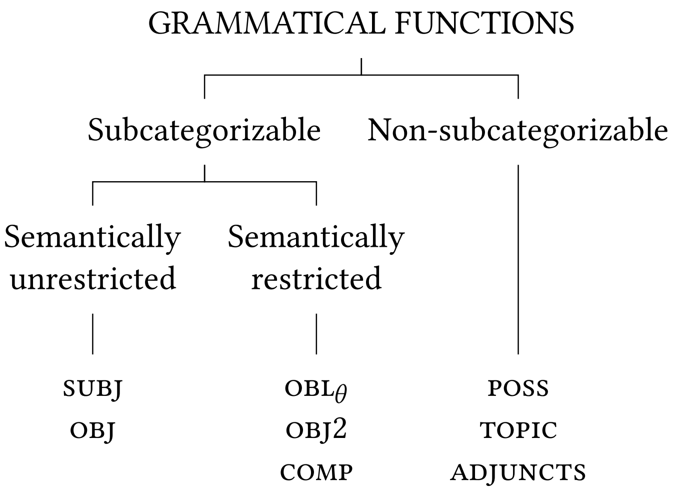
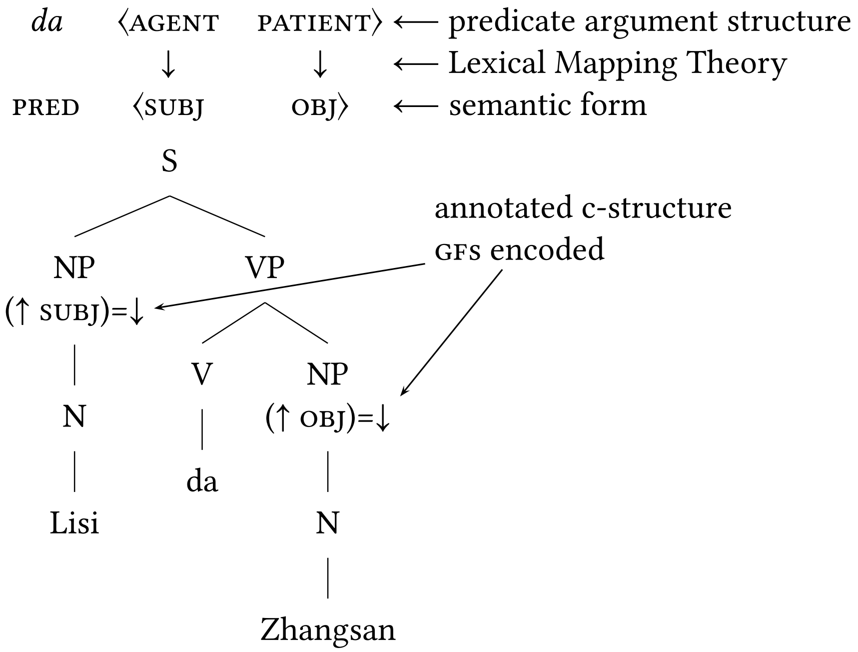


Figure 1: Classification of grammatical functions in Mandarin (Her 1990, 2008)



The treatment of TOPIC above touches on a fundamental issue related to the universal properties of GFs. Recall that Chinese is a topic-prominent language (see, for instance, Tsai (2022), for a discussion on the syntactic approaches to the phenomenon, and Tao (2022), among others, for a discussion on the functional approaches). Thematic TOPICS may be 'preposed', while non-thematic TOPICS may remain *in situ*. A set of frequently used constructions known as 'Pseudo-transitive constructions' (Chang et al. 1988) pose challenges to the grammatical status of topic, and this has been treated in detail in Huang (1989a). In these constructions, an NP which is clearly an argument of the verb may only occur in the pre-verbal topic position or some obl positions, but never in the postverbal obj position. The following two examples are from Huang (1989a).

(12) Mandarin

a. zeijian shi, ni zuozhu.
this matter 2sg make.master
'You'll take charge of this matter.'

b. *2sg zuozhu zeijian shi.
you make.master this matter

(13) Mandarin

a. yuyanxue, ta nashou.
linguistics 3sg take.hand
'S/he is good at linguistics.'

b. *ta nashou yuyanxue.
3sg take.hand linguistics

Huang (1989a) has made the following observations: (i) the topical NPs have clearly subcategorizable semantic roles; (ii) these constructions involve a large set of compound verbs, including some V+N compounds which are practically all disyllabic in Chinese, and all of the quadrisyllabic compounds, and (iii) topics can be regarded as being subcategorized (Bresnan 1982a). Based on these three observations, Huang shows that the most efficient account is to treat the topical NPs as subcategorized topics. Mo (1990) has proposed a new grammatical function stopic (s for 'subcategorized') to differentiate them from the non-thematic topics.

According to Huang (1989a), the subcategorizable topic achieves parsimony in terms of lexical encoding and mapping to c-structure, but this would introduce complexities to the LMT. Her (1991, 2010), based on the same LMT considerations, argues that topics should be regarded as strictly non-subcategorizable. To deal with the fact that pseudo-transitive verbs do not allow the stipulated objs to be realized in the canonical obj position, a feature-value pair [frame +] is assigned to those verbs. The [frame +] feature can only be obtained by way of unification with the topic. The annotated PSR in (14b) specifies that topic receives the feature [frame +] and it must be associated with some gf in the f-structure to fulfill the Extended Coherence Condition.

(14) Her (2010):

a. *nashou* V (↑ pred) = ‘be-good-at⟨subj obj⟩’
(↑ obj frame) $=_c$ +

b. S′ ⟶ NP S
(↑ topic)=↓ ↑=↓
(↑ frame)=+

It is important to note that neither account explicates how it will account for the NPs occurring in other non-obj positions, such as in (15).

(15) Mandarin
[[Mali zui nashou] de kemu] shi shuxue.
Mary most take.hand de subject be math
‘The subject that Mary is best at is math.’

In (15), a gap in the relative clause is linked to the head noun, and is then linked to the complement of the verb *shi* ‘be’. In Huang’s (1989a) account, the subcategorized subj will have to be linked to other gfs following the same mechanisms for control and complementation (Bresnan 1982a). See Her (2010) for a different account. In both cases, however, there is neither a clear solution to the entailed complexities for LMT, nor an answer to the question of why such a high-level solution is needed for what seems to be a parochial fact limited to a set of predicates in a specific language.

In sum, the pseudo-transitive verbs in Mandarin, where the obj-like arguments can only occur in the topic position, pose a great challenge to the theory of gf-encoding in LFG. The two existing proposals (Huang 1989a and Her 2010) both have their strengths and weaknesses. The fact that the set of verbs involved are some of the verbs currently undergoing changes in transitivity (Jiang & Huang 2018) suggests that the ultimate solution may involve a theory which takes historical changes involving gfs into consideration.

3.2 Cantonese

In contrast to the issue-driven discussion on gfs in Mandarin in the last section, this section will provide a survey on subj (Lee 2003), obj (Lam 2008), and the complement (Bodomo & Lee 2003, Lee 2002) in Cantonese.

3.2.1 Subject in Cantonese

Lee (2003) shows that two syntactic properties are of particular relevance in the identification of the subject in Cantonese. The first is the binding of the reflexive pronoun *zigei* 'self' to the subject *Mary* within the same clause, or to the subject *John* in the clause containing the local clause. This, following Tan (1991), clearly distinguishes the subject from the topic, both of which can be found preverbally.

(16) Cantonese
John$_i$ zi1 Mary$_j$ sik6-zo2 keoi5-zi6gei2$_{i/j}$ haap6 faan6.
John know Mary eat-PFV 3SG-self CLF rice
'John knows that Mary ate his/her lunch box.' (Lee 2003: 30)

The second distinctive property of the subject is that the possessor of the subject can be easily relativized with the gap strategy (17a), but the possessor of the object cannot be relativized in the same way (17b):

(17) Cantonese

a. [_ sing4zik1] ji5ging1 gung1bou3-zo2 ge3 hok6saang1
grades already announce-PFV REL students
'the students whose grades have been announced.' (Lee 2003: 37)

b. *hok6haau6 ji5ging1 gung1bou3-zo2 [_ sing4zik1] ge3 hok6saang1
school already announce-PFV grades REL students
(Intended meaning: 'the student whose grades have been announced by the school') (Lee 2003: 38)

Luke et al. (2001) discuss the Subject Condition in Cantonese. As with Sinitic languages in general, Cantonese allows pro-drop even without agreement morphology or case-marking. This poses a challenge to the identification of grammatical functions at f-structure. Luke et al. (2001) show that apparently 'subjectless' sentences, in fact, do have a subject, but discourse-pragmatic criteria, such as the speech context, must be taken into consideration in order to retrieve the subject. See also Liao (2010) for a discussion on the pro-drop patterns in Mandarin Chinese, and for an analysis within LFG.

3.2.2 Object in Cantonese

Lam (2008) investigates the syntax of objects in Cantonese, in particular, their syntactic behaviours in double object constructions (DOCs). Without morphological marking, the structural position of each object becomes an important clue in the identification of the different object functions – in (18), the recipient-object is found immediately postverbally, with the theme-object following it:

(18) Cantonese

a. Recipient-NP < Theme-NP
ngo gaau siupangjau zungman.
1sg teach children Chinese
'I teach children Chinese.'

b. *Theme-NP < Recipient-NP
*ngo gaau zungman siupangjau.
1sg teach Chinese children
'I teach children Chinese.'

This, however, is not the canonical order of objects for the verb GIVE – it is the theme-object that must be immediately postverbal.

(19) Cantonese

a. Theme-NP < Recipient-NP
ngo bei-zo bun syu ngo gaaze.
1sg give-pfv clf book 1sg elder.sister
'I gave the book to my elder sister.'

b. *Recipient-NP < Theme-NP
*ngo bei-zo ngo5 gaaze bun syu.
1sg give-pfv 1sg elder.sister clf book

A related question is – which one of these objects is the unrestricted object obj, and which is the restricted one obj$_{\theta}$? In LFG, the object in a DOC which grammatically patterns with the monotransitive object is obj, while the one which does not is obj$_{\theta}$. Passivization is often seen as *the* diagnostic for unrestricted objecthood, but in Cantonese, as in Mandarin Chinese, passivization is often constrained - the passive is associated with a meaning of adversity. As a result, not all verbs, even monotransitive ones, can be involved in passivization (20). It is therefore not a very helpful test for the unrestricted object. We shall return to a discussion of passivization in Section 4.

(20) Mandarin

a. Zhangsan gei ren du-si le.
Zhangsan give people poison-die prt
'Zhangsan was poisoned to death by people.'

b. *Zhangsan gei ren yi-hao le.
Zhangsan give people cure prt
'Zhangsan was cured by people.' (Lefebvre 2011: 257)

Patterns of relativization and pro-drop show that it is the theme-object which behaves like the monotransitive object. Lam (2008) thus concludes that the theme-object is the unrestricted object in Cantonese, while the recipient-object is the restricted object.

3.2.3 Complement in Cantonese

Lee (2002) and Bodomo & Lee (2003) show that Cantonese verbs such as *zidou* 'think' may take either a comp (21a) or an obj (21b), while other verbs subcategorize for only a comp (22a) but not an obj (22b):

(21) Cantonese

a. ngo zi dou $_{\text{S}}$[keoi hai hou jan].
1sg know 3sg be good person
'I know that s/he is a good person.'

b. ngo zi dou $_{\text{DP}}$[li gin si].
1sg know this clf matter
'I know (about) this.'

(22) Cantonese

a. ngo hei mong $_{\text{S}}$[keoi hai hou jan].
1sg hope 3sg be good person
'I hope that s/he is a good person.'

b. *ngo hei mong $_{\text{DP}}$[keoi].
1sg hope 3sg
['I hope him/her.']

They therefore argue that Cantonese is a 'mixed language', along the lines of Dalrymple & Lødrup (2000).

4 *Ba*, *Bei*, and Related Constructions

4.1 Mandarin

The Mandarin *bei* construction is considered to be the equivalent of the English *by* passive in the literature. The discussion of the *bei* passive is frequently compared to the *ba* construction, as they share almost identical surface structures. Note that in (23), the agent *gemi* 'fans' is optional, much like the *by*-agent phrase in English. A *bei* construction with the agent phrase is known as the 'long' passive, while a *bei* construction with the agent phrase omitted is the 'short' passive (Huang et al. 2009, Huang & Shi 2016).

(23) Mandarin
Amei bei (gemi) weizhu.
Amei BEI fans encircle
'Amei was encircled (by the fans).'

(24) Mandarin
gemi ba *(Amei) weizhu.
fans BA Amei encircle
'The fans encircled Amei.'

Several important and controversial issues have been raised over the passive analysis of the *bei* construction. The first is whether *bei* is a preposition like the English *by* (Huang 1982, Li 1990, Li & Thompson 1981, Lü 1980, McCawley 1992, Tsao 1996) or a verb (Bender 2000, Feng 1995, Her 1989, 2009, Hsueh 1989, Huang 1999). The current dominant view of *bei* as higher verb is heralded by Huang & Mangione's (1985) formal semantic account, and was first adopted in LFG syntactic studies (e.g. Huang & Mangione 1985, Bender 2000).

The second issue is whether there is one or two passive constructions. The dominant GB analysis treats the passive in Mandarin as having 'split' into two different constructions: the agentless short passive versus the long passive with an overt agent. This is motivated by the observation that the long passive allows a much wider range of syntactic behaviours than the short passive. Yet Her (2009) shows, with corpus data from Sinica Corpus (Chen et al. 1996), that the short passive in fact exhibits the same range of syntactic behaviours, and argues that the two should receive exactly the same analysis, with the only difference being whether the agent is overt or covert. The evidence is presented below. First, Her (2009) shows that short passives (26), just like long passives (25), allows long-distance gaps:

(25) Mandarin
bei ta qitu nuyi de ziyou renmin.
BEI 3SG attempt enslave DE free people
'the free people who were "attempted-to-enslave" by him'

(26) Mandarin

a. gongsi-de wanglu bei qitu ruqin.
company-POSS network BEI attempt hack
'The company network has been "attempted-to-hack".'

b. ziliao bei shefa kaobei le.
document BEI manage copy PRF
'The documents have been "managed-to-copy".'

Second, the claims in the literature that a long passive, but not a short passive, allows a resumptive pronoun to fill a gap are also incorrect, as in (27) and (28).

(27) Mandarin
Zhangsan$_i$ bei wo piping-le ta$_i$ yidun.
John BEI 1SG criticize-PFV 3SG once
'John was criticized once by me.'

(28) Mandarin
ta ba$_i$ pa bei renwei ta$_i$ wufa guanjiao haizi.
3SG father afraid BEI consider 3SG fail discipline children
'His father was afraid to be considered that he failed to discipline his children.'

Third, the split view claims that the pronominal particle *suo* is allowed in the long passive only, as in (29), and not the short passive. The corpus example in (30) shows that *suo* can be found in the short passive as well:

(29) Mandarin
ni hui bei ren suo chixiao.
2SG will BEI person SUO sneer
'I'm afraid your recent behavior toward him will be sneered at.'

(30) Mandarin
ni nanmian bu bei suo pian.
2SG unavoidably not BEI SUO trick
'Unavoidably you would be tricked.'

Finally, the split view claims that only the long passive allows an adverbial PP, as in (31), but not in the short passive. This is again shown to be wrong by the corpus example in (32).

(31) Mandarin
Zhangsan bei Lisi zai xuexiao pian-zou le.
John BEI Lee at school abduct PFV
'John was abducted at school by Lee.'

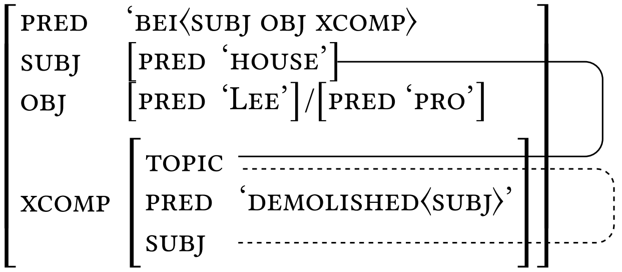
(32) Mandarin
yi zhi laoshu bei zai jiujing zhong jinpao-le yi nian.
one CLF mouse BEI at alcohol inside soak-PFV one year
'A mouse has been soaked in alcohol for a year.'

The analysis proposed by Her (2009) has *bei* as a three-place predicate requiring three theta roles, which are mapped to SUBJ, OBJ, and XCOMP, with a meaning that approximates (33). The lexical entry, including its lexical category, lexical form, and the control relations, is shown in (34). Note that the operation that links theta roles with GFs is γ; thus $\gamma(\hat{\theta})$ in (34) refers to the GF linked to the logical subject. (↑ OBJ) = (↑ XCOMP $\gamma(\hat{\theta})$) thus means that OBJ controls the GF in XCOMP that is linked to the $\hat{\theta}$. The f-structure of a typical *bei* sentence is illustrated in (35).

(33) *bei* ⟨*x y z*⟩: *x* is (adversely) affected by *y* in a way that *z* describes

(34) *bei* V (↑ PRED) = 'BEI⟨SUBJ OBJ XCOMP⟩'
(↑ SUBJ) = (↑ XCOMP TOPIC)
(↑ OBJ) = (↑ XCOMP $\gamma(\hat{\theta})$)
¬(↑ OBJ) ⇒ (↑ OBJ PRED) = 'PRO'

(35) Mandarin
na jian fangzi bei (Lisi) chai-le.
that CLF house BEI Lee demolish-PFV
'That house got demolished (by Lee).'

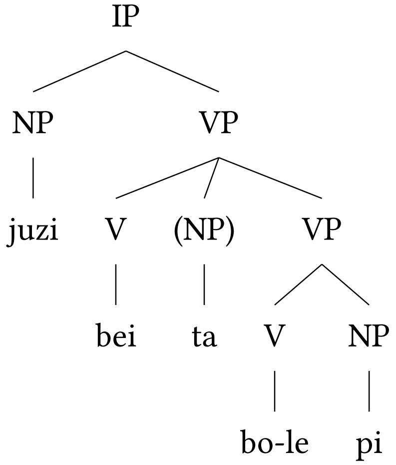


In (35), (↑ OBJ), which is either an overt agent *Lee* or a covert pronoun, is responsible for adversely affecting (↑ SUBJ), the house, in a way described by

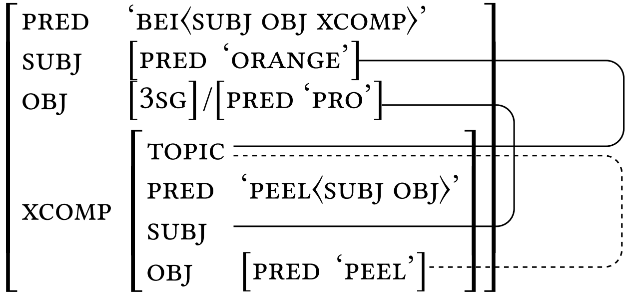
(↑ xcomp), i.e., the house is demolished. Note that (↑ subj) controls the topic in xcomp, which is anaphorically linked to subj, indicated by the dotted line. The matrix subj, the house, is also the subj of the embedded clause, which is passive in nature. A non-canonical example is given in (36), with both c-structure and f-structure illustrated.

(36) Mandarin
juzi bei (ta) bo-le pi.
orange bei 3sg peel-pfv peel
'The orange has its peel peeled off (by him).

a. c-structure:



b. f-structure:



In (36), (↑ obj), which is again either overt or covert, is responsible for adversely affecting (↑ subj), the orange, in a way described by (↑ xcomp), i.e., the orange has its peel peeled off. Note that (↑ subj) controls the topic in xcomp, and (↑ obj) controls the subj in xcomp. Within the xcomp, topic is anaphorically linked to obj.

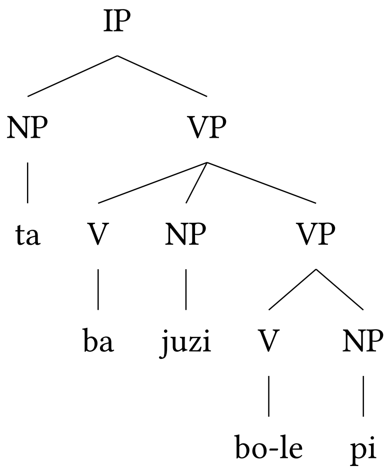
Based on this account, Her (2009) contends that the *bei* construction is the passive counterpart of the *ba* construction, not the canonical active sentence. Thus, *ba* is likewise a three-place predicate, as in (37), and its lexical entry is shown in (38). The example in (39) is therefore the active counterpart of the passive (36). See also Bender (2000) for an LFG analysis of the *ba* construction in Mandarin.

(37) *ba* ⟨*x y z*⟩: *x* affected *y* in a way that *z* describes

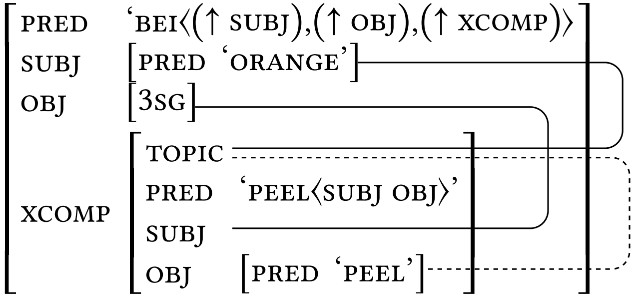
(38) *ba* V (↑ pred) = ‘ba⟨subj obj xcomp⟩’
(↑ obj) = (↑ xcomp topic)
(↑ subj) = (↑ xcomp $\gamma(\hat{\theta})$)

(39) Mandarin
ta ba juzi bo-le pi.
3sg ba orange peel-pfv peel
‘He peeled the peel off the orange.’

a. c-structure:



b. f-structure:



In (39), (↑ subj), *he*, is responsible for affecting (↑ obj), the orange, in a way described by (↑ xcomp), i.e., *he peeled the peel off the orange*. Note that (↑ subj) controls the subj in xcomp, and (↑ obj) controls the topic in xcomp, which is in turn anaphorically linked to obj.

In summary, *ba* and *bei* are both treated as three-place predicates. While the former involves a causer as subj, an affectee as obj, and an active proposition describing the caused event as xcomp, the latter involves an affectee as subj, a causer as obj, and a passive proposition describing the caused event as xcomp. Thus, in this sense the *bei* construction is the passive counterpart of the *ba* constructive.

See also Yang (2020) for a discussion of the impersonal BEI-passive in Mandarin.

4.2 Cantonese

A discussion on aspects of the passive structure in Cantonese is offered in Chow (2019). While Cantonese shares a phonologically similar passive morpheme *bei* with Mandarin, the two counterparts differing only in tones, one clear morphosyntactic difference is that the NP following *bei* in Mandarin is optional (40a), while that in Cantonese is obligatory (40b). In other words, the 'short' passive discussed in the previous section is not allowed in Cantonese. Even in agentless passives, the NP *jan* 'person' must follow *bei.*

(40) a. Mandarin
Zhangsan bei (Lisi) daa-le.
Zhangsan bei Lisi hit-pfv
'Zhangsan has been hit (by Lisi).'

b. Cantonese
Siuming bei *(jan) daa.
Siuming pass people hit
'Siu Ming was beaten up.'

Based on this, Chow (2019) argues that passivization in Cantonese involves the subject being linked to an oblique object, a non-core argument (Bresnan 1982c; Chow 2019: 232). It is also shown that, unlike Kit's (1998) and Her's (2009) analyses for the Mandarin *bei*, the Cantonese *bei* is a 'non-argument taking and a non-predicative' coverb (Chow 2019: 186), which contributes a (↑ voice)=pass feature to f-structure.

Similar to Her (2009), Chow (2019) acknowledges that the matrix subject in a passive structure is linked to the topic role. Indeed, the same propositional content may be expressed by an active, a 'direct' or canonical passive (41a), or a 'indirect' passive (42b) structure, depending on the information structure to be expressed. In an canonical passive structure, the entire theme-NP is topical

– it is expressed as the subject. In an ‘indirect’ passive structure, however, it is the possessor of the theme-NP which is topical – the possessor is linked to the subject.

(41) Cantonese

a. The ‘direct’ or canonical passive
[Can saang gaa ce] bei tungsi zong-laan zo.
Mr. Chan CLF car PASS colleague crash-broken PFV
‘Mr. Chan’s car has been crashed by his colleague.’

b. The ‘indirect’ passive
[Can saang] bei tungsi zong-laan zo [gaa ce].
Mr. Chan PASS colleague crash-broken PFV CLF car
‘Mr. Chan had his car crashed by his colleague.’

Semantically, the subject must be adversely affected in order for an indirect passive to be acceptable. Chow (2018, 2019) proposes that, for the indirect passive structure [NP1 BEI2 NP2 V NP3] to be licensed, an additional malefactive role, which must be topical, is introduced into the structure. Due to the limits of space, we shall leave the discussion here and ask interested readers to refer to these studies.

5 Dative alternation

Dative alternations, as well as ditransitive constructions, have been extensively discussed in the Chinese linguistics literature. In addition to the word order variations and the introduction of an applied object common in other languages (e.g. Bresnan et al. 2007), the challenges in analyzing the Mandarin dative alternative involve the position and the grammatical status of the lexical form *gei* ‘give’ (e.g. Chao 1968, Zhu 1982). The discussion in this section focuses on Mandarin only, as the dative alternation is not attested in Cantonese (Lam 2008).

(42) Ditransitive constructions with *gei* in Mandarin (42a, 42c & 42d are from Huang & Ahrens 1999)

a. SUBJ *gei* IO V DO

b. SUBJ DO V (*gei)* IO

c. SUBJ V (*gei*) IO DO

d. SUBJ V DO *gei* IO

The pattern in (42d) will be treated as the semantically most transparent word order for *gei* 'give.to'. It should, however, be noted that it is not clear whether a clearly favoured canonical word order is available (Yao & Liu 2010). In a ditransitive construction, *gei* introduces the IO as the goal towards which a theme DO moves. In the literature, there are several different views regarding the grammatical status of *gei*: *gei* is (i) a verb, producing a serial verb construction with the other verb in the construction; (ii) a co-verb/preposition, marking the IO in the construction. The verb/preposition debate is familiar in the Chinese linguistics literature, and has been applied to several other lexical items with similar distributions. Either account is generally adequate in describing the patterns in (42a) and (42d). The patterns in (42b) and (42c), where *gei* is optional and the optionality depends on the V, has generated interesting debates specific to the ditransitive construction (e.g. Chao 1968, Li & Thompson 1981, Cheng & Huang 1988). Huang & Ahrens (1999) observe that verbs without an inherent meaning of transfer (e.g. *ti* 'to kick', *bian* 'to knit'), typically require the presence of *gei*, while *gei* in structures with verbs with an inherent meaning of transfer may be optional (e.g. *song* 'to give as a gift, to send', *zhu* 'to lend', *mai* 'to sell,' and *gei* 'to give'). This suggests that the *gei* immediately after the verb is a stem that introduces an applicative goal role to the argument structure of the verb. This account has been incorporated into Huang's (1993a) LMT of Mandarin. The compounding account has also been adopted by several Construction Grammar-based accounts (e.g. Ahrens 1995, Zhang 1999, Liu 2006). Huang (1993a) argues that the postverbal *gei* is a part of the complex predicate which involves a morpholexical rule introducing an additional goal role into the argument structure. The study also observes that there is a significant contrast between the English and Chinese dative constructions — the theme can become SUBJ in a passive construction in Mandarin, but not the goal.

(43) a. Mary gave John a book.
b. John was given a book by Mary.
c. A book was given to Mary by John.

(44) Mandarin (adapted from Huang (1993a: example 22))
a. Zhangsan ti-*(gei) Lisi yi ge qiu.
Zhangsan kick-GEI Lisi one CLF ball
'Zhangsan kicked a ball to Lisi.'
b. *Lisi (bei Zhangsan) ti-gei-le yi ge qiu.
Lisi BEI Zhangsan kick-GEI-PFV one CLF ball

c. nei ge qiu (bei Zhangsan) ti-gei-le Lisi.
that CLF ball BEI Zhangsan kick-GEI-PFV Lisi
'That ball was kicked to Lisi (by Zhangsan).'

In sum, this account of V-*gei* compounding, adding an applicative GOAL role, illustrates the lower accessibility of the goal role on the Thematic Hierarchy, and predicts that the goal role cannot be linked to SUBJ in a Mandarin passive structure.

See also Her (2006a) for an alternative analysis of the Mandarin dative alternation.

6 Compounds

Compounding is a productive morpholexical process in Chinese (Hsieh et al. 2022). Mandarin is known to have at least the following types of compounds that can introduce new predicate-argument structures: (i) subject-verb (SV) compounds; (ii) verb-object (VO) compounds; (iii) verb-resultative (VR) compounds; and, (iv) verb-verb (VV) compounds. In this section, the LFG treatments of resultative compounds and VO compounds are presented in Sections 6.1-6.2 and Section 6.3, respectively.

6.1 Early LFG studies on Mandarin compounds

Chao (1968) has observed that a number of distinctive grammatical features of Chinese are related to the prevalence of compounds: (i) V+N compounds tend not to take another object directly; (ii) the noun in the compound is often separable even though it is a sub-lexical unit (called 'ionization' in Chao 1968); (iii) separable compounds allow certain degrees of internal modification, and in some cases, an object may appear in non-canonical positions. The earliest published studies in the LFG literature on Mandarin, Huang (1985, 1986, 1988, 1990) for example, have aimed to account for these separable compounds and their non-canonical object positions.

Huang (1990) provides an account for VO compounds in Mandarin. One example that is of particular interest is the idiom chunk *chi cu* 'be jealous of', consisting of the lexical verb *chi* 'eat' and the noun *cu* 'vinegar'. The chunk is a non-compositional compound, as the overall meaning is only available if both the V and the N are found in the sentence. What is interesting, and yet challenging, is the fact that the V and the N in the compound can be separated, by *de* in the following example:

(45) Mandarin
Sanbai conglai bu chi Yunniang de cu.
Sanbai ever NEG eat Yunniang DE vinegar
'Sanbai is never jealous of Yunniang.'

Huang (1990) proposes an account for separable compounds in terms of lexical discontinuity – both the verb and the separable noun contribute information to the overall interpretation. The subscript marks the use of this form as a component of an idiom. Note that PRED is associated with the noun, and the constraining equation ensures that the non-compositional meaning will only be available if the form *chi* also occurs in the sentence.

(46) a. *chi*$_2$ V (↑ VMORF) = CHI
b. *cu*$_2$ N (↑ PRED)='BE.JEALOUS⟨SUBJ OBL⟩'
(↑ VMORF) $=_c$ CHI
(↑ CL) = DE

Huang (1990) further shows that this proposal successfully accounts for various constructions in which the compound occurs, including topicalization. This example illustrates how complex structures can be captured with simple lexical rules.

6.2 VO compounds in Cantonese

VO compounds are found in Cantonese, too. As discussed in the previous section and as observed in Bodomo et al. (2017), among others, the challenge with analyzing VO compounds is that they seem to be lexical in that their meanings are often non-compositional and depend on the co-occurrence of a V and some specific N; but, at the same time, they seem to be phrasal in that other constituents can clearly be inserted in between the V and the N:

(47) Cantonese
a. jau-seoi
swim-water
'swim'
b. ngo jau-zo zan seoi.
1SG swim-PFV for.a.while water
'I have swum for a while.' (Bodomo et al. 2017: 389, ex. 18)

Bodomo et al. (2017) treat *seoi* 'water' as a syntactic object, whose form is obligatorily required to give the target meaning (hence the FORM feature in OBJ below), but it is not subcategorized for by the PRED, as the VO compound *jau-seoi* 'swim' requires only an agent argument at a-structure and *seoi* 'water' is athematic in the compound (Bodomo et al. 2017: 389):

(48)
$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{swim}\langle\textsc{subj obj}\rangle\text{'} \\ \textsc{subj} & \left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{num} & \textsc{sg} \\ \textsc{pers} & 1 \end{array}\right] \\ \textsc{asp} & \textsc{pfv} \\ \textsc{obj} & \left[\begin{array}{ll} \textsc{form} & \textsc{seoi} \end{array}\right] \\ \textsc{adj} & \left\{\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{zan}\text{'} \end{array}\right]\right\} \end{array}\right]$$

Bodomo et al. (2017) apply this analysis to Mandarin VO compounds, too. Che & Bodomo (2018) discuss Mandarin VO compounds, as well as idioms, and adopt a complex predicate analysis for VO compounds.

A complex predicate approach has also been proposed to analyze serial verb constructions, which are common in Chinese. See Bodomo et al. (2003) for a syntactic and semantic account of Cantonese serial verb constructions involving the benefactive role.

6.3 Resultative compounds

Chinese resultative compounds involve the concatenation of two verbs, and the merge of their predicate argument structures. They are called resultative compounds (VR) because the first verb denotes an action, and the second verb typically refers to the result caused. Previous studies have found that both verbs contribute to the argument structure of the compound. Li (1990) proposes a structure-based account that allows most possible predicate-argument structures, but fails to select the correct reading among other possibilities. Huang & Lin (1992) assume that VV compounds in Mandarin represent composite event structures and the complex predicate formation can be resolved with morpholexical mapping based on prototypical argument templates. Li (1995) proposes another account based on the causative hierarchy. Her (2004, 2007) offers an LFG account by incorporating unified mapping principles of LMT.

Her's (2004, 2007) account focuses on cases where the first V has either one or two arguments, while the second V has only one argument. In addition, it is assumed that the VR compounds have two arguments. Hence, there are cases in which each verb contributes an argument, or the more complicated cases where the argument from the second verb can be merged with either the first or the second argument of a transitive verb, such as *niu* 'to wring' in (50). The two argument merging scenarios are given in (49).

(49) V-V Resultative Compounding

$$V_1\langle x\ y\rangle + V_2\langle z\rangle \rightarrow \begin{array}{l}\text{(i) } \langle x\ y\text{-}z\rangle \\ \text{(ii)} \langle x\text{-}z\ y\rangle\end{array}$$

Given that the resultative compound is transitive, thus a two-place predicate, the single role of V_2 must join one of the two roles of V_1 and form a composite role. Logically, two possibilities are obtained as shown in (49), but three patterns of argument-function linking are observed, as in (50)-(52). Note also that a causative reading is also obtained, except in (51).

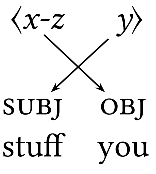
(50) Mandarin; causative
Lisi niu-gan-le maojin.
Lee wring-dry-PFV towel
'Lee wrung the towel dry.'

$$\begin{array}{cc} \langle x & y\text{-}z\rangle \\ \downarrow & \downarrow \\ \text{SUBJ} & \text{OBJ} \\ \text{Lee} & \text{towel} \end{array}$$

(51) Mandarin; non-causative
Zhangsan chi-yan-le zhe zhong dongxi.
John eat-tired.of-PFV this kind stuff
'John got tired of eating this kind of stuff.'

$$\begin{array}{cc} \langle x\text{-}z & y\rangle \\ \downarrow & \downarrow \\ \text{SUBJ} & \text{OBJ} \\ \text{John} & \text{stuff} \end{array}$$

(52) Mandarin; causative
zhe zhong dongxi hui chi-si ni.
this kind stuff will eat-dead 2SG
Eating this kind of stuff will make you dead.'



Her's (2007) resultative compound rules are given below in (53).

(53) V-V Resultative Compounding

$\mathrm{V}_{\mathrm{caus}}\langle x\ y\rangle + \mathrm{V}_{\mathrm{res}}\langle z\rangle \rightarrow \mathrm{V}_{\mathrm{caus}}\mathrm{V}_{\mathrm{res}}\langle \alpha\ \beta\rangle$, where $\langle \alpha\ \beta\rangle^{*}$ =

(i) $\langle x\ y\text{-}\cancel{z}\rangle$

(ii) $\langle x[\mathrm{caus}]\ \cancel{y}\text{-}z[\mathrm{af}]\rangle$

(iii) $\langle x\text{-}\cancel{z}\ y\rangle$

(iv) $\langle \cancel{x}\text{-}z[\mathrm{af}]\ y[\mathrm{caus}]\rangle$

*Unsuppressed *z* and the other unsuppressed role receive [af] and [caus], respectively

With these rules, and a modified version of LMT, all possible interpretations of resultative compounds with V⟨*x y*⟩ and V⟨*x*⟩ combinations can be accounted for. See Her (2007) for details.

7 Lexical Mapping Theory and locative inversion

LFG crucially observes radical lexicalism (Karttunen 1989), and views grammatical operations as the projection and unification of mentally represented lexical information (Bresnan 1982b). Word order variations and alternations are not accounted for by transformational rules, but by the projection and unification of the mental representation of information from conceptual structure to c-structure. See Belyaev 2023a [this volume] and Belyaev 2023b [this volume] for a discussion on the architecture of LFG.

The introduction of Lexical Mapping Theory (LMT) to LFG to derive lexicalized argument structures in terms of GFs is crucial in allowing the theory to account for concept-driven lexicalization. It also provides an elegant way to account for word order and other typological variations. LMT formulates rules to capture how conceptualized event structures are lexicalized as argument structures to mediate mapping to functional structures (Bresnan & Kanerva 1989, Alsina 1993). Huang (1993a) proposes an adapted LMT for Mandarin, adopting previous assumptions that the mapping is determined by the thematic hierarchy, and the theory of intrinsic and default classification of grammatical functions. The adaptations are proposed, taking into consideration both the theoretical concerns to incorporate Dowty's (1991) Proto-role properties, and the need to capture several atypical argument realization patterns in Mandarin. These patterns include the NP realization of extent/dimension (54a), and the use of time/location NPs instead of pleonastic pronouns in the subject position in presentative constructions (54b).

(54) Mandarin

a. Ta ti-le wo yi jiao.
3sg kick-pfv 1sg one foot
'S/he kicked me once'

b. Qiangshang gua-le ji fu hua.
wall.top hang-pfv several clf painting
'There are several paintings on the wall.'

Huang also provides evidence to show that the GOAL role is below the THEME role on the thematic hierarchy in lexicalized compounds, idiom chunks and ditransitive verbs. The thematic hierarchy for Mandarin is thus revised, as shown in (55). The intrinsic and default classification of grammatical functions (57a) are slightly modified to simplify feature assignments, and to accommodate the locative inversion construction in Mandarin.

(55) Thematic hierarchy for Mandarin Chinese (Huang 1993a)
ag > ben/mal > instr > th/pat > exp/goal > loc/dom

Huang & Her (1998) and Her (2010) propose a simplified LMT. This proposal keeps the universal thematic hierarchy, with the assumption that morpholexical operations can replace the Subject Condition. Note that the two proposals take different approaches to accommodate the Mandarin Chinese data. Huang (1993a) has revised the thematic hierarchy, but has kept intrinsic and default classification of grammatical functions, while Her (2010) has kept the thematic hierarchy (56), but has adjusted the criteria for the ±*r*(estricted) and ±*o*(bjective) specifications. The different proposals aim to account for several important generalizations in Chinese, some of which will be discussed below.

(56) Thematic Hierarchy for Mandarin Chinese (Her 2010)
ag > ben > go/exp > inst > pt/th > loc

In terms of the classifications, the [−] values, considered less marked than the [+] values, are thus given a higher position on the hierarchy. Her (2010) also assumes that [−*r*] (unrestricted) is less marked than [−*o*] (non-object-like), given that [−*r*] gfs are not restricted to specific argument roles, Huang (1993a) does not make the same assumption.

(57) Markedness Hierarchy of Grammatical Functions:

a. subj ([−*r*, −*o*]) > obj ([−*r*, +*o*]) / obl$_\theta$ ([+*r*, −*o*]) > obj$_\theta$ ([+*r*, +*o*]) (Huang 1993b)

b. subj ([−*r*, −*o*]) > obj ([−*r*, +*o*]) > obl$_\theta$ ([+*r*, −*o*]) > obj$_\theta$ ([+*r*, +*o*])
(Her 2010)

See also Fu (1993) and Pan (1997) for introductions to LMT published in Chinese journals.

Locative inversion is heavily influenced by considerations at information structure (Bresnan 1989; Dalrymple 2001: 209). It is also known as the presentative or existential construction. Gu (1992, 1997) assumes that most verbs which may participate in the locative inversion in Mandarin are derived from transitive verbs. Pan (1996, 1997) argues that it is necessary to distinguish two types of locative inversion, based on the presence of the aspectual markers *-le* pfv or *-zhe* dur on the verb. Huang et al. (1999) shows that the range of different meanings associated with the locative inversion and the presentative sentences can be accounted for by considering the interaction of constructional and lexical meanings. Cui & Yuan (2020) suggest that existential sentences exhibit features of ergativity.

The challenge that the locative inversion presents to LFG, especially to LMT, is how it is possible to map the locative role, ranked low on the thematic hierarchy, to the most prominent grammatical function subj. Bresnan & Kanerva (1989), based on data from Chicheŵa, propose a special default rule for the presentational focus construction. The rule assumes that the locative phrase bears the focus feature and ensures that a locative [−*r*] argument appears. Bresnan (1994) extends the account to English. Huang & Her (1998), however, shows that the proposal cannot account for the locative inversion in Mandarin, especially in constructions involving three-place predicates, such as *fang* ‘put’:

(58) Mandarin

a. Lisi fang-qian zai zhuo-shang.
Lisi place-money at table-top
‘Lisi placed some money on the table.’

b. qian (Lisi) fang zai zhuo-shang.
money Lisi placed at table-top
‘Money was placed on the table by Lisi.’

c. zhuo-shang (Lisi) fang-le qian.
table-top Lisi place-pfv money
‘On the table was placed some money.’

Crucially, both (58b) and (58c) are treated as locative inversion structures. There is, however, evidence suggesting that (58b), in fact, involves topicalization, but not locative inversion. First, *qian* 'money' is not a locative phrase. Second, the verb in (58b) does not require the presence of the aspectual markers -*zhe* DUR or -*le* PRF, unlike the verb in well-accepted Mandarin locative inversion structures. The preposed NP in (58b) can therefore be treated as a regular topicalized phrase, without further stipulations. See also Lui (2020) for a discussion of the locative inversion in Cantonese.

8 Classifiers and measure words

Mandarin is a textbook example of a numeral classifier language. As a lexical category, numeral classifiers have two subcategories, namely sortal classifiers (C), *aka* classifiers; and mensural classifiers (M), *aka* measure words (Huang & Shi 2016). See (59) and (60) for examples of Cs and Ms, respectively (Her 2012b).

(59) Mandarin

a. san gen xiangjiao
3 CLF banana
'3 bananas'

b. yibai ben shu
100 CLF book
'100 books'

c. shi pi ma
10 CLF horse
'10 horses'

(60) Mandarin

a. san da xiangjiao
3 M-dozen banana
'3 dozens of bananas'

b. yibai xiang shu
100 M-box book
'100 boxes of books'

c. shi qun ma
10 M-herd horse
'ten herds of horses'

C and M consistently appear after a numeral (Num) and before a noun (N) and are mutually exclusive in this position, as only one C/M can be used. It is a near consensus in the Chinese linguistics literature to assign the same phrasal structure to them. The syntactic position is typically called the classifier position. See Jiang et al. (2022) for a summary of syntactic approaches, and Chen et al. (2022) for a summary of semantic approaches to the Chinese classifier system.

Cs and Ms, however, do exhibit some differences (Chao 1968, Her 2017; see also Huang 2015 for an ontological account). In terms of modification, the adjective, whether it is found before or after a C, modifies the head N. (61a) and (61b) therefore have the same meaning. An adjective in a nominal structure with an M, however, modifies the immediately following element. Thus, in (62a), *da* 'big' modifies *xiang* 'box', yielding the meaning 'one big box of apples', while in (62b), *da* 'big' modifies *pingguo,* yielding the meaning 'one box of big apples' (Her 2012b):

(61) Mandarin sortal classifiers
 a. yi da ke pingguo
  1 big CLF apple
 b. yi ke da pingguo
  1 CLF big apple
  'one big apple'

(62) Mandarin mensural classifiers
 a. yi da xiang pingguo
  1 big M-box apple
  'one big box of apples'
 b. yi xiang da pingguo
  1 M-box big apple
  'one box of big apples'

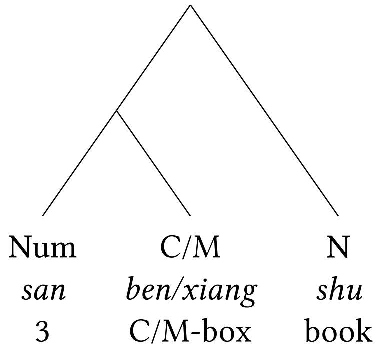
Another difference between Cs and Ms is that the former has the fixed numeral value of precisely *1*, while Ms can be of any value, numerical or non-numerical, except *1*, as shown in (63). In (63), K is a C or M, and k is the mathematical value of K.

(63) C/M distinction in mathematical values
 $[\text{Num}\ \underline{\text{K}}\ \text{N}] = [\text{NUM}\times k\text{N}]$, where K=C *iff* $k = 1$, otherwise K=M.

The LFG account offered in Her (2012b) assigns a left-branching c-structure to C/M, as in (64), consistent with the traditional approach but contra the dominant right-branching structure preferred in recent derivational syntax. See Her

(2017) and Her & Tsai (2020) for arguments from typological as well as Mandarin-internal perspectives. Sample lexical entries of N, Num, C, and M are given in (65).

(64) Unified left-branching c-structure of the classifier construction



(65) Sample lexical entries

a.	*shu*	N	(↑ PRED)=‘BOOK’ (↑ PROFILABLE)={BEN本,CE冊}
b.	*san*	Num	(↑ CARD)=3
c.	*ben*	C/M	(↑ PROFILED)=BEN本
d.	*xiang*	C/M	(↑ PRED)=‘BOX’

Cs and Ms are two subcategories of a single lexical category C/M. Their differences are located in f-structure. CLF in (65c) has no PRED, but M in (65d) does; C, however, has a feature PROFILED, whose value is the essential property each CLF serves to profile, or highlight. A noun can only have one or more of its essential features profiled and may thus co-occur with more than one C, though one at a time as a formal requirement. In (65a), for example, *shu* ‘book’ normally takes the CLF *ben*, but *ce* is also an option, accounted for by the feature PROFILABLE, which takes a set, {BEN, CE}, as its value. The relevant annotated phrase structure rules are given in (66).

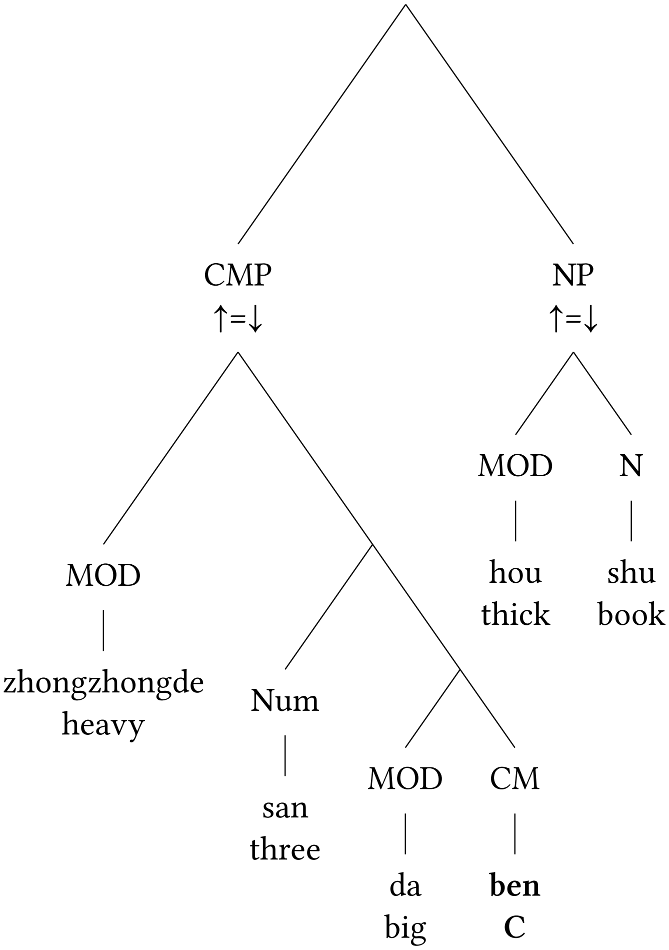
(66) Annotated phrase structure rules for the classifier construction

a. NP ⟶ … C/MP … N
(↓ PRED) ⇒ (↑ QUANTIFIER)=↓ ↑=↓
¬(↓ PRED) ⇒ {↑=↓, (↓ PROFILED) $\in_c$ (↑ PROFILABLE)}

b. C/MP ⟶ … Num … C/M
↑=↓ ↑=↓
((↑ CARD)=1)

The notation ‘A⇒B’ in (66) means ‘if A, then B’. Thus, in a C/MP, if it has PRED, indicating it is an M, then the information goes in a QUANTIFIER function; if it does not have PRED, indicating it is a C, then it serves as a co-head with N and its PROFILED value must be a member of N’s PROFILABLE set of values. The c-structure and f-structure of two nominal phrases with a CLF and an M are given in (67) and (68), respectively.

(67) Mandarin
zhongzhong-de san da ben hou shu
heavy-DE 3 big CLF thick book
‘three heavy big thick books’

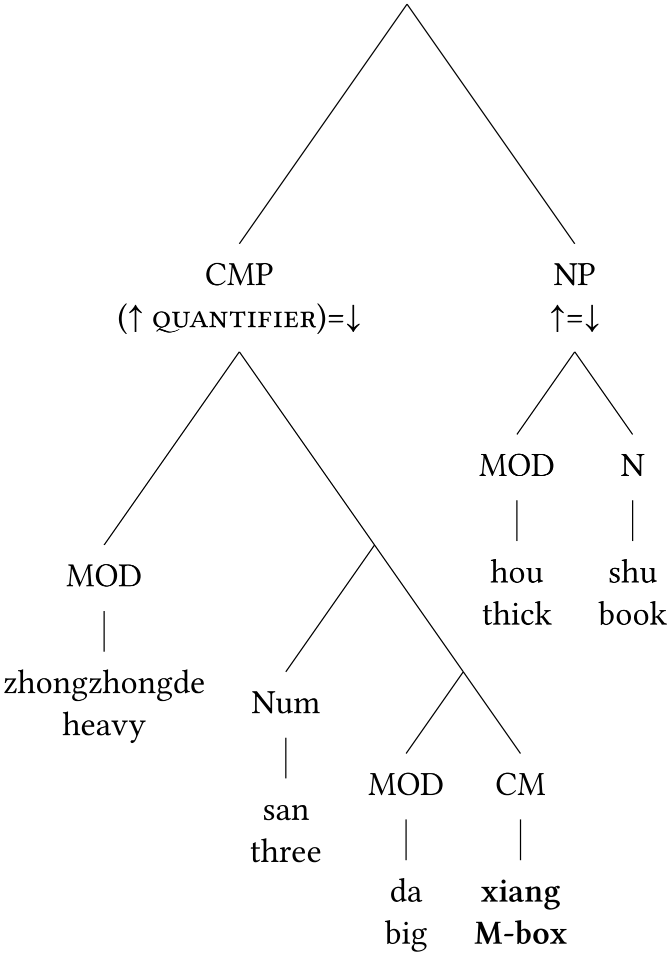


$$\left[\begin{array}{ll} \text{PRED} & \text{BOOK} \\ \textbf{PROFILED} & \textbf{BEN 本} \\ \text{PROFILABLE} & \{\text{BEN 本, CE 冊}\} \\ \text{CARD} & 3 \\ \text{ADJUNCTS} & \left\{\begin{array}{l} [\text{“HEAVY”}] \\ [\text{“BIG”}] \\ [\text{“THICK”}] \end{array}\right\} \end{array}\right]$$

(68) Mandarin

zhongzhong-de	san	da	xiang	hou	shu
heavy-DE	3	big	M-box	thick	book

‘three heavy big boxes of thick books’



$$\begin{bmatrix} \text{PRED} & \text{BOOK} \\ \text{ADJUNCTS} & \left\{\left[\text{“THICK”}\right]\right\} \\ \text{PROFILABLE} & \left\{\text{BEN 本, CE 冊}\right\} \\ \text{CARD} & 3 \\ \text{QUANTIFIER} & \begin{bmatrix} \text{PRED} & \text{‘BOX’} \\ \text{CARD} & 3 \\ \text{ADJUNCTS} & \left\{\begin{matrix} \left[\text{“HEAVY”}\right] \\ \left[\text{“BIG”}\right] \end{matrix}\right\} \end{bmatrix} \end{bmatrix}$$

The parallel architecture of c-structure and f-structure allows Cs and Ms to belong to one syntactic category and (67) and (68) thus share the same c-structure, while their differences are captured in the f-structure, where a CLF serves as a co-head of the nominal construction and an M serves as the head of a quantifier phrase.

See Börjars et al. (2018) for a different proposal for the c- and f-structures of Mandarin noun phrases containing classifiers and measure words, and Huang & Ahrens (2000) for a discussion on kind and event classifiers in Mandarin.

9 Other properties and phenomena

A number of other properties and phenomena are prominent in Chinese as well, and studies of these are available in the very large body of LFG literature on the analysis of Chinese. However, due to constraints of space and scope, we cannot discuss all of these in detail in this chapter. This section will hopefully serve as a pointer to some of these works. The syntax of Mandarin questions has been investigated in Shiu & Huang (1989) and Huang (1993b). Relativization and topicalization phenomena in Mandarin have been studied in Huang (1992), where the author proposes a functional uncertainty analysis (Kaplan & Zaenen 1989). Huang (1988) analyses ‘possessive subjects’ in Mandarin, while Huang (1990) offers an LFG account of possessive-object constructions in Mandarin, showing how these display lexical discontinuity. Chief (1996) explores an LFG account of Mandarin reflexive verbs. Dong (2016) provides an LFG analysis of pronominal binding in Mandarin. Lam (2020) investigates anaphoric and functional control in Mandarin. Che (2014) is a study of particles in Mandarin.

10 NLP applications of LFG in Chinese

LFG has played an important role in the development of Chinese NLP. Joan Bresnan, Ronald Kaplan, Lauri Karttunen and Annie Zaenen visited Taiwan at the dawn of Chinese computational linguistics in 1989 and made lasting impact (Bresnan 1989). One of the immediate outcomes was the Information-based Case Grammar (ICG, Chen & Huang 1990), the first comprehensive grammar of Chinese that incorporated features of both LFG and HPSG. Her et al. (1991) and Her (1995) describe a rule-based commercial machine translation system for English-Chinese, where parsing, transfer and generation are all based on LFG. This system was later acquired by Apptek (https://www.apptek.com/) and expanded to include multiple language pairs and many other NLP applications. Kit (1992, 1993a,b) and Kit & Webster (1992) are also among the earliest studies applying LFG assumptions to parse Chinese. Webster & Kit (1995) describe the use of a 'Chinese-Lexical Functional Grammar (C-LFG)' parser to analyze simple sentences from texts. Sun (2001) outlines the computational implementation of LFG in Chinese. Fang & King (2007) provide an LFG grammar of Mandarin for machine use. Guo et al. (2008) describes LFG-based generation for Chinese, while Burke et al. (2004) and Guo (2009) describe LFG-based Chinese treebanks. Chief et al. (2000) present a corpus-based approach to the analysis of synonyms in Chinese. Jiang et al. (2018) annotate Chinese light verb constructions according to the paradigm of PARSEME, a platform built based on LFG and other theoretical frameworks.

11 Conclusion: LFG and Chinese Linguistics

The assumptions of LFG have been applied to the research on a number of grammatical phenomena in Chinese languages since Huang (1985). A number of LFG-based studies on Chinese have made a significant impact to Chinese linguistics. Huang & Mangione (1985), one of the earliest LFG papers on Chinese, has inspired Huang's (1988) treatment of, and a long debate on, the status of V1 and V2 in the Mandarin resultative verb construction. Interestingly, the V2-as-matrix-verb analysis, initially proposed by Huang & Mangione (1985), is gradually emerging as a possible consensus. Similarly, the functional uncertainty of LFG allows a transparent account of Mandarin long-distance dependencies without abstract levels and movements (Huang 1992). Huang (1993a) first introduced the concept of applicatives to Mandarin, and initiated many interesting discussions in Chinese linguistics in the past 20 years. LFG studies (Huang 1989a, Tan 1991, Her 1991) on the TOPIC and SUBJ functions in Chinese have contributed to the ongoing topic/subject debate in Chinese. LFG studies have also provided crucial insights to the understanding of the *ba* and *bei* constructions in Chinese (e.g. Her 1989, Bender 2000, Her 2009), especially in terms of treating *ba* and *bei* as the main predicate. The seeming dilemma of Chinese compounds displaying lexical non-compositionality and phrasal compositionality (e.g. the separable compounds) can be straight-forwardly dealt with by adopting the assumptions of LFG. This is perhaps one of the topics receiving the most attention in the LFG literature on Chinese, including but not limited to Huang (1990), Huang & Lin (1992), Her (1996, 1997), and Bodomo et al. (2017).

Accounts of Chinese languages have contributed to the development of the LFG framework, too. Shiu & Huang (1989) was one of the first LFG accounts on sentential clitics (e.g. Mandarin question particles). Huang (1992, 1993b) applies the concept of functional uncertainty to account for Mandarin data. Her (2006b) introduces the concepts of interaction and optimality to LMT. Her (2012a,b) provides a full account of the classifier system. Finally, Bodomo (2001) and colleagues' work on Cantonese and Zhuang have added to the typological diversity of LFG research.

Acknowledgments

We thank our reviewers for their constructive comments, which have helped improve the chapter in many ways. All remaining errors are our own.

Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

EXP	experiential	PRT	particle
M	measure word	ZAI	marker meaning 'now' or 'at the moment'

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Chapter 36

LFG and Slavic languages

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This chapter provides a survey of LFG work on Slavic languages. It briefly introduces some of the Slavic family's most salient grammatical properties, before outlining how they have been handled in the framework of LFG. The topics include lexical categories and their grammatical features, the morphology-syntax interface, agreement and government, clause structure and information packaging, passivisation, subjectless and impersonal constructions, copular clauses, clitics, negation, distance distributivity, anaphoric control, and coordination. LFG analyses are placed in a wider context, highlighting how they have enhanced our understanding of Slavic, as well as how Slavic has contributed to modifying the formalism of LFG.

To the memory of my grandfather, Metodi Alexandrov,
named after one of the first teachers of the Slavs

1 Introduction and background

1.1 The Slavic languages

Today, the Slavic (or Slavonic) languages are spoken in their heartland of central and eastern Europe, as well as in vast swathes of Asia and various immigrant communities around the world. They all evolved from a common ancestor, Proto-Slav(on)ic/Common Slav(on)ic, itself a variety descended from Proto-Indo-European which can be reconstructed based on the evidence from the attested daughter languages, as well as data obtained from wider comparison across Indo-European (see Comrie & Corbett 1993, Schenker 1993, 1995, Sussex & Cubberley 2006, Berger et al. 2009). The Slavic languages are conventionally divided into

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three main branches according to the splits that occurred after the breakup of the original Slavic speech community in the first millennium AD:

East: Russian, B(y)elorussian (Belarusian), Ukrainian;

West: Czech, Slovak(ian), Polish, Kashubian (Cassubian), †Polabian, Upper and Lower Sorbian;

South: †Old Church Slavonic (Old Bulgarian), attested between the 9th and 11th centuries AD and in many respects close to the common Slavic progenitor, Bulgarian, Macedonian, Bosnian/Croatian/Serbian, formerly also known as Serbo-Croat(ian), Slovene (Slovenian).

In their authoritative description of the family, Comrie & Corbett (1993: 5) note that "in many ways the Slavonic languages form a homogeneous group within Indo-European. They are therefore an ideal area for comparative and typological work." Most LFG work has been done on Russian, Polish, Bulgarian and Bosnian/Croatian/Serbian. Below, I first survey some of the salient grammatical properties of the members of the Slavic family, before exploring how they can be captured and elucidated in the framework of Lexical Functional Grammar.

1.2 Salient grammatical properties of Slavic languages

Some of the major issues which are still at the forefront of contemporary Slavic linguistics, including LFG research, received a pioneering treatment in the foundational volumes on Slavic studies, most notably Miklosich (1862–1875) and Vondrák (1906–1908). Such topics include case, number and gender inflections and their usage, constituent order and information packaging, pro-drop, as well as clitic placement.

1.2.1 Case, number and gender inflections

Slavic languages have a very rich morphology, boasting an elaborate inflectional system, which makes them a conservative group within the larger Indo-European family. The morphosyntactic categories found in Slavic are those typically found in Indo-European. They are primarily encoded by fusional affixes, i.e. with one morpheme marking several grammatical categories, e.g. case, number and gender (see Comrie & Corbett 1993: 6, 14–17, Sussex & Cubberley 2006: Chapters 5 and 6, Berger et al. 2009). As is typical of Indo-European, verbs and nouns are grouped into conjugational and declensional classes.

The Common Slavonic case values inherited from Proto-Indo-European include: nominative (for subjects and predicative subject complements/PREDLINK), accusative (characteristically for direct objects, but also for objects of prepositions, temporal adjuncts, etc.), genitive (for possession and various other relations, also taking over the functions of the IE ablative), dative (typically for indirect objects), instrumental (for means or accompaniment, including with prepositions), locative (for location in space or time, now required by diverse prepositions), and vocative (for direct address). The majority of cases have been preserved more or less intact in the modern Slavic varieties, with the exception of Bulgarian and Macedonian, where case has been almost completely abandoned.[1]

The original three-number contrast between singular, dual, and plural has usually been reduced to a binary opposition between singular and plural, with vestiges of the dual found in all the Slavic languages, though only Slovene and Sorbian retain the dual as a distinct category. The standard Late Indo-European genders of masculine, feminine and neuter find continuation in Slavic, which additionally saw the development and spread of a (masculine) personal subgender, sometimes later extended as animate vs. inanimate (see Browne 1993: 319, 363–364, Rothstein 1993: 696–698, Schenker 1993: 108, Timberlake 1993: 836ff, Kibort 2006: Section 2, Berger et al. 2009). Since gender is a grammatical category, there can be disparities between the grammatical gender of a noun and its semantics – for instance, words denoting humans (e.g. ‘child’, ‘boy’ or ‘girl’) can be grammatically neuter, while face cards can be treated as animate.

The morphosyntactic categories listed above participate in extensive agreement, including subject-verb agreement (normally in person and number, except for some tenses consisting solely of historically participial forms which agree in gender and number, as in (8) below; cf. (24), with person, number and gender agreement in Polish; see further Sussex & Cubberley 2006: 279–280). There is agreement in number, gender, and case (in the languages that have it) between

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[1] Przepiórkowski & Patejuk (2011, 2012a,b, 2015), Patejuk (2015) and Patejuk & Przepiórkowski (2014a,b, 2018) offer explicitly formalised outlines of case in Polish, addressing various specificities, including the so-called instrumental of predication (cf. Dalrymple et al. 2004: 192 for instrumental predicative complements in Russian). For an LFG take on case in contemporary Russian, consult Neidle (1988), King (1995: Chapter 8), and Bresnan et al. (2016: 422–425). In addition to their main uses, individual cases can possess more idiosyncratic meanings/functions – for instance, direct objects in negated clauses can appear in the genitive rather than the accusative. The fact that essentially the same phenomenon may exist in more than one Slavic language does not guarantee that it operates in the same way across the board: the “genitive of negation” facts in Modern Russian, for example, differ considerably from those in Polish and even from those in earlier Russian, while this characteristic quirk of Slavic grammar is by now virtually extinct in Czech.

dependents inside the NP and the head noun. In an LFG setting, Dalrymple (2001: 146–148) and Dalrymple et al. (2019: 223–225) discuss agreement in gender and number between Russian relative pronouns and their antecedents, while Neidle (1982, 1988) and Bresnan et al. (2016: 402) examine the behaviour of so-called second predicates in Russian, alongside other agreement phenomena. The interaction of inflectional patterns and morphosyntactic features with syntax and semantics sometimes leads to feature clashes and complex resolution rules which have attracted a great deal of descriptive/typological and theoretical interest, including from scholars working within constraint-based frameworks such as LFG and HPSG (see Section 2.2–Section 2.3, as well as Corbett 1983, Huntley 1993: 134–136, Rothstein 1993: 732–734, Timberlake 1993: 865–866).

1.2.2 Constituent order and information packaging

In Modern English, word order encodes syntactic functions like subject (which comes before the verb) or object (characteristically after the verb). Changing the order of constituents either changes the meaning (*Mary kissed John* ≠ *John kissed Mary*, both SVO), or results in ungrammaticality (**Mary John kissed*, SOV). By contrast, all the permutations of S, V and O are permissible in Slavic, even in a language which has lost noun case marking, like Bulgarian:[2]

(1) Bulgarian (personal knowledge)

a. Marija celuna Ivan [SVO]
Marija kissed.3sg Ivan
‘Marija kissed Ivan.’ (neutral)

b. Ivan (go) celuna Marija [OVS]
Ivan (him) kissed.3sg Marija
‘(As for Ivan,) Ivan was kissed by Marija.’/‘It was Marija that kissed Ivan.’/‘It was Ivan that Marija kissed.’ (with the exact interpretation depending on context, stress/intonation and the presence/absence of the optional clitic pronoun *go* ‘him’)

c. Marija Ivan celuna [SOV]
Marija Ivan kissed.3sg
‘It was Ivan that Marija kissed (not somebody else).’ (one possible interpretation)

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[2] See Rudin (1985: Chapter 2). “Freer” word order is typical of early Indo-European languages and can be attributed to PIE, which might have had SOV as its basic pattern, at the same time allowing various alternative arrangements. Sussex & Cubberley (2006: Chapter 7) and some of the chapters in Berger et al. (2009) provide an overview of Slavic sentence structure, including specific phenomena like passives. While Bulgarian word order is free, major constituents such as NPs have a stricter internal structure and cannot be broken up.

d. Ivan Marija (go) celuna [OSV]
Ivan Marija (him) kissed.3sg
'It was Marija that kissed Ivan.' (one possible interpretation)

e. Celuna (go) Marija Ivan [VSO]
kissed.3sg (him) Marija Ivan
'Marija did kiss Ivan.'

f. Celuna (go) Ivan Marija [VOS]
kissed.3sg (him) Ivan Marija
'Marija did kiss Ivan.'

Note that most of these will be ambiguous out of context without a reduplicated/resumptive object clitic pronoun and/or appropriate intonation. In the absence of evidence to the contrary, preference might be given to SVO interpretations as the most neutral. Case will serve to disambiguate the meaning in the languages that retain case inflections on nouns, such as Russian, Czech, Polish or Bosnian/Croatian/Serbian, barring syncretism in some declensions. While Bulgarian and Macedonian have lost the original Slavic case declensions for nouns, they preserve vestigial case distinctions on pronouns, not unlike English or Romance. Sometimes the ambiguity can be resolved by subject-verb agreement, for instance where the subject and object are not identical in number and/or person (or gender for some participial forms).

Crucially, the sentences in (1a)–(1f) do not differ in terms of the subject and agent (*Marija* in all of them) and the syntactic object/semantic patient (*Ivan*). Thus, unlike in English, word order in Slavic does not encode grammatical relations. Instead, word order serves information-packaging purposes, namely the arrangement of given and new information or the topic and the focus of the message (Comrie & Corbett 1993: 7, 12–14, King 1995).[3] These insights became prominent due to work done by linguists from the Prague School on information packaging in Czech, variously labelled functional sentence perspective, communicative dynamism or topic-comment/theme-rheme structure (see Mathesius 1939, 1947, Hajičová et al. 1998, as well as other representatives of the Prague School listed in Dalrymple et al. 2019: 369–370). Given information, which is shared by the speaker and the addressee, tends to be placed towards the beginning of the

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[3] Compare Browne (1993: 343–344) for Bosnian/Croatian/Serbian, Huntley (1993: 164–165) for Old Church Slavonic, Rothstein (1993: 723, 726–727) for Polish, Scatton (1993: 222, 234–235), Timberlake (1993: 858–860), Bresnan et al. (2016: 199–207, with references) for Russian, Bulgarian and Macedonian.

sentence, while important new information, i.e. the focus, tends to be placed towards the end of the sentence; this is especially notable in (1b) in the presence of the object clitic, which assumes that *Ivan* is old and familiar information on which the rest of the message can be "pegged" (something like 'As for Ivan, he was kissed by Marija'). Therefore, Comrie & Corbett (1993: 13) conclude that "in a sense the basic word order in most Slavonic languages can be said to be Topic-X-Focus, where X represents material other than the topic and focus (non-focus comment material)." The sentence-initial slot can alternatively be associated with a focused constituent, as in some of the examples/interpretations above, including (1b) in the sense 'It was Ivan that Marija kissed', this time without the object clitic and with stress on *Ivan* (see Section 2.4 for a more precise formalisation). It can thus be generalised that Topic-X-Focus order is the default for statements in written Slavonic, but in spoken varieties clause-initial stress may function as a marker of focus.

This means that it is hard to fit individual Slavic languages into types such as SVO, SOV, etc. SVO is the most frequent and therefore arguably the most basic default (surface) word order across the family, though King (1995) proposes that Russian, and perhaps the rest of Slavic, is underlyingly VSO.[4] The frequency of subject-initial clauses might have to do with the frequency of subjects acting as typical topics (cf. Jaeger & Gerassimova 2002: 210).

1.2.3 Passives and passive-like constructions

Related to organising the informational content of a message are passive constructions, which Slavic builds with a passive participle combined with the auxiliary 'be' (alongside alternative auxiliaries in some varieties). There also exist reflexive constructions with a reflexive marker (clitic or affix) derived from Proto-Slavic **sę* (<IE **s(w)e-*), which sometimes indicate "middle" or passive meanings, as in (2) (see Section 2.5 below; cf. Browne 1993: 333 for Bosnian/Croatian/Serbian, Rothstein 1993: 712–714 and Kibort 2006: Section 3, for Polish).

(2) Bulgarian (personal knowledge)

a. Ivan otvori vratata
   Ivan opened the.door
   'Ivan opened the door.'

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[4] Suggestions that Bulgarian may have a flat/exocentric S structure, discussed in Section 2.4.2 and Section 3.3, or be a VSO language, can be found in King (1995: 120 fn. 21, 127); cf. Rudin (1985).

b. Vratata se otvori
the.door REFL opened
'The door opened.'/'The door was/got opened.'

Sussex & Cubberley (2006: 369) note that passives are less common in Slavic than in English: while one of the major roles of the passive in a syntactically more rigid language like English is to enable the rearrangement of old/new information in the clause, a natural way to achieve that in Slavic is to use OV(S) word order instead (cf. (1b) and its passive English translation).

1.2.4 Pro-drop and impersonal clauses

Since finite verbs express the number and person of their subjects, unstressed and unemphatic subject pronouns are often omitted, although the individual languages vary in terms of the extent to which they favour so-called pro-drop or zero anaphora (Comrie & Corbett 1993: 7).[5] Subject pronouns may be inserted for special stress and emphasis.

Slavic additionally has genuinely subjectless/impersonal clauses which neutralise the categories of verbal person and number (as well as gender), utilising the default third person singular (neuter) in the absence of a subject (even an implied one), as in (3)–(4), with accusative or dative experiencers (see Scatton 1993: 222, 227, Schenker 1993: 107–108, King 1995: 134–135).

(3) Russian (from King 1995: 18)
Ann-u tošni-l-o.
Anna-ACC be.sick-PST-N.SG
'Anna was [feeling] sick.'

(4) Russian (ibid.)
Mne budet xolodn-o.
me.DAT be.FUT.3SG cold-N.SG
'I will be cold.'

In an LFG context, Dalrymple (2001: 19) adduces syntactic evidence that Russian, unlike English, has bona fide subjectless sentences. Further discussion, also highlighting disputed matters and controversies, can be found in Section 2.6.

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[5] Cf. Browne (1993: 365–366), Huntley (1993: 175), Rothstein (1993: 742), Scatton (1993: 234), Timberlake (1993: 871–872), King (1995: 17, 21–22, 69), Sussex & Cubberley (2006: 402).

1.2.5 Clitics

Three classes of clitics, inherently stressless words which are unable to stand on their own, can be distinguished in Slavic: proclitics, enclitics and variable clitics, which can be either pro- or enclitics depending on the environment. Proclitics are placed in front of their host (the word/phrase they need to "lean on"), while enclitics follow their host. The position of clitics with respect to other words is fixed and sometimes regulated by complex rules, which (unsurprisingly) differ across the individual members of the family, even when it comes to the distributional restrictions imposed on otherwise cognate items (see further Section 2.8).

Examples of clitics from the material above include the so-called "short" personal pronoun *go* 'him' (3SG.M.ACC) in (1b) (as opposed to the longer/full non-clitic *nego* 'him'), or the reflexive *se* in (2b). Bulgarian *go*, for instance, belongs in the group of variable clitics: it acts as an enclitic on a stressed verb form when the verb form is sentence-initial, (1e); otherwise, *go* is a proclitic which precedes its verbal host, (1d). By contrast, clitics in the closely related Bosnian/Croatian/Serbian are consistently enclitic, forming an accentual unit with the word that precedes them (see Browne 1993: 345–346, Dimitrova-Vulchanova 1999, Bresnan et al. 2016: 427–429, Diesing & Zec 2016, Zec & Filipović Đurđević 2016, for more detail and refinement).

1.2.6 Other phenomena

Apart from the most salient grammatical phenomena of Slavic languages outlined above, the discussion below will feature some additional phenomena that have generated debate in the LFG literature. One such phenomenon is something approximating negative concord/agreement, as in (5), where the negative particle *ne* on the verb appears with other negative forms (see Section 2.9):

(5) Bosnian/Croatian/Serbian (from Browne 1993: 362)
Ni(t)ko nigd(j)e ne vidi nikoga.
nobody nowhere NEG sees nobody
'Nobody sees anybody anywhere.'

Another peculiarity, typical of Russian, is the regular omission of the copula 'be' in the present tense, which will receive more attention in Section 2.7 (see also Timberlake 1993: 861–864, 869, 874). Finally, very little work has been done in LFG on Slavic aspect, a conspicuous feature of verbs across the family. Slavic aspect for the most part has to do with semantics (e.g. completion/incompletion), morphology and syntax, all of which are self-contained modules in LFG, so existing analyses can be imported "wholesale", as noted by an anonymous reviewer, though spelling out the Glue details or the morphology-syntax interface would still be an intriguing and non-trivial task. This work would be unlike transformational work, where aspectual derivation is commonly done in the syntax.

Revisiting the main points from this introduction, Section 2 examines LFG treatments of the major grammatical phenomena in Slavic, beginning with the unit of the word, more specifically lexical categories/parts of speech (Section 2.1) and the morphosyntactic features associated with them (Section 2.2). Section 2.3 then zooms in on agreement and government processes, whereas Section 2.4 outlines how LFG models the structure of the clause. This is followed by brief accounts of specific constructions like passive (Section 2.5), subjectless, impersonal (Section 2.6), and copular (Section 2.7) clauses, clitics and clitic placement (Section 2.8), as well as negation and negative concord (Section 2.9). The final sub-sections are dedicated to distance distributivity (Section 2.10), coordination (Section 2.11), and anaphora (Section 2.12). Section 3 places the relevant LFG research in the context of other frameworks, while Section 4 sums up how LFG has contributed to our understanding and adequate description of the grammar of Slavic languages.

2 LFG analyses of major grammatical phenomena

2.1 Lexical categories and the morphology-syntax interface

This section gives a taste of the rich Slavic inflectional system outlined in the opening of the chapter, highlighting how relevant morphological information can be captured in LFG terms and interfaced with the syntax, especially in cases of discrepancy between them. Having assembled at least partial morphological entries of word forms in this and the following two sections, I then illustrate how they are plugged into the syntax, a topic discussed at greater length in Section 2.4.

Building on typological work by Baerman et al. (2015) and Spencer (2013: 122–123), Dalrymple et al. (2019: 451–453) provide an LFG-based account of mixed lexical categories like Russian *stolovaja* 'dining room, canteen', a lexeme which shares properties of adjectives and nouns. Historically, it derives from an adjective but synchronically it behaves like a noun with a set of adjectival inflections, as illustrated in Table 1, where the paradigm of the deadjectival noun *stolovaja* 'dining room' is laid out side by side with those of the regular adjective *bol'š-oj* 'big' (with a feminine in *-aja*), and the regular feminine noun *lampa* 'lamp'.

Table 1: Nominal and adjectival declensions in Modern Russian (Spencer 2013: 123).

	Noun ‘dining room’	Adjective ‘big’	Noun ‘lamp’
NOM	stolov-aja	bol’š-aja	lamp-a
ACC	stolov-uju	bol’š-uju	lamp-u
GEN	stolov-oj	bol’š-oj	lamp-y
DAT	stolov-oj	bol’š-oj	lamp-e
INS	stolov-oj	bol’š-oj	lamp-oj
PREPOSITIONAL/LOC	stolov-oj	bol’š-oj	lamp-e

In the notation of LFG, a regular adjectival form like *bol’šaja* will be assigned to the M-CAT:ADJ, M-CLASS:REGULAR, with an M-CASE value NOM. These are some of its important morphological properties. The feminine noun *lampa* will accordingly be of the M-CAT:NOUN, M-CLASS:REGULAR, with M-CASE:NOM. Crucially, the mixed lexical category *stolovaja* will have an entry to acknowledge its intermediate status between an adjective and a noun: M-CAT:ADJ (i.e. a word which patterns morphologically as an adjective), M-CLASS:MIXED-A-N (i.e. a mixed category with the syntactic behaviour of a noun), M-CASE:NOM. These so-called m(orphological)-entries are then fed into a mapping rule, which will assign the mixed-category word *stolovaja* with the m-feature M-CLASS:MIXED-A-N to the c(onstituent)-structure category of N(oun) – this is the word-class membership relevant to the syntax. The mapping rule will essentially map the M-CAT:ADJ to the c-structure category N in the presence of the m-feature M-CLASS:MIXED-A-N, or to the c-structure category of A(djective) if the m-feature is specified as M-CLASS:REGULAR. Depending on the mapping, the word forms thus interfaced can in turn be plugged into c-structure trees as N or A terminal nodes, as discussed in more detail in Section 2.4. There have been similar discussions in the specialist literature whether to treat participles as verbal forms or as adjectives, or whether deverbal nouns are actually nouns or verbal forms.

2.2 Concord and index features and mismatched nouns

As noted in Section 1.2.1, Slavic preserves a great deal of its Indo-European morphological heritage, including elaborate declensional patterns. This has prompted a lot of important typological work to do with case, number and gender agreement, most notably by Corbett (1983, 1986, 2006), among others. Material from

Slavic has additionally revolutionised the way agreement is thought of in non-transformational theories like HPSG and LFG. Starting with analyses of Bosnian/Croatian/Serbian cast in the HPSG framework, Wechsler & Zlatić (2000, 2003) propose that there exist two bundles of syntactic agreement features, labelled concord and index, in addition to purely semantic features. Earlier HPSG work likewise recognises AGR/INDEX features, participating in morphosyntactic vs. index agreement (see Czuba & Przepiórkowski 1995, with references, dealing with agreement and case assignment in Polish; consult also Haug 2023 [this volume]).

In Wechsler & Zlatić's model, concord and index both belong to syntax, the former more closely related to morphological declension and the latter more closely reflecting semantics, while semantic properties form a separate category. All the values reside in the lexical entries of individual nouns and generally match, but not always. The motivation behind postulating three separate sets of attributes comes from Bosnian/Croatian/Serbian nouns like *deca* 'children' and *braća* 'brothers', which are said to control feminine singular attributive targets (concord agreement), neuter plural verbs/participles and pronouns (index agreement) and, potentially, masculine plural pronouns (semantic/pragmatic agreement), as in (6), where I illustrate concord agreement within the subject NP and index agreement in the predicate.[6]

(6) Bosnian/Croatian/Serbian (from Wechsler & Zlatić (2003: 51))

Ta	dobr-a	deca	su	doš-l-a.
that.F.SG	good-F.SG	children	AUX.3PL	come-PTCP-N.PL

'Those good children came.'

Figure 1 provides an LFG representation of the features involved in (6), complete with lexical entries which supply the feature values and/or the requirements of individual word forms, alongside a f(unctional)-structure matrix, expressing the functional syntactic relations between the various elements.

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[6] Being closer to declension, the concord bundle is comprised of case, number and gender, whereas the index bundle, being closer to semantics, includes person, number and gender – note that subject-verb agreement in person and number, visible on finite *su* 'are', must therefore operate with the index bundle (cf. Dalrymple et al. 2019: 69–71). Here, I focus on gender and number. The analysis of the participle ending in *-a* as neuter plural rather than feminine singular is justified in Wechsler & Zlatić (2003, 2012), Dalrymple & Hristov (2010), Hristov (2012, 2013a). Although this is not shown in (6), anaphora between clauses can involve masculine plural pronouns, e.g. *deca…oni* 'they'/*koji* 'who', though *deca* can control feminine singular agreement in the relative pronoun, especially when it appears in cases other than the nominative.

ta ‘that’: (*s* concord gend) = f
(*s* concord num) = sg
dobra ‘good’: (*s* concord gend) = f
(*s* concord num) = sg
deca ‘children’: (*s* concord gend) = f
(*s* concord num) = sg
(*s* index gend) = n
(*s* index num) = pl
došla ‘come’: (*f* subj index gend) = n
(*f* subj index num) = pl

$$f\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{come}\langle\textsc{subj}\rangle\text{’} \\ \textsc{subj} & s\left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{children}\text{’} \\ \textsc{spec} & \text{‘}\textsc{that}\text{’} \\ \textsc{adj} & \left\{\left[\begin{array}{ll}\textsc{pred} & \text{‘}\textsc{good}\text{’}\end{array}\right]\right\} \\ \textsc{concord} & \left[\begin{array}{ll}\textsc{gend} & \textsc{f}\\ \textsc{num} & \textsc{sg}\end{array}\right] \\ \textsc{index} & \left[\begin{array}{ll}\textsc{gend} & \textsc{n}\\ \textsc{num} & \textsc{pl}\end{array}\right]\end{array}\right]\end{array}\right]$$

Figure 1: Lexical entries and f-structure for a clause with a mismatched BCS noun (adapted from Dalrymple & Hristov 2010: 189)

Hristov (2012, 2013a) advocates the usefulness of these distinctions in the description of the closely related Bulgarian, which has lost its declensions but nevertheless still exhibits analogous gender mismatches in certain nouns. This feature geometry has been further developed in LFG/HPSG and applied to additional Slavic material by Dalrymple & Kaplan (2000), Przepiórkowski et al. (2002), King & Dalrymple (2004), Dalrymple & Hristov (2010), Hristov (2012, 2013a), and Belyaev et al. (2015). Those publications sketch out a formalised typology of agreement configurations in conjoined and non-conjoined environments, as well as factors which might influence the choice of one pattern over another. Such agreement mismatches have been instrumental in formulating hypotheses about the (non-)distributivity of features in conjoined contexts (i.e. does a requirement hold of every single conjunct), feature resolution (i.e. computing the value(s) of a conjoined phrase based on the values of its constituents), or what acts as the default value.

In sum, this tripartite split into concord, index and semantics has been widely adopted by researchers in the LFG and HPSG community and has generally proved fruitful, though it is still a matter of debate, with some disagreement over whether the bifurcation into two syntactic features, concord and index, is really justified (see Alsina & Arsenijević 2012a,b,c, Wechsler & Zlatić 2012, Hristov 2013a). It remains an outstanding issue for more conclusive future research to determine which features tend to be distributive, resolving or both, as well as their domain(s) of operation. Wechsler (2011), for instance, proposes that predicative adjectives in Bosnian/Croatian/Serbian can exhibit concord, rather than just index, agreement (cf. (6)). The predicative adjective in (7) shows plural (concord) agreement even when the second person plural subject pronoun is used formally for a single addressee.

(7) Bosnian/Croatian/Serbian (Wechsler 2011, quoted in Dalrymple et al. 2019: 79)

Vi	ste	duhovit-i
you.PL	be.PRS.2PL	funny-M.PL

'You (one formal addressee/multiple addressees) are funny.'

In Bulgarian, on the other hand, some predicative participles may oscillate between singular and plural, while predicative adjectives will normally be singular with single-addressee *Vie* 'you.PL' (cf. Sussex & Cubberley 2006: 567 for variation across Slavic).

2.3 Agreement and case assignment in a constraint-based setting

As became apparent in the previous section, agreement is modelled in LFG by relying on the lexical entries of individual word forms, which project information that is then propagated to the f(unctional)-structure – the locus of agreement phenomena in LFG (see Figure 1, as well as Haug 2023 [this volume]). Unlike transformational approaches, where agreement is handled by copying feature values from one node in the syntactic tree to another or by moving items in order for features to be checked, non-derivational constraint-based frameworks like LFG and HPSG tend to assume that two elements which participate in an agreement relation supply partial information about a single linguistic object – a view which amounts to seeing agreement as multiple specifications of compatible feature values by a controller and its target(s) (see Pollard & Sag 1988: 237, Pollard & Sag 1994: Chapter 2, Bresnan 2001: Chapter 8, Dalrymple 2001: Chapter 5, Corbett 2006: 115, Wechsler & Zlatić 2003, Dalrymple & Hristov 2010: 186, Hristov 2012: 24ff, and Haug 2023 [this volume]).

This works very well for Slavic data, especially when it comes to mismatched or underspecified targets and controllers. It is likewise eminently suitable for pro-drop in null-subject languages like Slavic, where the subject controller is often not present, so it would be mysterious where the agreement information on the verbal target was "copied" from (unless one posits "disembodied" features or invisible/underlying elements which are then deleted). These considerations have led LFG and HPSG scholars to reject formalisations of agreement as directional feature copying, favouring instead a view of feature co-specification (with transformational feature checking more in this spirit; see the entry in (16), Section 2.4.2, as well as Section 2.6).

Similarly, case assignment is modelled in LFG via the interaction of the inflectional entries of lexemes, c(onstituent)-structure configurations and the flow of compatible features between c- and f-structure, as in Figure 2 below (cf. Butt 2023 [this volume]). In the spirit of constraint-based grammatical architectures, case specification can be further governed by language-specific constraints, illustrated for Russian in Section 2.4.3. Analysis and LFG notational conventions for case assignment in Polish can be found in Patejuk (2015), Patejuk & Przepiórkowski (2014b), and Patejuk & Przepiórkowski (2017: 337–339), where the authors rely on, inter alia, disjunctive rules to account for the variation between accusative and genitive objects depending on the presence/absence of negation. Przepiórkowski (1999, 2000), Przepiórkowski & Patejuk (2011, 2012a,b), Patejuk (2015) and Patejuk & Przepiórkowski (2014b, 2017, 2018) deal with agreement, structural case assignment and control phenomena in Polish, especially in conjoined and gapped contexts. Case in Slavic is an important and interesting topic, and LFG provides many novel ideas and accounts in this area, for which the reader is referred to the relevant works cited above, as well as early work by Neidle (1982, 1988), or Dalrymple et al. (2009) on indeterminacy (to be revisited in (32) below).

2.4 Constituent structure, the encoding of grammatical functions and information structure

2.4.1 Russian

A contrast was drawn in Section 1.2.2 between languages like English, where word order encodes syntactic functions, and Slavic, where word order serves information-packaging purposes. These divergent typological preferences find a natural reflection in LFG's parallel architecture, which relies on separate modules to represent constituency and word order (c-structure), syntactic functions (f-structure), and discourse functions (i(nformation)-structure). Although separate, all of these modules are appropriately interfaced to constrain each other, so that

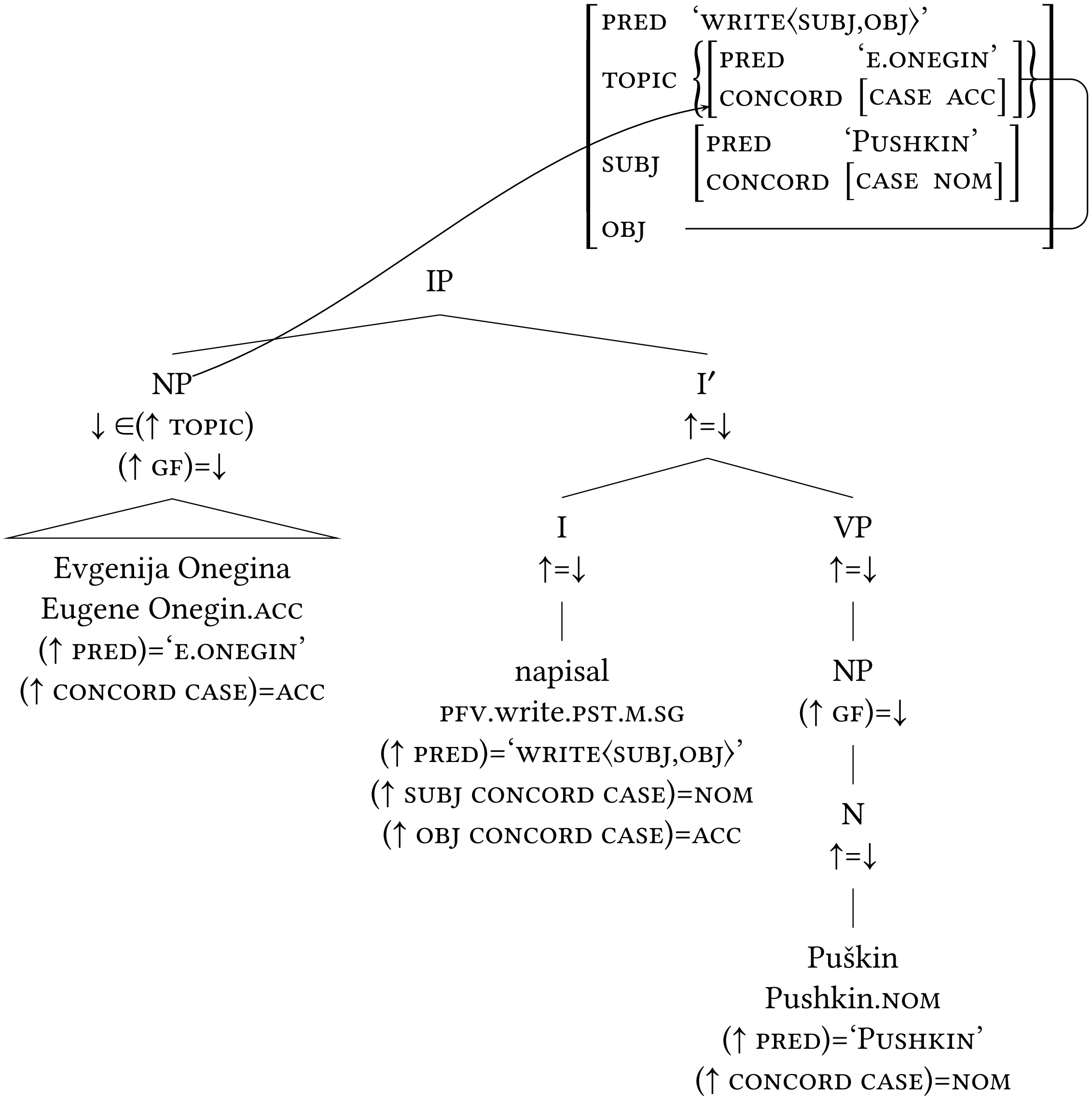

Figure 2: C- and f-structure for a Russian sentence with a topicalised object

accurate description of typologically diverse linguistic systems can be achieved (see Belyaev 2023b,a [this volume]).

English is traditionally assumed to associate the specifier of IP at c-structure with the SUBJ function at f-structure, in line with the generalisation that word order in English encodes syntactic functions. By contrast, King (1995) demonstrates that the specifier of IP in Russian is associated with the discourse functions of topic or focus, in line with the generalisation that word order in Slavic encodes discourse functions, rather than syntactic ones. Formalised in Figure 2, (8) is an example from King (1995: 206) (also cited in Dalrymple 2001: 72 and Bresnan et al. 2016: 203, where the VP is replaced with S, discussed further below).

(8) Russian
‘Evgenija Onegina’ napisal Puškin.
Eugene Onegin wrote Pushkin
‘Pushkin wrote ‘Eugene Onegin’.’ [in answer to the question ‘Who wrote ‘Eugene Onegin’?’]

In Figure 2, the topic value is modelled as a set (indicated with curly brackets), since there can be more than one topic, and the topic is further associated with a grammatical function within the clause, since the topic is simultaneously a constituent which bears a certain syntactic function. In addition, the topic is housed within the f-structure, whereas other authors might prefer to accord it a separate interfaced level (i-structure; cf. King 1995: 216–218, 250–251, King 1997, Dalrymple 2001: 182–183, Patejuk 2015: 22, Bresnan et al. 2016: 98–99, 106, Dalrymple et al. 2019: 121ff., 366–367, 374–394, Zaenen 2023 [this volume]).[7]

Furthermore, note that in Russian and many other languages, all finite verbs appear in I, while in English this phrase-structure position is reserved for tensed auxiliaries, excluding tensed lexical verbs. Only non-finite verbs appear within the VP in Russian, hence finite verbs are of category I and non-finite verbs of category V (King 1994, 1995, Dalrymple 2001: 53–54, 61–62, Bresnan et al. 2016: 102, 104, 109, 147–150, 199–209, Dalrymple et al. 2019: 99–100, 108ff., 119).[8]

The topic in (8) happens to be a noun phrase, but it could have been a different type of constituent. To indicate that pretty much any type of phrase can appear

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[7] Based on Russian data, King (1997) provides detailed argumentation why a separation between f- and i-structure is necessary. In (8), the focused constituent *Puškin* appears clause-finally – in more emotive and intonationally and/or pragmatically marked contexts, it can be clause-initial, preceding the topic (see further King 1995: 91–92, 153, 207ff.). On the relationship between prosody and constituent structure in Russian and more generally, see King (1995: 128ff.), Dalrymple (2001: 50), Dalrymple et al. (2019: 94–95, 400ff.); for Serbian/Croatian, cf. O’Connor (2006), as well as Bögel 2023 [this volume].

[8] King (1994), King (1995: esp. Chapter 3), Dalrymple (2001: 62–63), Bresnan et al. (2016: 201–203) and Dalrymple et al. (2019: 110) provide empirical evidence for distinct IP and VP constituents in Russian, including coordination and negation, where the negative proclitic *ne* attaches to finite verbs in I, and not to infinitives in V:

(i) Ja [ne bud-u [pisa-t’ pisem]$_{\mathrm{VP}}$ i [čita-t’ knig]$_{\mathrm{VP}}$]$_{\mathrm{I'}}$
I NEG will-1SG write-INF letters.GEN and read-INF books.GEN
‘I will not write letters and read books.’ [negation scopes over both conjoined VPs and unproblematically licenses the “genitive of negation” on both objects]

in the specifier of CP or IP in Russian, King (1995: 171, 197–198) uses the metacategory XP in the following phrase-structure rules (cf. Dalrymple 2001: 94, 96–97, Dalrymple et al. 2019: 141–142, 144–145, including formal statements to the effect that specifiers appear before heads and complements after heads):

(9) Phrase-structure rules for Russian:
CP ⟶ XP, C′
C′ ⟶ C, IP
IP ⟶ XP, I′

XP is in turn spelled out as follows:

(10) XP ≡ {NP | PP | VP | AP | AdvP}

In Figure 2, the topic happens to be the object, but topics in general can be identified with any grammatical function. The functional uncertainty of the grammatical function assigned to the topic constituent can be represented by defining an abbreviatory symbol GF as a disjunction of all grammatical functions (Dalrymple 2001: 139–140, Dalrymple et al. 2019: 205–206):

(11) GF ≡ {SUBJ | OBJ | OBJ$_{\theta}$| COMP | XCOMP | OBL | ADJ | XADJ}

Thus, King (1995: 204) proposes the following annotated phrase-structure rule for an IP in Russian, which can be seen as an instruction on how to build a c-structure tree and assign functions to the constituents:[9]

(ii) *Ja [ne pisa-l-a pisem]$_{\text{I}'}$ i [čita-l-a knig]$_{\text{I}'}$
I NEG write-PST-F.SG letters.GEN and read-PST-F.SG books.GEN
'I did not write letters and read books.' [negation cannot scope over both I's; each I' needs to be negated separately; from King (1995: 42–43, 184ff.)]

It is worth stressing that erstwhile *l*-participles like *(na)pisal(a)* 'wrote' have been reanalysed as finite tensed forms after the loss of the copular auxiliary in what used to be a periphrastic/analytic present perfect construction – now a synthetic preterite in Modern Russian. Analogous IP/VP contrasts exist in Bosnian/Croatian/Serbian and elsewhere in the family (see King 1995: 41, fn. 31).

[9] Note that the rule has GF (rather than GF+ or GF*), which means that the TOPIC has to bear some grammatical function in the same clause, and not an embedded clause (see Dalrymple et al. 2019: 126); cf. Kaplan 2023 [this volume], since many constructions with functional uncertainty allow for long-distance uncertainty (GF*), and not just local uncertainty (GF); see also the discussion of embedding in Bulgarian below, as well as Dalrymple et al. (2019: 223–225) for embedding in Russian relative clauses.

(12) $$\text{IP} \longrightarrow \begin{pmatrix} \text{XP} \\ \downarrow \in (\uparrow \textsc{topic}) \\ (\uparrow \textsc{gf}) = \downarrow \end{pmatrix} \begin{pmatrix} \text{I}' \\ \uparrow = \downarrow \end{pmatrix}$$

King (1994, 1995), Bresnan et al. (2016: 70–71, 204–210) and Dalrymple et al. (2019: 113–114) discuss how further topics can be adjoined in Russian (and Bulgarian), as well as the complexities of scrambling, extraction and the domain of the operation of the principles of function assignment. Having thus presented the basics of Russian phrase structure, in the next section I outline the phrase structure of Bulgarian, which has a great deal in common with Russian, but there are some important typological differences too.

2.4.2 Bulgarian

Similarly to Figure 2 above, since they are focused and hence discourse-prominent elements, *wh*-phrases in Bulgarian will also appear in the specifier of IP (Rudin 1985, Izvorski 1993, Dalrymple 2001: 73).[10] In this respect, Russian and Bulgarian (unlike English) are both discourse-configurational and have in common the fact that the specifier of IP is reserved for arguments with certain (grammaticised) discourse functions (topic and/or focus), irrespective of the syntactic roles those arguments may perform (subject, object, etc.). (13) illustrates a *wh*-question with a sentence-initial topic, formalised in Figure 3.

(13) Bulgarian (from Dalrymple 2001: 73, Dalrymple et al. 2019: 124)
Ivan kakvo pravi?
Ivan what does
‘What is Ivan doing?’

Unlike Russian, which seems to require strict locality of topic extraction according to the rule in (12), the discourse functions in Bulgarian can be related to arguments in an embedded subordinate clause, as shown in (14) and the accompanying Figure 4:

(14) Bulgarian (from Dalrymple et al. 2019: 125)
Ivan kakvo kaza, če pravi?
Ivan what say.PST.2SG COMP does
‘What did you say that Ivan is doing?’

---

[10] On the availability of multiple specifiers with multiple *wh*-constituents in Bulgarian and Russian, consult Rudin (1985: 94ff.), Dalrymple (2001: 57), Jaeger & Gerassimova (2002: 209–210), Dalrymple et al. (2019: 98, 677–678, 694–696), which also feature discussion of long-distance dependencies.

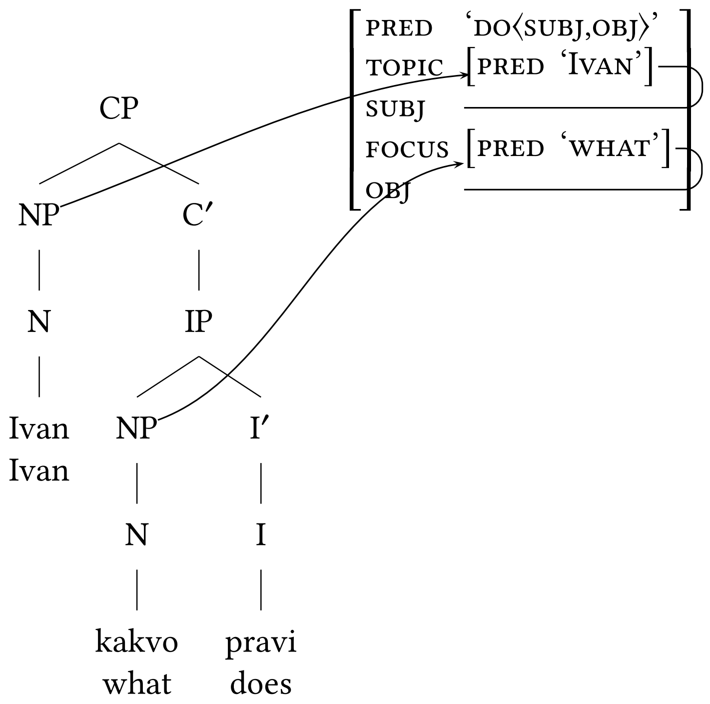

Figure 3: C- and f-structure for a Bulgarian sentence with topic and focus

Despite the immediately apparent family resemblance between Bulgarian and Russian, reflected in the structure of their clauses, there are some subtle differences which are worth noting. Figure 3 and Figure 4 demonstrate that the specifier position of CP is associated with the topic function in Bulgarian and focused *wh*-words appear in the Spec of IP, while in both English and Russian *wh*-phrases are found in the specifier of CP (with Spec of IP reserved for the Russian topic in Figure 2).[11] Thus, although word order in Russian and Bulgarian is reasonably free, scholars have arrived at different conclusions as to the way the constituent structure in each of those two related languages is organised and interfaced with

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[11] See Rudin (1985: esp. 18ff.), King (1995: esp. Chapters 3, 5 and 10), Dalrymple (2001: 64, 73), Jaeger & Gerassimova (2002: 205ff.), Dalrymple et al. (2019: 124–125), for evidence and argumentation; cf. (1c)–(1d) above, which fit this template of Topic-Focus-Verb very well too. According to other sources, however, either C or Spec of CP does serve as the “landing site” for (certain) question words in Bulgarian (see Rudin 1985: 83ff. and King 1995: esp. 56–60, 120ff., 247–248 for a panoply of proposals, also featuring some discussion of other Slavic varieties). It likewise remains an open question how one should best represent sentences in colloquial Russian which contain non-initial *wh*-words, e.g. *Ivan čto skazal?* ‘What did Ivan say?’, which matches the surface order of the Bulgarian interrogative in (13) (cf. the comments about additional topic adjunction in the previous section).

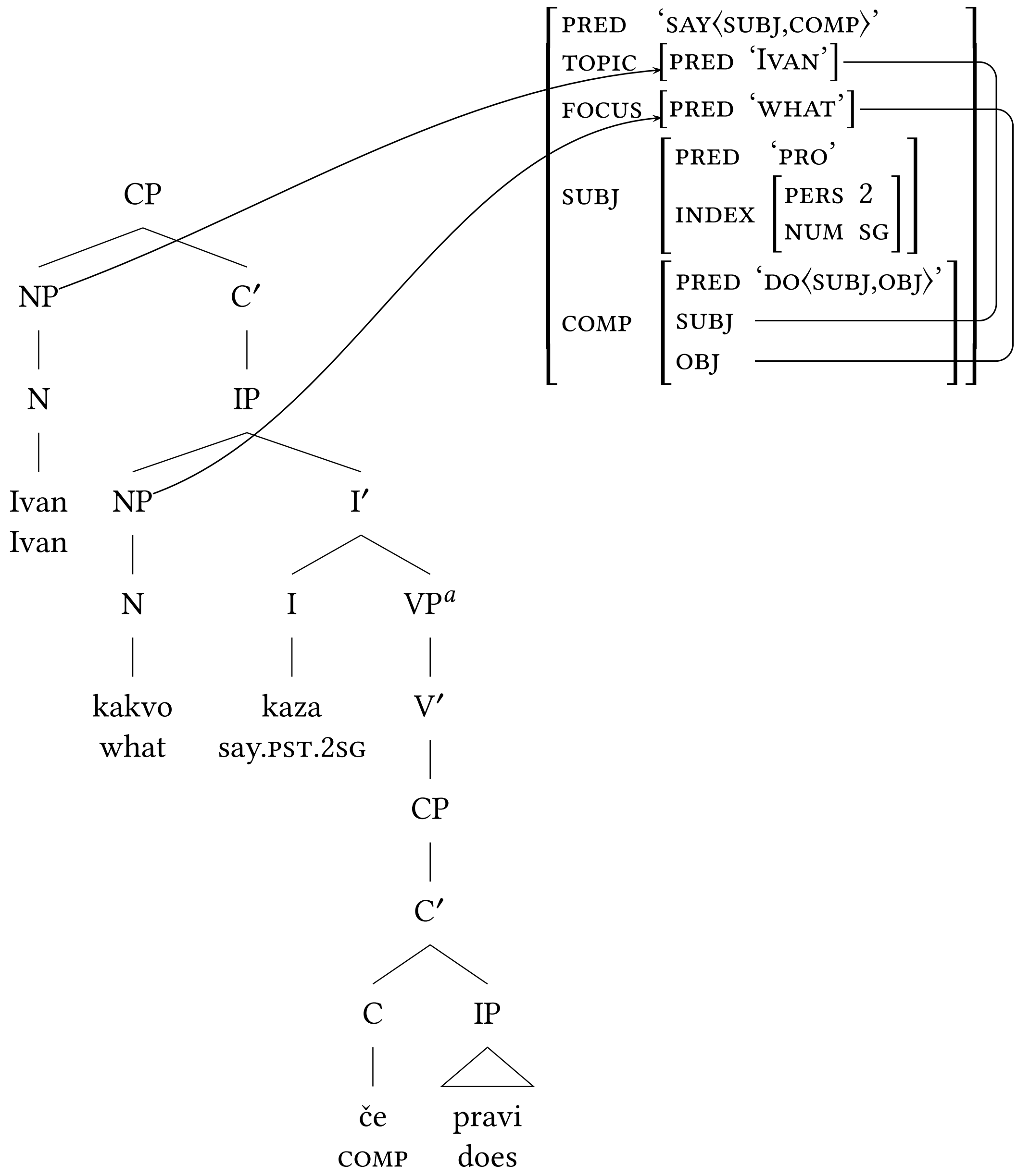

Figure 4: C- and f-structure for a Bulgarian sentence with embedding

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[a] The VP and V’ might host the non-finite form in a periphrastic construction like the viable Bulgarian perfect *si kazal* ‘have said’ (see footnote 8 for finiteness and *l*-participles). The VP and V’ nodes have been copied along with their labels from the original source, but the reader should additionally consult the phrase-structure rules and the discussion of (reasonably innocuous) inconsistency below.

the other levels of representation, most notably the structure of discourse. It remains for future work to subject these conclusions to further empirical and theoretical scrutiny and to extend them to the rest of the family.[12]

Another important point specific to LFG is the optionality of c-structure constituents, including heads. For example, the VP in Figure 2 does not dominate a head V node, since the finite verb in Russian appears in I, and Figure 3 is missing the head of CP, since the sentence contains no complementiser. Specifiers are also optional in LFG, so if there are no appropriate topicalised or focused constituents, those slots too will remain unoccupied (see King 1995: 171–172, Dalrymple 2001: 60, 63, Dalrymple et al. 2019: 107–108).

As pointed out in Section 1.2.2, Bulgarian is cross-linguistically unusual in that it allows free word order even though it has lost its nominal case inflections, with only vestigial case forms of pronouns. In this way, Bulgarian and Macedonian stand out typologically among the members of the Slavic family and beyond. Quite frequently, the syntactic functions of subject and object can be identified by relying on subject-verb agreement and/or clitic doubling. There are situations, however, where there are no morphosyntactic clues as to the functions the arguments in a clause will perform – then a phrase may be assigned any of the grammatical functions selected by the predicate, depending on context and/or world knowledge (Rudin 1985, Dalrymple 2001: 133–135, Dalrymple et al. 2019: 184–189).

I will now proceed to first outline some general phrase-structure rules for Bulgarian, followed by a sample entry of a verb, which forms the core of the clause and assigns roles to its arguments. I will then illustrate three possibilities for clauses with or without morphosyntactic clues as to the assignment of syntactic roles. Finally, I will compare the Bulgarian system to those of members of the family which retain case declensions.

In line with the assumption that the specifier of IP is associated with the discourse function of focus in Bulgarian, Dalrymple (2001: 134) proposes the following phrase-structure rules. The NP daughter of IP is assigned the focus discourse function and in addition will bear a grammatical function at f-structure too (GF). As in Russian, there is no requirement as to what this grammatical function will be (cf. the discussion of GF vs. GF*, which might be needed in the context of embedding; see further Rudin 1985: esp. Chapter 7, as well as the slightly updated notation in Dalrymple et al. 2019: 185).

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[12] See Patejuk (2015) and Patejuk & Przepiórkowski (2017: 329–330, 340–341) for similar proposals regarding the clause structure of Polish, notably with a suggested flat IP.

(15) Annotated phrase-structure rules for Bulgarian

$$\begin{array}{lll}
\mathrm{IP} & \longrightarrow & \left(\begin{array}{c}\mathrm{NP}\\ (\uparrow \textsc{focus}){=}\downarrow\\ (\uparrow \textsc{gf}){=}\downarrow\end{array}\right) \left(\begin{array}{c}\mathrm{I}'\\ \uparrow{=}\downarrow\end{array}\right)\\
\mathrm{I}' & \longrightarrow & \left(\begin{array}{c}\mathrm{I}\\ \uparrow{=}\downarrow\end{array}\right) \left(\begin{array}{c}\mathrm{S}\\ \uparrow{=}\downarrow\end{array}\right)\\
\mathrm{I} & \longrightarrow & \left(\begin{array}{c}\mathrm{Cl}\\ (\uparrow \textsc{obj}){=}\downarrow\end{array}\right) \left(\begin{array}{c}\mathrm{I}\\ \uparrow{=}\downarrow\end{array}\right)\\
\mathrm{S} & \longrightarrow & \left\{\begin{array}{c|c}\mathrm{NP} & \mathrm{V}\\ (\uparrow \textsc{gf}){=}\downarrow & \uparrow{=}\downarrow\end{array}\right\}^{*}
\end{array}$$

In essence, these annotated rules are similar to those operative in other languages which allow relatively free word order, such as Warlpiri or Latin (cf. Nordlinger 2023 [this volume]). Naturally, these phrase-structure rules are only a fragment of a fuller grammar and will need to be elaborated and fine-tuned in order to attain more comprehensive coverage of Bulgarian syntax. The diagrams and the phrase-structure annotations in this section demonstrate that there is still some inconsistency within and between the various LFG publications, so more uniformity would be desirable in future work (cf. the VP in Figure 4 to the S here, among other small details, e.g. finite verbs labelled as V rather than I in some of the sources). Nevertheless, this is a good starting point illustrating what the skeleton of a Bulgarian clause looks like. According to the rules in (15), the desired freedom with which the constituents are arranged is achieved with the help of the exocentric S node, which here supersedes the VP from the earlier diagrams and can contain NPs with any grammatical function preceding or following the verb (cf. Dalrymple 2001: 64–67, 77–78, Dalrymple et al. 2019: 112–114).[13]

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[13] The S rule licenses any number of NPs or Vs in any order, but having more than one lexical/main/full verb will lead to a clash at f-structure (two different semantic PREDs in the same clause contributed by each of the two verbs; cf. Section 3.1). So the phrase-structure rule will give too many possibilities (in particular, it will allow any number of verbs), but these will be filtered out by f-structure constraints (assuming that all lexical verbs contribute a semantic PRED– this rule will allow two verbs, as long as one of them is auxiliary-like and contributes only grammatical features, while the other contributes the semantic PRED) (M. Dalrymple, p.c.). Similarly, the NPs will have to be subcategorised for by the verb, which prevents the proliferation of NPs at will. As noted above, other LFG work offers alternative treatments. Jaeger & Gerassimova (2002: 201–202), for instance, postulate the following flat unordered VP phrase-structure rule for Bulgarian (see further Section 3.3):

(i) $$\mathrm{VP} \longrightarrow \left(\begin{array}{c}\mathrm{XP}\\ (\uparrow \textsc{gf}){=}\downarrow\end{array}\right), \left(\begin{array}{c}\mathrm{PP}\\ (\uparrow \textsc{obj2}){=}\downarrow\end{array}\right), \begin{array}{c}\mathrm{V}'\\ \uparrow{=}\downarrow\end{array}$$

Moving on to the syntactic core of the clause, the following is the lexical entry for the finite verb form *celuna* '(he/she) kissed', appearing as an I terminal node in tree diagrams:

(16) Lexical entry for a Bulgarian verb

celuna I (↑ PRED) = 'KISS<SUBJ,OBJ>'
((↑ SUBJ PRED) = 'PRO')
(↑ SUBJ INDEX PERS) = 3
(↑ SUBJ INDEX NUM) = SG
(↑ SUBJ CONCORD CASE) = NOM
(↑ OBJ CONCORD CASE) = ACC

In addition to stating the subject's person, number and case properties, this entry contains an *optional* equation which specifies a pronominal value ('PRO') for the semantic PRED of the verb's subject. This is LFG's way of capturing pro-drop – this equation kicks in only if there is no overt subject and the information about it comes solely from the features marked on the verb (cf. Section 2.6; Bresnan et al. 2016: 59, 358, 440; Toivonen 2023 [this volume]). However, for a transitive verb like *celuna* '(he/she) kissed', either an overt object phrase or an object clitic pronoun must obligatorily appear, because no PRED value is specified for the object of the verb.

This lexical entry and the phrase-structure rules can now be combined to generate a clause. In (17), the personal names *Ivan* and *Marija* are not marked for case, so both of them are compatible with either nominative or accusative specifications. As before, the metavariable GF in Figure 5 represents any grammatical function – this metavariable is arbitrarily instantiated to SUBJ for *Marija* and OBJ for *Ivan* based on the context or extra-linguistic knowledge (see Rudin 1985: esp. 15–16, Dalrymple 2001: 134, 136). For a sentence like this, language users cannot appeal to phrase-structure position, case marking or agreement to disambiguate the syntactic roles of the two arguments, though SVO might be strongly preferred out of context (cf. (22) and Section 1.2.2).

(17) Bulgarian
Ivan celuna Marija
Ivan kiss.PST.3SG Marija
'It was Ivan that Marija kissed.'

Things are different in (18), which furnishes morphosyntactic clues to the assignment of grammatical functions. Here, the clause-initial FOCUS NP is plural,

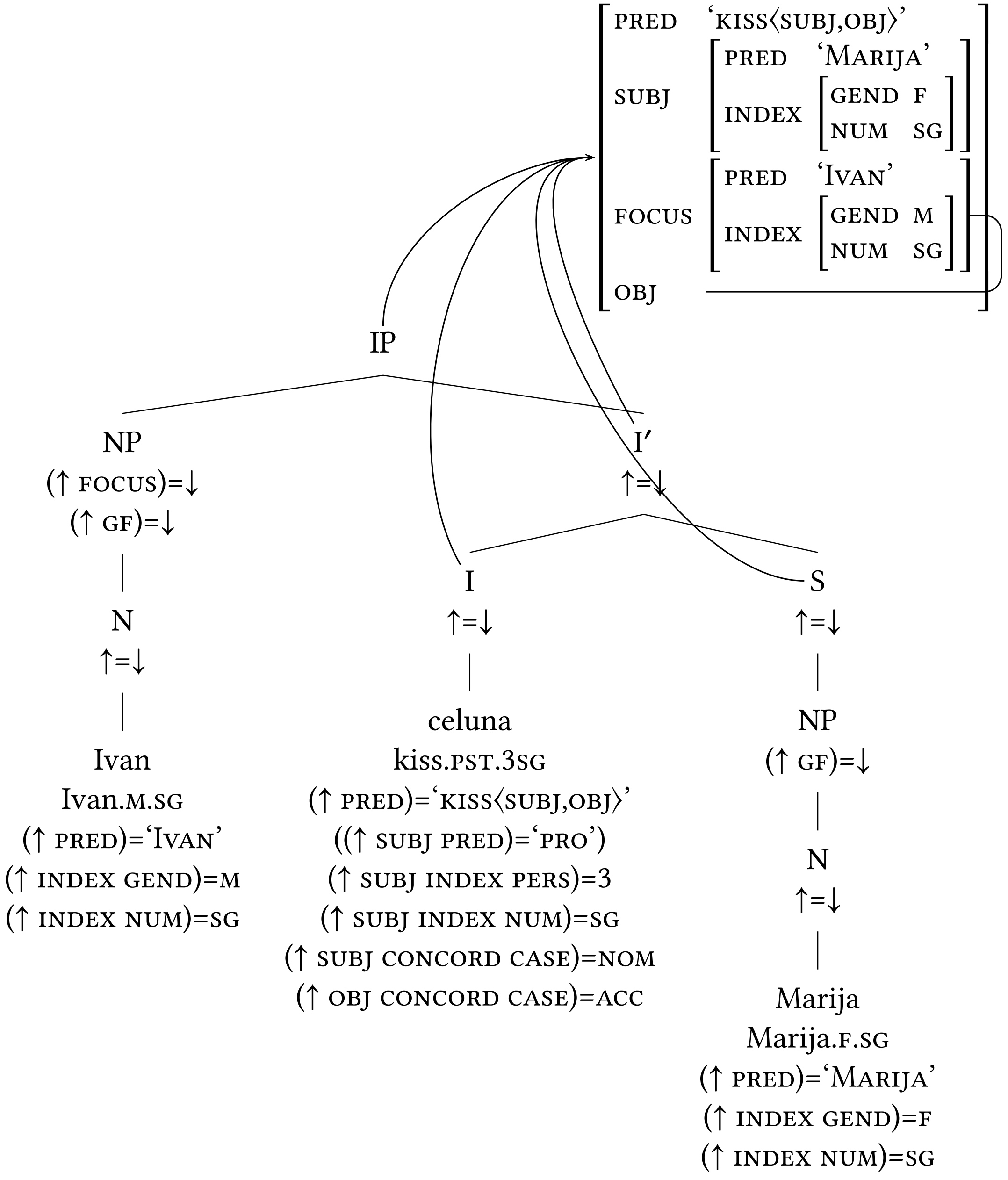

Figure 5: C- and f-structure for an ambiguous sentence in Bulgarian

so the subject must be *Marija* because the verb shows unambiguous third person singular agreement with its subject (consult Rudin 1985: 15, Dalrymple 2001: 137).

(18) Bulgarian
Deca-ta celuna Marija
children.PL-DEF kiss.PST.3SG Marija
'It was the children that Marija kissed.'

Apart from subject-verb agreement, disambiguation can also be achieved by doubled/reduplicated object clitics, as in (20), which relies on the following lexical entry for the clitic pronoun *go* 'him':[14]

(19) Lexical entry for a Bulgarian object clitic pronoun

go ((↑ PRED) = 'PRO')
(↑ INDEX PERS) = 3
(↑ INDEX GEND) = M
(↑ INDEX NUM) = SG
(↑ CONCORD CASE) = ACC

If no full object NP is available, the semantic PRED value for the object function will be contributed by the object clitic. Since the PRED of this clitic is optional (enclosed in parentheses), *go* can unproblematically appear even when the object function is filled by a masculine NP like *Ivan*, but not a feminine NP like *Marija*, which would be incompatible in terms of gender (see Dalrymple 2001: 135, 138; cf. Section 2.8 and Alsina 2023 [this volume]).

(20) Bulgarian
Marija go celuna Ivan
Marija him.OBJ.CLITIC kiss.PST.3SG Ivan
'Marija kissed Ivan.'/'It was Marija that kissed Ivan.' (with the exact emphasis depending on context and prosody, so Marija could be a focused element or play another role at information-structure)

Note that the overtly marked case of *go* 'him' appears in the f-structure for the non-case-marked *Ivan* because the two c-structure nodes (the clitic *go* and the N *Ivan*) correspond to the same f-structure, with the information from each node in the tree diagram fed into the f-structure that they share (cf. Dalrymple 2001: 74–75, Bresnan et al. 2016: 48). Without providing a separate semantic PRED value (which would go against LFG's Consistency Principle), the clitic in Figure 6 effectively supplies a case value for the caseless noun it agrees with.

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[14] See Rudin (1985: 17), as well as Jaeger & Gerassimova (2002), on the interaction between word order, information structure and (topic-marking) object clitics.

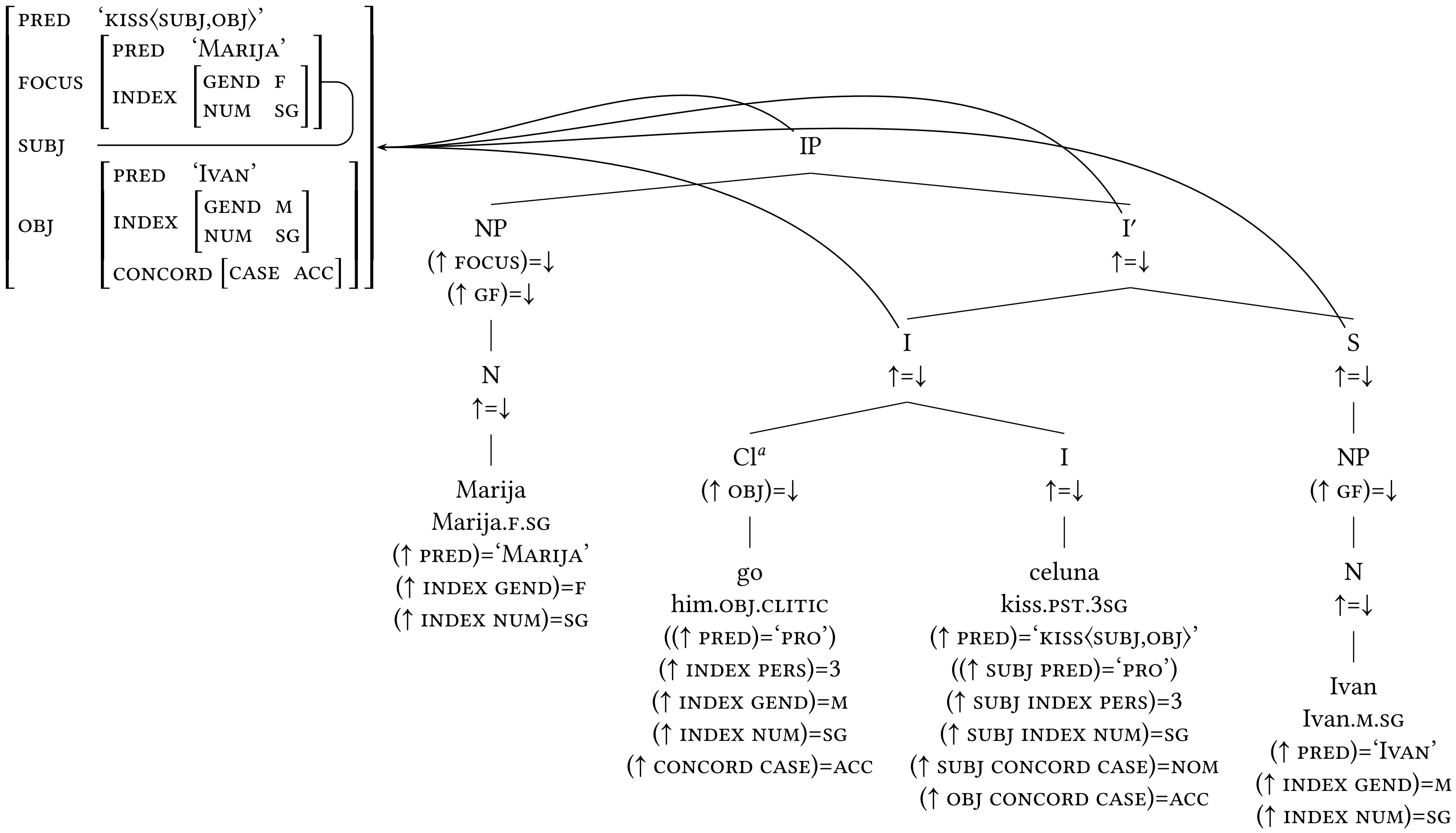

Figure 6: Disambiguation with clitics in Bulgarian

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[a] Alternatively, the object clitic could be represented as a non-projecting noun – see Dalrymple et al. (2019: 188) and Section 2.8.

2.4.3 Slavic in general

The situation in the Slavic languages with healthy case-marking on nouns, such as Russian, Ukrainian, Czech, Polish or Bosnian/Croatian/Serbian, will be very similar to that in Bulgarian. What Bulgarian and Macedonian achieve with clitics is achieved with case inflections in the rest of the family.[15] The unambiguous case values normally contributed by each nominal argument serve to uniquely identify that argument's syntactic function, much like a clitic in Bulgarian/Macedonian (cf. Figure 2 and Figure 6). The case principles of function specification in Russian can be formulated as follows:

(21) Case principles of function specification in Russian (from Bresnan et al. 2016: 70–71, 203–205)
(↓ CASE)=NOM ⇒ (↑ SUBJ)=↓
(↓ CASE)=ACC ⇒ (↑ OBJ)=↓

These annotations state that if the case of a node is nominative, it will serve as the subject of the construction that contains it. Conversely, if the case of a node is accusative, it will serve as the object of the matrix construction. Naturally, similar statements will be needed for the additional functions/meanings of cases. These are morphological means of function specification which are independent of c-structure position (the latter would be needed for function specification in a configurational language like English).[16]

In circumstances of syncretism, where case distinctions collapse, the assignment of syntactic functions will of necessity proceed randomly or depending on the wider context, world knowledge and/or subject-verb agreement, much as in Bulgarian/Macedonian. In (22), neither noun distinguishes nominative from accusative.

(22) Russian (from Comrie & Corbett 1993: 14)
Mat' ljubit doč'
mother.NOM/ACC loves daughter.NOM/ACC
'The mother loves the daughter.'

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[15] An important difference is that clitics are arguably head-marking on the verb, while case is dependent-marking on the nominal arguments of the verb – see Jaeger & Gerassimova (2002), Bresnan et al. (2016: 113–115, 205–207).

[16] Consult Neidle (1988), King (1995: esp. Chapter 8), and Bloom (1999), for the syntactic distribution of Russian cases from a general LFG perspective, including different methods of case assignment (configurational, grammatical/functional, lexical, and semantic). Przepiórkowski & Patejuk (2011, 2012a,b) and Patejuk (2015) offer discussion of Polish. For English, see Hristov (2012, 2013b).

Although (22) is syntactically ambiguous in the same way as (17), an SVO interpretation might be preferred as the most neutral out of context (see Jakobson 1936, Comrie & Corbett 1993: 14, King 1995: 2 fn. 2, Sussex & Cubberley 2006: 319, 406–407). In spoken language, intonation will normally dispel the ambiguity, as noted in seminal monographs by Yanko (2001, 2008). LFG's parallel architecture is perfectly suited for handling such phenomena where the interplay between syntax, morphology and prosody is not a trivial one-to-one correspondence.

2.5 Passives and related constructions

Instead of being considered a syntactic transformation, the passive is seen in LFG as a lexical operation/alternation in the argument structure of a verb. Argument structure itself is a separate module in the LFG architecture which maps onto the morphology and the syntax – there is an association between thematic/semantic roles, argument slots and syntactic functions, as in (23) (cf. Section 2.1; Kibort 2007; Bresnan et al. 2016: Chapter 3, 76–79; Dalrymple et al. 2019: 340–345; Findlay et al. 2023 [this volume]).

(23) Argument structure of a Polish transitive verb

SUBJ OBJ
| |
wyłał ‘spilled < __ , __ >’
| |
AGENT THEME

In the passive and some related constructions, the thematically highest argument, which is otherwise aligned with the syntactic function of subject, is suppressed or demoted in the argument structure, and hence unavailable for linking to the subject function in the syntax. Therefore, the next highest argument compatible with such a function is mapped/promoted to SUBJ, which ties in well with the general descriptive intuition about what passivisation accomplishes.

Apart from passives proper, Kibort (2001, 2004, 2006, 2007, 2012) discusses similar alternations which exhibit divergent mappings between the argument structure and the syntactic component, as in the following pair of sentences (cf. Section 1.2.3):

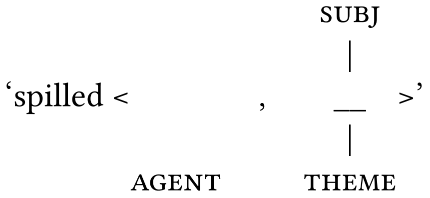
(24) Polish (from Kibort 2012: ex. 14, also cited in Dalrymple et al. 2019: 343)

a. Tomek wylał zup-ę
Tomek(M)[NOM.SG] spilled[3SG.M] soup(F)-ACC.SG
‘Tomek spilled the soup.’

b. Zup-a wylał-a się
soup(F)-NOM.SG spilled-3SG.F REFL
'The soup spilled.'

Kibort (2001, 2007, 2012) asserts that the transitive and reflexive versions of 'spill' have two distinct lexical entries, based on different argument structures, though of course both thematically entail a spiller agent and a spillee patient/theme. The transitive one has an agent (Tomek) assigned to the subject role and a patient/theme (the soup) which is realised as the object, as in (23) above. The reflexive 'spill', by contrast, has no core argument position with which the agent can be associated (since it expresses the event affecting the patient/theme without specifying the cause), so the sole patient/theme argument is mapped to the subject role:

(25) Anticausative in Polish (based on Kibort 2001: ex. 43: Kibort 2012: ex. 16)



If the agent is mentioned, it will appear as a secondary/oblique object (a non-volitional human participant or perhaps a maleficiary) or as an optional adjunct – the former scenario entails demotion, while the latter entails suppression of the agent argument. Although they come up with a somewhat dissimilar formal proposal, Patejuk & Przepiórkowski (2015) likewise note that reflexive *się*, rather than being a legitimate reflexive pronoun, here just indicates that the verb has been detransitivised (cf. Schenker 1985; a similar point is made in pioneering generative papers on Bulgarian, Walter 1963a,b, for which see Venkova 2017, as well as in traditional/transformational descriptions, e.g. Bojadžiev et al. (1999: 604). Kibort (2012) labels such "anticausative" operations as lexical detransitivisers which, according to her, delete the first core argument from the valency frame (though they do not obliterate the corresponding semantic participant).

Kibort (2007, 2012) claims that the passive proper is different from such reflexive anticausative constructions in that it does not suppress/erase the agent argument (thereby relegating it merely to a potential adjunct role in the syntax), but only changes the agent's argument-structure specifications, so that it is linked to a non-subject syntactic function, such as an oblique argument (though it then ought to be stipulated that such arguments are optional).

Unlike in English, even intransitive verbs can be passivised in Polish and elsewhere in Slavic, resulting in an impersonal construction (see Kibort 2001, 2012).

Essentially the same account is available for such intransitive impersonals, whereby the agent subject in the active is altered in terms of its argument specifications so that it is forced to map onto an oblique in the passive (if it appears at all). As a result, the sole (optional) argument of a passivised intransitive verb like *palić* in (26) is not realised as SUBJ and the clause is truly subjectless – which takes us to the topic of the next section.[17]

(26) Polish (from Kibort 2006: ex. 55; also cited in Dalrymple et al. 2019: 344)
Wchodzi-sz i czuje-sz, że był-o palon-e.
come.in-2SG and smell-2SG that was-3SG.N smoke.PTCP-N.SG
'You come in and you can smell that there has been smoking (here).'

Kibort's demarcation of fine distinctions between various possible interfaces amounts to suggesting that meaning-preserving/morphosyntactic operations like the passive interfere only with the argument-to-function mapping, whereas other, morpholexical and morphosemantic, meaning-altering processes (e.g. the anticausative) additionally affect the lexical and/or semantic tiers of representation of the predicate. These intriguing predictions arising from LFG's modularity have a bearing on describing in greater depth the nature of Slavic argument alternations, more of which are discussed in Kibort's work.

2.6 Pro-drop, subjectless and impersonal constructions

Many linguistic theories include a stipulation that all predicates must have subjects. This is dubbed the Subject Condition in LFG, the Final 1 Law in Relational Grammar and the Extended Projection Principle in Chomsky's (1981) generative framework (see Bresnan 2001: 311, Kibort 2001, Dalrymple et al. 2019: 21). In clauses with pro-drop, the subject has simply been omitted but it can be recovered based on the agreement morphology of the verb. Pro-drop is a widespread phenomenon in Slavic, as noted in Section 1.2.4. In theories where syntactic functions are defined positionally and equated with phrase-structure configurations, pro-drop is usually regarded as a phrase-structure operation – either the transformational deletion of a pronoun or the licensing of a phonologically null con-

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[17] Alternatively, the agent might be said to potentially surface as an adjunct rather than an oblique argument, if one adopts a suppression as opposed to a demotion account of passivisation. The exact status of these agents remains unsettled, as does the subtle distinction between suppression and demotion. For more detail, including the overarching principles of LFG's Lexical Mapping Theory and the notational technicalities, consult Kibort (2001, 2007) and Findlay et al. 2023 [this volume]. Passivisation is discussed in relation to raising by Kibort (2012) and Patejuk & Przepiórkowski (2014a), who see the auxiliary as a raising main predicate taking the passive/resultative participle of the lexical verb as its complement.

stituent which represents the pronominal argument in the tree diagram. By contrast, in the grammatical design of LFG pro-drop involves the *functional* specification of a pronominal argument by a head – in our case, the verbal head of the clause specifies a pronominal value for its subject argument, as in (16), which entails the (potential) absence of an overt subject pronoun from the phrasal structure (see Kibort 2006, Bresnan et al. 2016: 154 fn. 4, Toivonen 2023 [this volume]). Still, sentences with pro-drop have a (covert) subject, which is represented in LFG's more abstract f-structure, as in Figure 4. Therefore pro-drop does not violate the Subject Condition.[18]

While the Subject Condition holds in English and numerous other languages, it has been argued that certain languages do admit genuinely subjectless sentences. Kibort (2006, 2012) discusses Polish constructions she claims to be truly subjectless. They comprise a small class of inherently impersonal predicates, as in (27) below, or intransitive predicates which have undergone passivisation, as in (26) above (cf. Dalrymple et al. 2019: 22).

(27) Polish (from Kibort 2006; also cited in Dalrymple et al. 2019: 22)

Słychać	ją	/ jakieś	mruczenie
hear	her.ACC	some.N.ACC	murmuring.N.ACC

'One can hear her/some murmuring.'

Formally, the verb in (27) is identical with the infinitive, so there is no agreement morphology on this non-finite form which could be said to introduce subject features (as in pro-drop). It has long been recognised in traditional descriptive grammars of Slavic that no subject can be reconstructed for such clauses. As noted by Kibort (2006: §4.1), those defective verbs do not have even a "covert" subject which could participate in syntactic control or reflexive binding. The impersonal clauses from Section 1.2.4, with default third person singular (neuter) agreement on the predicate, are also traditionally regarded as truly subjectless, i.e. clauses which cannot have an overt subject, so the Subject Condition might not be universal in the face of this Slavic data.[19]

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[18] King (1997) also shows how lexical entries for verbs specifying a PRO value for their subjects can be further annotated with the TOPIC discourse status typical of such elided elements.

[19] However, Kibort (2006) treats Polish weather constructions and impersonals involving adversity or physical/psychological states as special instances of subject ellipsis/pro-drop, contrary to the traditional view whereby they lack a subject. The reader can find a more elaborate classification of types of subjectlessness in Kibort (2006). In another strand of research, verbs with non-nominative arguments like Russian *menja tošnit* 'I feel sick' have sometimes been analysed as having "non-canonical subjects", though this too remains a matter of debate. The same goes for the status of "genitive subjects" in negative constructions (see Timberlake 1993: 868ff., with references).

2.7 Copular constructions

English and many other languages, including members of the Slavic family, require the presence of a copular/link verb in copular clauses. Russian, on the other hand, famously has copular constructions with no overt copula, as pointed out in Section 1.2.6 and illustrated in (28). The c-structure of a Russian verbless clause can be represented as in Figure 7, with a headless IP (Dalrymple et al. 2019: 191; cf. Section 2.4.2 and Section 3.1 for headlessness in LFG).

(28) Russian (from Dalrymple et al. 2004: 192)
On student
He student
'He is a student.'

In a construction like this, it is not immediately obvious what contributes the main semantic PRED of the clause, which is required for the f-structure to be complete and coherent (see Section 3.1 below; cf. a similar issue arising from pro-drop). According to one analysis, the main clausal PRED is contributed by the predicative nominal; according to another, the main clausal PRED is contributed by a special phrase-structure rule or the phrase-structure configuration. Such competing analyses have been put forward for both verbless clauses and constructions with an overt link verb (Dalrymple et al. 2004, Nordlinger & Sadler 2007: 141–142, Dalrymple et al. 2019: 189ff.).[20]

Especially in the absence of a verb, it could be argued that the main clausal PRED value is contributed by the predicative nominal element, which will then select arguments in the same way an ordinary verb would. On this so-called single-tier view, the predicative nominal is the syntactic head of the clause; its f-structure will therefore be identified with the f-structure of the clause and it will contribute the clausal PRED value, as in Figure 8. Consequently, there must exist a lexical entry for the noun *student* which contributes the main clausal PRED value and selects a subject, i.e. (↑PRED) = 'STUDENT<SUBJ>', alongside a "normal" lexical entry for the same nominal form which does not require a subject (for clauses such as 'He met a student', where the subject requirements are imposed by the verb).

Under the so-called double-tier approach, by contrast, both non-verbal elements are arguments (a subject and a predicative complement/PREDLINK). The main PRED selecting these arguments can be supplied by an overt copula or by

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[20] In the case of overt copulas, the debate surrounding the construction revolves around whether the copula supplies a semantic PRED value or just the tense, aspect, mood, number and person features. Patejuk & Przepiórkowski (2014a) highlight similar issues in the analysis of *be* in Polish passive constructions.

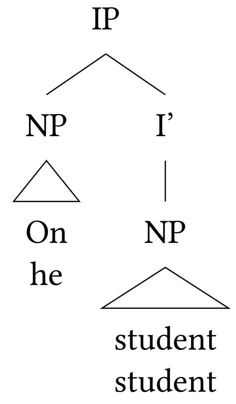

Figure 7: A verbless copular clause in Russian

$$\begin{bmatrix} \text{PRED} & \text{‘STUDENT}\langle\text{SUBJ}\rangle\text{’} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{‘PRO’} \\ \text{INDEX} & \begin{bmatrix} \text{PERS} & 3 \\ \text{GEND} & \text{M} \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Figure 8: Single-tier analysis of *On student* (based on Dalrymple et al. 2004: 192, Nordlinger & Sadler 2007: 141–142, and Dalrymple et al. 2019: 194)

the phrase structure (in the case of verbless clauses). This type of analysis might rely on empty-node rules or the constructional properties of the configuration to license the requisite PRED value. Importantly, LFG’s rule annotations can introduce a PRED value in the f-structure, but they will not customarily produce any empty nodes in the constituent structure (as might be done in other theories). One possible f-structure resulting from this approach is presented in Figure 9.

$$\begin{bmatrix} \text{PRED} & \text{‘BE}\langle\text{SUBJ,PREDLINK}\rangle\text{’} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{‘PRO’} \\ \text{INDEX} & \begin{bmatrix} \text{PERS} & 3 \\ \text{GEND} & \text{M} \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix} \\ \text{PREDLINK} & \begin{bmatrix} \text{PRED} & \text{‘STUDENT’} \end{bmatrix} \end{bmatrix}$$

Figure 9: Double-tier analysis of *On student* (based on Dalrymple et al. 2004: 193, Nordlinger & Sadler 2007: 141–142, and Dalrymple et al. 2019: 194–195)

In the spirit of LFG, there have been claims that the presence or absence of a copula is just a matter of superficial c-structure variation, and the “underlying” f-structure for both types of construction should be identical, especially in the light of the fact that both constructions can coexist in the same language, with the appearance or omission of the copula correlating with tense, among other factors.[21] The double-tier approach appears to have gained wider currency in the LFG literature, though the debate as to whether a unified solution should be sought, and if so, which one, is ongoing.

2.8 Clitics and clitic placement

In the more recent LFG literature, clitics are seen as non-projecting words which do not project their own phrases according to the X-bar schema (see Jaeger & Gerassimova 2002, Bresnan et al. 2016: 116–117; cf. Figure 6). This treatment recognises their intermediate status between independent words and bound affixes and primarily concerns the behaviour of clitics at c-structure, which is additionally regulated by language-specific phrase-structure rules of the type we saw for Bulgarian in (15). Other phenomena are modelled via the interface of lexical entries and f-structure.

One important process involving clitics is clitic doubling/reduplication. Some Slavic languages allow it, while others do not. Bosnian/Croatian/Serbian, for one, does not – a clitic pronoun and a full pronoun cannot be used in the same sentence in this South Slavic variety. In the constraint-based lexicalist framework of LFG, the ungrammaticality of clitic doubling is accounted for by giving both types of pronoun, clitic and full, a semantic form of the following shape (as part of the lexical entry):

(29) (↑ PRED)=‘PRO’

If both a full pronoun and a coreferential clitic were to appear in the same clause, there would be a clash because of the multiple specifications of semantic forms for the same f-structure object, resulting in an ill-formed, inconsistent f-structure (cf. Section 3.1).

By contrast, it became apparent in the earlier sections that clitic doubling is found in other Slavic languages spoken in the Balkans, including Bulgarian and Macedonian, both central members of the Balkan Sprachbund/Linguistic Area

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[21] In Russian, the copula is null in the present tense but it has to be overt in the past and the future (Dalrymple et al. 2004: 191–192). Traditionally, this is used as an argument in favour of a zero copula in the present, but an argument can be made that there is a structural difference between copular and copula-less sentences. Ukrainian admits either null or overt copulas in the present tense. See Section 1.2.6, as well as Patejuk & Przepiórkowski (2014a, 2018), who discuss certain copular constructions in Polish, another Slavic language with optional copulas; cf. Dalrymple et al. (2019: 195–197).

(see Jaeger & Gerassimova 2002; cf. Alsina 2023 [this volume] for Spanish). LFG models this typological parameter by making the PRED value of the clitic optional in a language which admits clitic doubling. A clitic will then contribute a semantic value only if it is the sole object; if it reduplicates a full NP, including a non-clitic pronoun, the clitic will not contribute its own semantic value due to its optionality and no clash will ensue (see entry in (19) and Figure 6 above, as well as Franks & King 2000, Dalrymple 2001: 105–106, Bresnan et al. 2016: 357–358, 440, Dalrymple et al. 2019: 130–131, 152–153).[22]

When more than one clitic occurs in a clause, they group in what is known as a clitic cluster. The rules regulating the internal order inside this clitic cluster, as well as where the clitic cluster can go in the clause, can also be very strict and complex (see Franks & King 2000: 234ff, Jaeger & Gerassimova 2002: 201, Bögel et al. 2010; cf. Section 1.2.5).

2.9 Negation and negative concord

The Russian negator *ne* was described as a proclitic in Section 2.4.1, though this status has been contested for some of its cognates elsewhere in Slavic, as well as for Russian itself. There have been arguments in the LFG literature that, as in Czech, the Polish equivalent negator is actually a prefix, rather than a clitic, though the negator is written as a separate word in Polish, while Czech orthography has long recognised its bound status (see Patejuk & Przepiórkowski 2014a, Przepiórkowski & Patejuk 2015; cf. King 1995 for similar ideas regarding Russian). Irrespective of its status as clitic or prefix, the negative item in Slavic can license morphosyntactic phenomena like the genitive of negation as well as negative concord, both of them already encountered in the preceding exposition (Section 1.2.1, Section 1.2.6, Section 2.3, Section 2.4.1).[23]

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[22] In varieties with clitic doubling, the clitic pronouns appear to be undergoing reanalysis as agreement markers which match the morphosyntactic features of the constituent they reduplicate. See Bresnan et al. (2016: Chapter 8) and Toivonen 2023 [this volume] for further discussion, including the diachronic developments from one stage to the next, e.g. bleaching from obligatory semantic PRED > optional semantic PRED > no semantic PRED (as for an agreement affix), as well as links to pro-drop, pronoun incorporation and the grammaticalisation of agreement affixes.

[23] The affixal status of the negative marker in Czech and Sorbian is acknowledged in the World Atlas of Language Structures (Dryer 2013), but a similar status is denied there to Polish *nie* (cf. Przepiórkowski & Patejuk 2015: 329, fn. 10). Importantly, the claim that the Polish marker is also an affix is made regarding verbal negation only. When the same form *nie* negates a distinguished clausal constituent, it is not a bound morpheme, as it may be separated from the constituent it negates and it may scope over coordination, among other characteristic features. Furthermore, Polish constituent negation does not trigger the genitive of negation, nor does it license other negative words in negative concord.

As dictated by negative concord, negative words with negative meaning need to appear in the presence of verbal negation. Indeed, there are words in Slavic which are allowed to occur only where negation is available in the relevant domain. Such words are referred to as *n*-words or negative polarity items and include Polish *nikt* 'nobody' in (30), as well as those from Bosnian/Croatian/Serbian in (5), among many others (see Patejuk & Przepiórkowski 2014a: §4.3.1). This sets Slavic apart from Standard Modern English, where such multiple negation is prescriptively outlawed (though it is still common in dialects).

(30) Polish (from Patejuk & Przepiórkowski 2014a: ex. 22)
Nikt *(nie) odszedł głodny.
nobody.NOM NEG left hungry
'Nobody left hungry.'

Although *n*-words are grammatically negative in themselves and certainly carry negative meaning (e.g. the word for 'nobody' can give a negative answer to a question even when uttered on its own), they do not contribute additional negation when they fall within the scope of sentential negation. This is basically the nature of what is referred to as negative concord, a phenomenon akin to agreement where features need to match for purely syntactic reasons.[24]

Both the genitive of negation and negative concord can operate in contexts of clause embedding too (e.g. with so-called open/infinitival complement clauses missing a separate subject), though embedded items are sometimes not obligatorily affected and certain types of embedding can prevent negation-sensitive phenomena (e.g. finite full/closed/sentential complements with their own subject which are insensitive to negation in the matrix clause). This is where LFG's distinction between XCOMP for the former (infinitival) complements and COMP for the latter (finite) clausal complements comes in very useful in differentiating between those natural classes (see Przepiórkowski 2000 and Patejuk & Przepiórkowski 2014b). As is usual for LFG and related theories, the interaction between polarity and polarity-sensitive phenomena such as the genitive of negation and negative concord is modelled via constraints (see Bond 2023 [this volume]). The restrictions also find natural expression in the setting of f-structure. Further issues concerning negation in Polish are discussed by Przepiórkowski & Patejuk (2015), who propose different f-structure representations for the two major types

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[24] Note that this is a different use of the term *concord*, distinct from the concord bundle of features discussed in Section 2.2, though both these concepts have to do with the more general idea of agreement.

of negation: constituent negation and eventuality negation (a.k.a. predicate/sentential negation). In the attribute-value matrices, negation can be introduced as an adjunct feature or as a binary NEG or polarity feature. Adjunction makes it easy to represent multiple negation via multiple negative elements in the adjunct set.

2.10 Distance distributivity

Distance distributivity is observed in English sentences like *I gave the boys two apples each* – *each* attaches to the NP denoting the distributed quantity (the apples) and looks elsewhere in the sentence, here for a set of boys, to distribute over. In Slavic, distance distributivity is discussed with regard to Polish by Przepiórkowski (2013, 2014, 2015), as well as Przepiórkowski & Patejuk (2013). Przepiórkowski & Patejuk (2013) contend that Polish has a number of function words expressing distance distributivity which share their form and semantic contribution but differ in their syntactic behaviour, namely different lexical items instantiated as *po* 'each'. While *po* may at first glance appear to be a single item, it can in fact be classified as a preposition (governing the strictly prepositional locative case), or as an adnumeral operator compatible with a variety of cases and hence transparent to case requirements. In order to account for this discordant behaviour, Przepiórkowski & Patejuk harness the LFG mechanisms of templates (a complex template of sub-entries within one main entry) and restriction, as well as the notion of weak head borrowed from HPSG.[25] The issue is further explored in Przepiórkowski's (2013, 2014, 2015) work, where he additionally deploys Glue semantics (see Asudeh 2023 [this volume]).[26]

2.11 Coordination

The interaction of coordination with concord and index features was already discussed in Section 2.2, so the current section will be dedicated to other problematic areas in the analysis of conjoined structures (cf. Patejuk 2023 [this volume] for a fuller account). Przepiórkowski & Patejuk (2012a), Patejuk & Przepiórkowski (2012, 2014b, 2017: 338–339) and Patejuk (2015) discuss the coordination of unlike categories in Polish, here an NP and a clause, both serving as arguments

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[25] Weak heads inherit morphosyntactic properties from their complements, for instance whenever *po* appears to be transparent to case requirements and the case value of the phrase it heads is determined by the complement.

[26] See Franks (1995: §5.2.1) for a comparison of distributive *po* across Slavic couched in generative linguistics; cf. Berger et al. (2009: Chapter 32), as well as Sussex & Cubberley (2006: 467–468), who suggest that *po* might even be a prefix.

(one an obj, the other a comp) of the same predicate, with the same semantic interpretation:

(31) Polish (from Patejuk & Przepiórkowski 2017: 338)

Lisa	chciała	książkę	i	żeby	ktoś	ją	przytulił.
Lisa.nom	wanted	book.acc	and	that	somebody.nom	she.acc	hug

‘Lisa wanted a book and someone to hug her.’

Other unlike coordination strategies might involve a governing predicate (or even different heads) taking conjoined nominal arguments in different cases and/ or with different grammatical functions. The possibility of all of these is ensured by specifying, say, the verb for ‘want’ in (31) as requiring either a case-bearing accusative NP object or a *that*-clause. Probably the biggest challenges in such cases are to ensure that the different alternatives can be realised simultaneously in the same sentence (rather than only on different occasions), as well as to decide how to label the function of the conjoined phrase as a whole.[27]

The inverse scenario entails having two coordinated heads which impose different restrictions on a shared dependent. Those requirements can be met by a single constituent in cases of syncretism, as in (32).

(32) Polish (from Dyła 1984: ex. 2)

Kogo	Janek	lubi	a	Jerzy	nienawidzi?
who.acc/gen	Janek	likes	and	Jerzy	hates

‘Who does Janek like and Jerzy hate?’

The verb form *lubi* requires its object to bear accusative case, while *nienawidzi* takes an object marked for the genitive – *kogo* is syncretic/indeterminate between the two and can simultaneously satisfy both requirements. Dalrymple & Kaplan (2000) therefore propose a set-valued case attribute for this syncretic form, as in (33), while Patejuk & Przepiórkowski (2014b) and Patejuk (2015: 41ff.) refine the original proposal.

(33) Partial lexical entry for Polish *kogo*

kogo Pron (↑ pred)=‘who’
(↑ case) = {acc,gen}

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[27] See further Patejuk & Przepiórkowski (2012), Przepiórkowski & Patejuk (2012a), Dalrymple et al. (2019: 225–230, 617ff., 650–651), where mention is made of the existence of similar constructions in Russian and Croatian. Patejuk (2015: 54–55, 68ff.) discusses both the issues of simultaneous realisation and labelling, in addition to the issue of embedding.

2.12 Anaphoric control

In obligatory anaphoric control constructions, there should be coreference between an argument of a main/matrix clause and a so-called controlled argument in a subordinate complement clause (see Dalrymple et al. 2019: 561ff.). The coreference of the two arguments is represented in LFG by coindexing them at f-structure (see Rákosi 2023 [this volume], Kaplan 2023 [this volume], Vincent 2023 [this volume]). Early work on obligatory anaphoric control in Serbian/Croatian was carried out by Zec (1987), while Neidle (1982) covers control in Russian (cf. Bojadžiev et al. 1999: 607–610 for Bulgarian, relying on different types of empty "pro"). Control in Polish is discussed by Patejuk & Przepiórkowski (2018). In (34), the dative experiencer acts as the controller of the unexpressed subject of the bracketed infinitival clause: the author is taken to be both the person experiencing difficulty and the person receiving the details.[28]

(34) Polish (from Patejuk & Przepiórkowski 2018: 316)
Oczywiście autorowi najtrudniej był-o [uzyskać
obviously author.dat difficult.adv.superl was-3sg.n get.inf
szczegóły].
details.acc
'Obviously, to get the details was the most difficult [thing] for the author.'

3 LFG analyses in the context of other frameworks

The preceding sections have provided a survey through the lens of LFG of a wide range of grammatical phenomena illustrated from several Slavic languages, which are not always typologically identical. Bresnan et al. (2016: xi) describe LFG as "a theory of grammar which has a powerful, flexible, and mathematically well-defined grammar formalism designed for typologically diverse languages". In the LFG view of grammar, the surface form and organisation of clauses differs from language to language. This is reflected in c-structure, which entails no claims to universality. The categories and the types of constituents, as well as their surface arrangement, all have to be justified on a language-by-language basis (cf. the argumentation in Section 2.4.1). However, the underlying functional

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[28] Cf. the discussion of raising in the context of the Polish passive in Section 2.5, with raising seen as "functional" (as opposed to anaphoric) control in LFG. As noted by an anonymous reviewer, there are no uncontroversial examples of functional control/raising in Slavic, with the exception of the analysis of the passive mentioned above, and also possibly verbs like 'begin', although this has not been discussed in LFG.

makeup of clauses is regarded as cross-linguistically more uniform, as expressed in LFG's more abstract f-structure (cf. the closing remarks in Section 2.7). Even close relatives like Bulgarian and Russian were shown to have typologically divergent clause structures, despite both organising their clauses according to the packaging of information in discourse (Section 2.4).

In addition, LFG operates with a constraint-based, parallel correspondence architecture. Unlike transformational theories, no use is made of serial derivations, and the framework postulates no "deep" structures as inputs to syntactic operations. LFG shares these principles with theories like HPSG (see Przepiórkowski 2023 [this volume]; cf. the relevant chapters in Berger et al. 2009). Indeed, there has been a great deal of common ground and cross-pollination, with numerous ideas borrowed from HPSG, most notably Wechsler & Zlatić's HPSG-based proposal about agreement features in Bosnian/Croatian/Serbian (Section 2.2), or Przepiórkowski's and Patejuk's generalisations about Polish originally inspired by HPSG or cast in HPSG terms and cited on numerous occasions above. It is likewise worth singling out Borsley & Przepiórkowski's (1999) edited volume on Slavic in HPSG, which promoted some seminal ideas, or HPSG work on individual languages, e.g. Osenova's (2001), Venkova's (2006) and Osenova & Simov's (2007) analyses of Bulgarian, among many others. While HPSG and LFG analyses are highly compatible and often easily convertible from one formalism to the other, LFG has some design features which make it stand out from other theories, especially dominant transformational ones. These are briefly outlined below in the light of the Slavic data presented in this chapter.

3.1 Optionality of c-structure heads and no movement or other transformations

The optionality of c-structure heads is a distinctive property of LFG (see Lovestrand & Lowe 2017, Lowe & Lovestrand 2020), along with the absence of movement operations, which LFG shares with other non-transformational approaches to grammar. It emerged in the discussion of the phrase structure of Slavic languages (Section 2.4) that finite/tensed verbs in Russian and in other members of the family appear in the I slot, and the VP may contain no V head. In the theory of LFG, such examples need no special treatment and the verb is not believed to have "moved" to the c-structure position in which it appears (cf. Sells 2023 [this volume]). Due to its finite morphology, a tensed verb is simply assumed to be of category I in LFG, whereas in transformational frameworks it needs to travel from V to I in order to receive or check these morphological features.

The possibility and well-formedness of this non-transformational configuration is predicted by the overarching principles of LFG. Firstly, Russian finite verbs are assigned to the phrase-structure category of I, so they appear in I rather than within the VP. Having two main/full/lexical verbs, one in I and the other in the VP, is ruled out because each verb would contribute a PRED value to the f-structure, and LFG's Consistency Principle does not allow f-structures having a PRED feature with two different semantic forms as its value (cf. the analysis of clitic doubling in Section 2.8). Secondly, the theory rules out sentences with no verbs whatsoever, because then the main f-structure would be without a PRED, violating the Coherence Principle (though compare the discussion of verbless clauses). Therefore, exactly one verb must appear and it must be housed in the c-structure position appropriate for its constituent structure category.[29]

Compared to prevalent transformational approaches, the non-transformational LFG view is empirically more attractive and intuitive in handling typological diversity. A non-transformational theory avoids the biased assumption that languages with a word order and phrase structure very much unlike that of English, including the Slavic family, actually start out with a deep/underlying structure suspiciously reminiscent of that of English, but then undergo various transformations to achieve the desired "scrambling" effects (see Bresnan et al. 2016: 6ff.; cf. Rudin 1985, who assumes a "non-configurational base" in her transformational treatment of Bulgarian word order).

Modern transformational accounts by now operate with highly abstract underlying structures which, although historically derived from English patterns, even in English itself require a lot of derivation to produce the surface form of the sentence. However, what remains English-influenced is the general idea that (a) constituent structure is the main level of syntactic representation where most grammatical phenomena can be modelled; (b) constituent structure positions are strictly associated with specific grammatical functions. LFG, by contrast, works much better for Slavic because its modularity gives more prominence to relational syntax (f-structure), case morphology, etc.[30] LFG can still capture constituent structure phenomena equally neatly, including "binding" phenomena, as exemplified by Russian *svoj* 'one's own', or VP-internal asymmetries in Russian (cf. Bailyn 2011: 140–151).

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[29] See King (1995: Chapter 10), who additionally provides an account of Russian questions without resorting to movement, as well as Dalrymple (2001: 79, 104–106), Dalrymple et al. (2019: 129–130); consult Rudin (1985) for a transformational treatment of word order, complementation and *wh*-constructions in Bulgarian.

[30] This was brought to my attention by an anonymous referee, who adds that it is not an accident that the notion of constituent structure did not really exist in the Slavic local linguistic traditions (e.g. in Russia, or in Prague School structuralism) before Chomsky: a kind of informal dependency grammar was traditionally used, and in the structuralist era, various dependency-based frameworks (Tesnière's approach or Mel'čuk's Meaning-Text Theory).

3.2 Modularity (parallel architecture)

It emerged in Section 2 that LFG's modular parallel architecture was well placed to deal with various grammatical phenomena in Slavic, not least the interdependence between flexible word order and the flow of information in discourse. Appealing to the interaction between c-, f- and i-structure, as well as semantics, proved more satisfactory than relying exclusively on the syntax, which would be inadequate on its own to capture all the relevant generalisations. The independence of grammatical and discourse functions from constituent structure, coupled with the constrained interface between the different modules, is designed to provide a good fit for languages which do not encode grammatical functions positionally, like the Slavic family.

In the light of these insights, the assignment of nominative and accusative case in Polish and Russian discussed in Section 2 was tied to grammatical function, independently of the phrase-structure position of the argument bearing this function. However, in a theory like GB or Minimalism, functions are defined positionally, so "structural" case can only be dispensed in certain c-structure configurations, with the relevant constituents then rearranged to obtain the desired "surface" word order. Such theory-motivated complications do not arise in LFG. Another area where LFG's interfaced modularity made rather interesting empirical predictions was argument alternations, some of which might affect the correspondence between argument structure and syntactic functions, while others might additionally interfere with the semantic representation of events (Section 2.5).

Moreover, as mentioned by an anonymous reviewer, LFG is different not only from transformational grammar but also from structuralist approaches which view language as a hierarchy of multiple levels (this view is also implicit in a lot of general/descriptive linguistic work). In LFG, the levels are parallel, which allows for a much more natural view of the interaction between them.

3.3 Exocentric S

Finally, using the exocentric S node (or equivalents), essentially a string which does not comply with X-bar schemata, also proved expedient in capturing the flexibility of Slavic syntax, similarly to the way it has ensured improved description of other non-configurational languages (see the rest of this volume, as well as Bresnan et al. 2016: 112–116). It was mentioned in Section 2.4 that there were actually several competing but underlyingly similar proposals – either S, a flat VP or a flat IP have been proposed for Slavic languages, including Russian, Bulgarian and Polish. LFG admits all of those as it does not constrain the rules of syntactic structure by demanding strict binary branching or X-bar theoretic templates at any cost (though see Bresnan et al. 2016: Chapter 6, Lovestrand & Lowe 2017). Whichever of those solutions a researcher adopts will bring the desirable consequence of more accurate modelling – allowing the requisite surface freedom of constituent arrangement, without scrambling transformations from deep structures which may be empirically hard to justify.

4 Conclusion

It has been my aim throughout this chapter to highlight the contribution of LFG to understanding and describing Slavic languages in a theoretically illuminating way, at the same time pointing out how Slavic material has in turn contributed to adjusting and updating the formal apparatus of LFG, for instance augmenting the sets of agreement attributes. The chapter has demonstrated that the typological pliability of LFG is well suited to Slavic data and enhances our understanding of it, especially the interplay between "free" word order and information structure, agreement, case assignment and negation phenomena, alternations in the argument structure of verbs or pro-drop and verbless clauses, among other processes. On the other hand, Slavic data has posed some challenges to the design and principles of LFG, notably the existence of genuinely subjectless sentences, which might call for revising or abandoning the Subject Condition. Many of the debates continue and are likely to shed more light on the actual linguistic material as well as the best theoretical tools to explore it with. Needless to say, a great deal more remains to be done in order to attain fuller coverage of Slavic grammar.

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Part VII

Comparing LFG with other linguistic theories

Chapter 37

LFG and Cognitive and Constructional Theories

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Goldberg's (Cognitive) Construction Grammar and Langacker's Cognitive Grammar are compared with LFG. The comparison to be made involves differences in the notions coded in the representations recognized in these theories. It is shown that information factored out in different structures in LFG is often coded in a single structure in the two theories examined. Once such differences are recognized, a fruitful comparison of analysis is possible, in spite of apparent differences in the areas of interest in language and the conceptualization of grammar.

1 Introduction

In this chapter, I will compare LFG with cognitive and constructional theories of grammar. I will specifically discuss the (Cognitive) Construction Grammar (CxG) of Adele Goldberg, and Cognitive Grammar (CogG) of Ronald Langacker. These two theories have several commonalities, including the nonderivational, parallel-structure architecture of grammar, the central role of form-meaning pairs, the embodiment of the usage-based view of grammar, and the cognitive-linguistic conceptualization of language. These pose interesting similarities and differences in their comparison with LFG.

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2 Construction Grammar

2.1 What is Construction Grammar?

2.1.1 The characteristics of Construction Grammar

Construction Grammar (CxG) originates in the work of Charles Fillmore in the 1980s, when he began to work on the noncompositional properties of syntactic units larger than the word (e.g. Fillmore 1988, Fillmore et al. 1988; see Fillmore 2020). His thinking was further developed by Adele Goldberg's work on Argument Structure Constructions (Goldberg 1995, 2003, 2006, 2019). Over the years, various versions of Construction Grammar have emerged, including Radical Construction Grammar (Croft 2001), Embodied Construction Grammar (Bergen & Chang 2005), Sign-based Construction Grammar (Boas & Sag 2012), and Fluid Construction Grammar (Steels 2011). (I will not attempt a comparison of these theories; see Hoffmann & Trousdale 2013 for a survey). Culicover & Jackendoff's (2005) Simpler Syntax is also a version of construction grammar (see Varaschin 2023 [this volume]). Langacker's Cognitive Grammar, which will be discussed later in Section 3, also incorporates the notion of construction (Langacker 2003, 2005). The idea of construction has also been applied to the area of morphology in the work of Riehemann (1998) and the Construction Morphology of Booij (2010, 2018).

The constructional view cuts across the distinction between formalist and cognitivist theories of grammar. One of the more formal versions of Construction Grammar is Sign-based Construction Grammar, which is a variant of HPSG (Pollard & Sag 1994; see also Sag 2010 and Müller 2021). In this chapter, I will mainly consider Goldberg's, which is often called Cognitive Construction Grammar (Goldberg 2006: 214) due to the influence of the ideas of Lakoff (1987) as seen in the role of metaphor and prototype (see Section 2.1.2 for the role of metaphor). I will briefly touch on other theories encompassing the notion of construction.

CxG takes the notion of construction as central. Constructions are conventionalized clusters of syntactic, phonological, semantic, and pragmatic properties. According to Fillmore and Goldberg, construction manifests at all levels of linguistic structures: sentence, phrase, word, and morpheme, etc. This view is encapsulated in the slogan "it's constructions all the way down" (Goldberg 2006: 18).

One example of a sentence-level grammatical construction is given in (1).

(1) Comparative correlative construction (Covariational conditional construction):
The higher you go, the cooler it becomes.

The comparative correlative construction in (1) has a number of formal and semantic properties unpredictable from the forms/meanings of its parts and the normal rules of their combinations (see Goldberg 2006: 6; see also Culicover & Jackendoff 2005; Hoffmann 2019). The concatenation of two clauses without a conjunction is unusual in English, and so is the parallel structure involving the preposing of *the* plus comparative. The meaning of correlation cannot be reduced to any of its parts (i.e. there is no overt lexical item indicating correlation, such as the conjunction *as*), although the sense of correlation is implicit in the formal parallelism of the two clauses. It is argued that properties of sentences like (1) must be stated with the pairing of form and meaning at a unit larger than the word, suggesting that the notion of the sign can be extended to nonlexical units, with consequences on the status of compositionality in grammar. One can thus say that CxG focuses on the subregularities found in grammatical combinations, unlike theories like LFG that pay attention to regularities and broad generalizations.

Goldberg's CxG incorporates the usage-based view of grammar and language acquisition: the representation of grammar is shaped by language use (see Langacker 1988, Barlow & Kemmer 2000, Bybee 2006, Diessel 2015, 2019). This is reflected in the view that "item-specific knowledge co-exists alongside generalizations" (Goldberg 2006: 12), which is implemented in the hierarchy of constructions in CxG (see Section 2.1.2). It also means that knowledge of grammatical constructions includes the frequency with which the forms are used (Goldberg 2006, Diessel 2015, Perek 2015), and language acquisition is seen as the process of making generalizations over the specific constructions (Goldberg 2006, Goldberg et al. 2004, Tomasello 2003). Such a usage-based view of grammar is largely shared by the probabilistic and exemplar-based LFG (Bresnan & Hay 2008, Bresnan & Ford 2010), though perhaps not by all practitioners of LFG.

What is regarded as a construction has changed somewhat over the years. In Goldberg (1995: 4), a construction is defined as a form-meaning pair in which "some aspect of form or function is not strictly predictable from its component parts." In Goldberg (2006: 5), the range of constructions was widened to include fully predictable patterns "as long as they occur with sufficient frequency." More recently Goldberg states that one needs to keep track of all uses in order to know whether a form-meaning pair occurs with sufficient frequency, and therefore speakers have representations of form-meaning pairs regardless of their frequency. She now defines constructions as "emergent clusters of lossy [i.e. not specified in full detail] memory traces that are aligned within our […] conceptual space on the basis of shared form, function, and contextual dimensions" (Goldberg 2019: 8).[1]

2.1.2 Argument Structure Constructions

Some constructions such as Ditransitive, Caused motion, Resultative constructions, relate to argument structure, and are thus called Argument Structure Constructions (Goldberg 1995, 2003, 2006, 2019, Boas 2003, Barðdal 2008). Take the example of the Caused motion construction exemplified in (2).

(2) Caused motion construction:
Susan sneezed the napkin off the table.

What motivates the constructional status of Caused motion is that verbs which normally do not subcategorize for an object and an oblique, such as *sneeze*, can appear with them in this construction. Goldberg argues that the argument structure and the semantics of caused motion in (2) come from the construction, and not from the verb. Goldberg represents the form and meaning of this construction as in (3).

(3) Caused motion construction, Goldberg (2006: 73):

Form	Meaning
[Subj V Obj $\text{Obl}_{\text{path/loc}}$]	[X causes Y to move $\text{Z}_{\text{path/loc}}$]

In Goldberg's view, the roles that a verb has and those that a construction has are different, and are called *participant roles* and *argument roles*, respectively. The participant roles of the verb (e.g. sneezer of the verb *sneeze*) is linked to the argument roles of the construction in the way represented in Figure 1. Participant roles are based on the semantic frame of a verb (cf. Fillmore 1982), and bear names specific to the event described (e.g. sneezer) rather than thematic role names. The *Coherence Principle* (Goldberg 1995) ensures that only those participant roles compatible with argument roles can be "fused" or linked.

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[1] I would like to add a brief comment on Construction Morphology (CxM; Booij 2008, 2010, 2018; see also Chen & Matsumoto 2018). CxM is influenced by Goldberg's CxG. CxM is a theory of morphology in which complex words are analyzed in terms of constructions (pairs of form and meaning), which are represented in the form of constructional schemas (e.g. $[[x]_A\text{-ness}]_N \leftrightarrow$'the property/state of A'). In this theory the lexicon lists both constructional schemas and words that instantiate them, which are organized in a hierarchical network, as in Goldberg's CxG.

One significant similarity of CxM and LFG lies in the "full-entry" view of lexical items (Jackendoff 1997, Jackendoff & Audring 2019). This means that in CxM, words including inflected forms are fully formed and listed in the lexicon, as in LFG. In this respect, CxM is highly compatible with LFG.

Sem	CAUSE-MOVE	⟨	cause	goal	theme	⟩
	| R		|	⋮	|	
R: means	SNEEZE	⟨	sneezer			⟩
	↓		↓	↓	↓	
Syn	V		SUBJ	OBL	OBJ	

Figure 1: Composite structure of Caused motion + *sneeze* (Goldberg 1995: 54)

An important notion in CxG is the notion of a *constructional network* (Goldberg 1995, 2006). A network of constructions is built through *inheritance links*, through which many of the properties of particular constructions are motivated by more general or larger constructions. There are several types of inheritance links. One is *metaphorical extension links*, which are posited when two constructions are related by metaphorical mapping in the sense of Lakoff & Johnson (1980). Goldberg states that the Resultative construction is metaphorically inherited from the Caused motion construction (Goldberg 1995), as shown in Figure 2.[2]

Instance links are posited when a specific construction is a special case of a more general construction. Broad generalizations are captured at the level of general constructions which are inherited by more specific constructions. Subregularities are captured by positing constructions that are at lower levels of the network. An ultimate case of specific construction is fully instantiated sentences specified with lexical items. Goldberg (2006: 55) argues that even general constructions are stored in the mental lexicon together with specific examples that are highly conventional and frequent (e.g. *Give me a break* as an instance of the Ditransitive construction). In such a case, she argues, it is clear that both generalizations and instances are stored. CxG allows for such redundancy because specific constructions (including specific examples) are often associated with idiosyncratic meanings and special pragmatic functions. Moreover, speakers have knowledge of the frequencies of specific instances, providing evidence for the inclusion of such instances in grammar for even highly compositional constructions.

It is also important to note that expressions inherit from several constructions due to *multiple inheritance* (Goldberg 1995, 2003). For example, (4) inherits not just from the Caused motion construction but also from the Subject-auxiliary inversion and Passive constructions.

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[2] In contrast, Jackendoff (1990) treats the two constructions as parallel instantiations of the same thematic structure, with different semantic field features (see Goldberg & Jackendoff 2004: note 13).

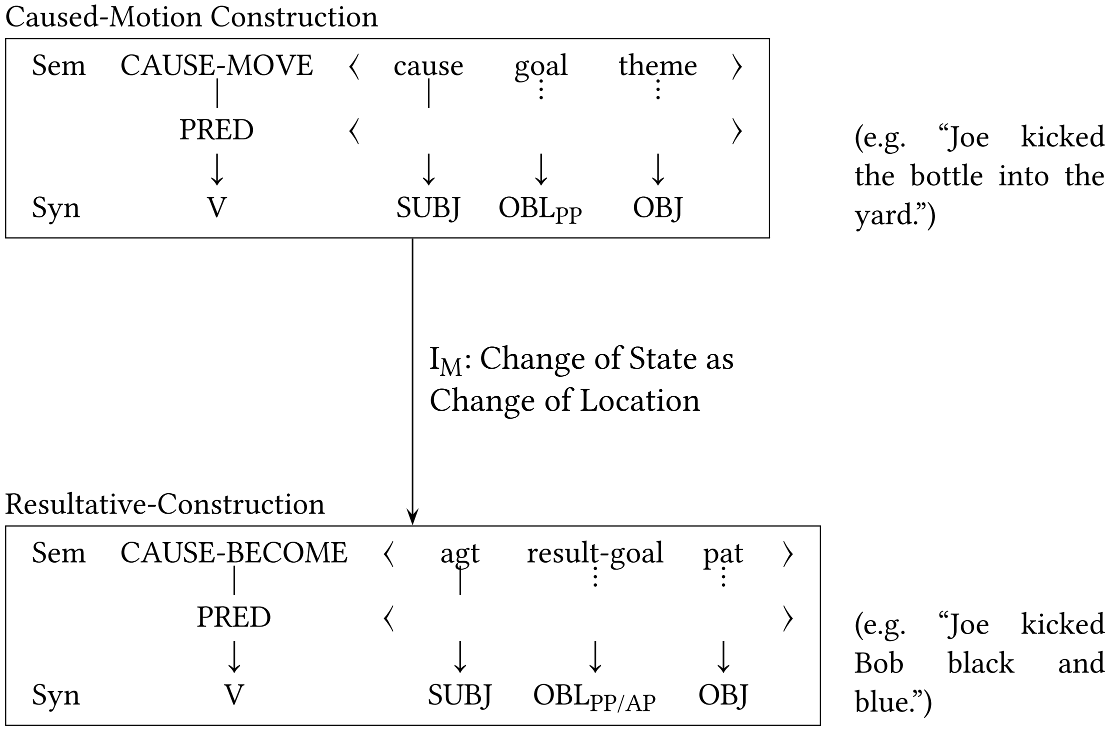

Figure 2: Caused motion construction and Resultative construction (Goldberg 1995: 88)

(4) *Was the ball thrown into the net?*

Goldberg’s (1995) theory of argument structure constructions was criticized within the CxG community for the generality of constructions posited and the underestimation of the role of verb meanings; see Boas (2003) and Iwata (2008, 2020) for models in which verb meanings play greater roles.

2.2 CxG and LFG

2.2.1 Factorization of grammar in CxG and LFG

CxG is, like LFG, a nonderivational theory of grammar, in which two representations (form and meaning) are not derivationally (i.e. transformationally) related but exist in a parallel way. In comparing LFG and CxG, it is worthwhile to consider what sort of factorization of grammar is achieved in different representations in the two theories. LFG recognizes c- and f-structures as grammatical structures, in which different grammatical information is coded (Kaplan & Bresnan 1982), and p-structure, a-structure, s-structure and i-structure in addition, in order to represent other information (see Dalrymple et al. 2019). In contrast, Goldberg's CxG recognizes two representations, form and meaning.

One issue to consider is which LFG grammatical structure the form in CxG corresponds to. In some cases, it appears to correspond to c-structure. The form of some constructions, such as lexically filled idioms (e.g. *give the devil his due*), includes the sound forms of words and linear order, which are c-structure information. In the formulation of the Caused motion construction in (3), however, the form contains linearly ordered grammatical functions, and thus contains parts of c-structure and f-structure information. The formalization of forms in CxG is eclectic.[3]

Goldberg's CxG contrasts with some other constructional theories, which have stricter separation of phonology and grammar. Jackendoff (1997), Jackendoff & Audring (2019) and Booij (2010), for example, adopt the tripartite Parallel Structure Architecture, involving phonological, syntactic, and semantic structures. In these theories, constructions are a set of these three structures.[4]

The way Goldberg uses the term *form* has been discussed by Langacker (2005) and Verhagen (2009). Langacker points out that the form in Goldberg's CxG (as well as Croft's Radical CxG) is in many cases not phonological and therefore is not truly the form. He argues that the form must not include grammatical information, which must reside in the relationship between the form and the meaning (see Section 3).

One may note that Goldberg's formulation of the formal properties of argument structure constructions shows some influence of LFG, as can be seen in the use of grammatical functions such as SUBJ, OBJ, and OBL (though Goldberg often uses the categorial term PP in place of OBL). Sometimes she has even used

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[3] The following quote from Goldberg (2013) reveals her thinking over formalism in her construction grammar.

> I have avoided using all but the most minimal formalization in my own work because I believe the necessary use of features that formalism requires misleads researchers into believing that there might be a finite list of features or that many or most of the features are valid in cross-linguistic work. The facts belie this implication. The meanings or functions of words and constructions do not lend themselves to semantic decomposition [...] and often-suggested syntactic primitives such as noun, subject, agreement, or agent actually vary crosslinguistically as well [...] (Goldberg 2013: 30)

It is to be noted that there has not been much discussion on the phrase structures or phonology of sentences in CxG.

[4] Jackendoff recognizes tiers within a structure. One of them is the Grammatical Function Tier, which represents grammatical functions separately from phrase structure (Culicover & Jackendoff 2005: Chapter 6).

the LFG term XCOMP to refer to result phrases in the Resultative construction (e.g. Goldberg 1995:3), though not in her later writings (e.g. Goldberg 2006).

2.2.2 Construction, lexical integrity, and the lexicon

The most important difference between CxG and LFG lies in the role of the syntax-lexicon distinction. LFG treats the Principle of Lexical Integrity as central (Bresnan & Mchombo 1995, Bresnan 2001), by which syntax cannot operate into the internal structure of words. Bresnan (2001: 91) formulates this idea as: "Morphologically complete words are leaves of the c-structure tree and each leaf corresponds to one and only one c-structure." This principle suggests a clear division of syntax and the lexicon. LFG also assumes that all features of the whole are shared by those of its head, ensured by the up-equals-down functional annotation on the head. In contrast, all grammatical entities (e.g. phrases, words, and morphemes) are constructions in CxG, and in this sense there is no strict division between syntax and the lexicon. Syntactic and lexical constructions differ in their internal structure, but they are essentially the same pair of form and meaning (Goldberg 1995: 7). In addition, CxG acknowledges that the properties of a construction may differ from those of its head, as can be seen in the argument structure involved in the Caused motion construction in (2).

There have been attempts to treat constructional properties in LFG. Kaplan & Bresnan (1982) placed the special properties of an idiom *keep tabs on* in a lexical entry of *keep*, which calls for a specific object to be used in the meaning of 'observe'. Alsina (1996) and Butt (1995) went somewhat beyond what is normally expected from lexical integrity in LFG and recognized the case where two nonadjacent lexical items form one complex predicate (a single predicate in f-structure: see Andrews 2023 [this volume]). They argue that the mechanism of predicate composition creates a single predicate in such a case, and formulate how a complex a-structure maps onto a single predicate in f-structure (see Findlay et al. 2023 [this volume]).

Asudeh et al. (2013) argue for an analysis incorporating constructions that preserves lexical integrity. They distinguish between Phrase-structurally flagged constructions (such as the Swedish Directed Motion Construction; see Lødrup 2023 [this volume], and Lexically flagged constructions (such as the English *way*-construction; see Goldberg (1995: Chapter 9)). In the former case, a special construction-specific phrase structure rule is posited, which encodes the subcategorization frame of the construction and introduces a template containing information on the special properties of the construction. In the latter, such a template is introduced by the key lexical item in the construction. In this view, lexical integrity is preserved, but the subcategorization is now constructionally captured in terms of c-structure rules and the subcategorization specified in the lexicon is only a default one (see Asudeh et al. 2013: 27–29). It appears that this analysis can capture some properties of sentential constructions. It is not clear, however, whether Asudeh et al. (2013) would like to apply this sort of analysis to all cases of Goldberg's constructions, which would result in a large number of construction-specific phrase-structure rules. See Müller (2018) for discussions of Asudeh et al. (2013), and Findlay (2019) for a more recent treatment of multi-word constructions in LFG.

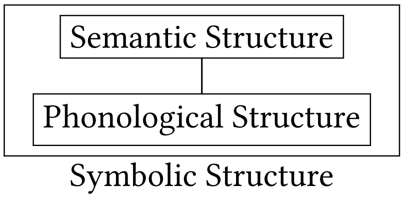
3 Cognitive Grammar

3.1 What is Cognitive Grammar?

Cognitive Grammar (CogG) is a theory developed by Ronald Langacker and his associates (Langacker 1987, 1990, 1991, 1999, 2008, 2009, Van Hoek 1995, Kumashiro & Langacker 2003: etc.). The theory grew out of Langacker's dissatisfaction with generative grammar, which he once adhered to. CogG abandons Chomsky's autonomy thesis (grammar is independent of semantics or matters of language use) and regards "language as an integral facet of cognition" and grammar as "inherently meaningful" (Langacker 1987: 509). For Langacker, the goal of linguistic investigation is to characterize language as a cognitive entity. In this respect CogG is part of the linguistic endeavor known as Cognitive Linguistics, along with works by Lakoff (1987) and others. While theories like LFG are interested in the the roles of different grammatical information, such as grammatical cateogories and functions, CogG is interested in the semantic import of grammatical notions.

CogG posits only semantic structure, phonological structure, and symbolic links between the two, based on the "symbolic" view of language, as shown in (5).

(5) Symbolic structure of Langacker:



Unlike CxG, Langacker posits the form part of the symbolic structure as purely phonological (Langacker 2005: 104). The lexicon, morphology and syntax in CogG reside in the way the phonological and semantic structures are linked, and there is no independent grammatical structure in CogG. In this respect CogG crucially differs from LFG.

Langacker (1987: 53) adopts the *content requirement* for entities used in his representations: only those elements that are part of the directly apprehended primary data or those that emerge from them by means of "basic psychological phenomena of schematization and categorization"[5] are permitted in grammar. This has led to the elimination of syntactic notions in CogG:

> Semantic structures, phonological structures, and symbolic links between them are the minimum needed for language to serve its communicative function. Cognitive Grammar is thus maximally austere in claiming that only these elements are necessary. (Langacker 2005: 106)

CogG, like Goldberg's CxG, embodies the usage-based view of language (see Langacker 1988, 2000). Langacker was the first to use the term *usage-based* (Langacker 1987: 46), and for him this meant that, unlike generative grammarians, grammar lists "the full range of linguistic conventions, regardless of whether these conventions can be subsumed under more general statements" (Langacker 1987: 494). Thus, grammar includes not just high-level broad generalizations but also low-level, limited-range generalizations that speakers can make out of the particular forms they are exposed to, a view which influenced Goldberg (see Section 2.1 above). Recent usage-based research has shifted to corpus-based frequency studies, but Langacker himself has not engaged in corpus-based frequency study.

3.2 CogG and LFG

3.2.1 Nature of representations

Langacker's CogG may appear to have little resemblance to LFG, and there has not been much interaction between the two theories. The adoption of image-schematic representation in CogG (see below) may strike LFG practitioners as quite alien, and the CogG abandonment of key grammatical notions used in LFG may lead one to think that any comparison is hopeless. Therefore an important purpose of this section is to try to find commonalities and areas of comparison.

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[5] By schematization, Langacker means "the process of extracting commonality inherent in multiple experiences to arrive at a conception representing a higher level of abstraction," and by categorization, "the interpretation of experience with respect to previously existing structures" (Langacker 2008: 17).

There *are* some interesting similarities between the two theories, inviting meaningful comparison. Cognitive Grammar is a nonderivational theory in which different structures coexist without any derivational (i.e. transformational) relationship between them, as in LFG. CogG recognizes two structures, phonological structure and semantic structure, as noted above. It is beneficial to compare the phonological structure of CogG with LFG's c-structure and p-structure, and the semantic structure with f-structures and a-structure.

Phonological structure encodes surface formal groupings and linear order, and in this sense it encodes part of the information found in LFG c-structure. It also lacks empty categories, again similar to c-structure, in which they are avoided, used only as a last resort (see Kaplan & Zaenen 1989, Bresnan 1998, Bresnan et al. 2016: Chapter 9). Unlike c-structure, however, it does not contain category labels and *syntactic* phrase structure. The formal groupings that Langacker envisages are more phonological than syntactic. The phonological structure of the sentence (6a) is simply (6b), rather than (6c) (Langacker 2003: 79).

(6) a. *Bill said Joe believes Roger is angry.*
b. Bill said / Joe believes / Roger is angry.
c. [Bill said [Joe believes [Roger is angry]]]

Langacker argues that the grammatical constituency (embedding) often assigned for sentences like (6a) is in fact conceptual groupings, and does not exist in the phonological structure. Langacker's phonological structure is thus more similar to the p-structure in LFG proposed in Bögel et al. (2009), in which prosodic phrasing is encoded.

The most characteristic aspect of CogG is the adoption of the *image-schematic* representation in the semantic structure. The semantic structure is exemplified in Figure 3, which represents the semantic structure of *near the door*.

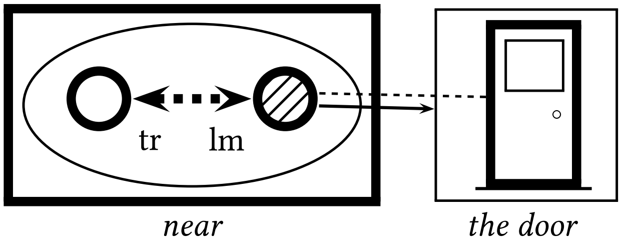

Figure 3: The semantic structure of *near the door* (Langacker 2008: 201)

The preposition *near* represents a relationship (represented by a bidirectional arrow) between two entities (represented by circles) within a vicinity (represented by an oblong area). The slashed entity is elaborated by the semantic structure of *the door*, with elaboration represented by a thin arrow), and the dotted line represents identity. (The abbreviations "lm" and "tr" refer to "landmark" and "trajector" respectively, which will be expounded later.)[6]

Note that the semantic structure includes not just what is foregrounded (*profile*) in the meaning of each expression but also what is in the background (*base*), such as the vicinity border. Profiles are indicated in thicker lines. The box for *near* is profiled since it is the head of the phrase *near the door*.

In the two structures seen above, we see an attempt to encode different information in a different kind of representation with its own geometry and categories, as is the case with LFG. Although the particular representations chosen are very different, we see in both theories attempt to find alternatives to phrase structure trees that have been used to represent all kinds of linguistic information. The two theories thus share the spirit of *liberating linguists from phrase structure trees* so familiar to linguists through Chomsky's generative grammar. In LFG, this is seen in the adoption of attribute-value matrices for f-structure, in which functional information is coded (Kaplan & Bresnan 1982). In CogG, it is seen in the adoption of image-schematic representation for the semantic structure seen above.

3.2.2 Phrase structure,grammatical categories and grammatical functions

CogG clearly differs from LFG in terms of the (lack of) belief in the independent grammatical structure and grammatical notions. In CogG, there is no phrase structure, grammatical categories or grammatical functions *per se*. CogG's phonological structure does not code syntactic constituency, as noted above. According to Langacker, constituency is in fact conceptual groupings. There is no independent representation in which grammatical categories or grammatical functions are stated, either. What is represented is the *conceptual import* of these notions.

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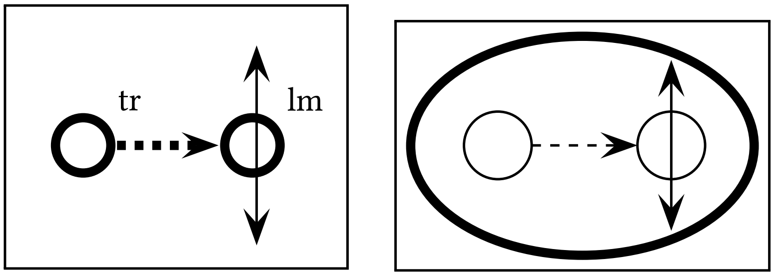
[6] Concerning the nature of semantic structures, Langacker (2008: 12) states the following:

> yet another [misconception] is that the schematic images they employ purport to be direct depictions of conceptual structure. The actual intent of these diagrams is rather more modest: to allow certain facets of conceptual organization to be represented in a format that is both user-friendly and explicit enough to serve as a basis for semantic and grammatical analysis.

CogG adopts a "notional approach" to grammatical categories (Rauh 2010). Grammatical categories are defined in terms of the nature of the profile in the semantic structure. Nouns designate Things; Verbs designate Processes; Adjectives, Adverbs, and Prepositions designate Atemporal Relationships. In this view, the verb *choose* can be represented in Figure 4a, and the noun *choice* (in the sense of the action of choice) in Figure 4b.



a. *choose* (V) b. *choice* (N)

Figure 4: Semantic structures for *choose* and *choice* (Langacker 2008: 100)

Here, a circle represents a Thing, and an arrow, a Process. While the verb *choose* profiles a Process involving two Things, for the noun *choice* (in the sense of the action of choosing) the whole Process is construed as a Thing (represented by a large oblong circle). The two refer to the same event, but they represent different *construals* of the event.

Grammatical functions are not recognized per se, either, in sharp contrast to LFG. Subject and Object in CogG are nominals which designate *prominent* participants in semantic structure. Among the participants of a relational expression like a verb and a preposition, the one given primary focal prominence is called a *Trajector* (tr), and the one given secondary focal prominence is called a *Landmark* (lm). In the case of a verb, the former is the subject of the verb, and the latter, the object. This is illustrated in Figure 5, which represents the semantic structure of a transitive verb in the Active, Passive, and Middle uses (e.g. *I opened the door*; *The door was opened*; *The door opens easily*). (The double arrows represent processes involving the transmission of force; single arrows represent changes; Δ indicates that a participant is left unspecified.)

The three are identical in terms of the *action-chain* represented (the energy source of which is agent, which acts on the patient, which undergoes a change). However, the three representations differ in the participant construed as a Trajector; it is agent in the case of Active, and patient in Passive and Middle. Note also that agent in the Middle verb (which is not an argument of the verb) is represented though not profiled. Langacker's semantic structure includes this sort

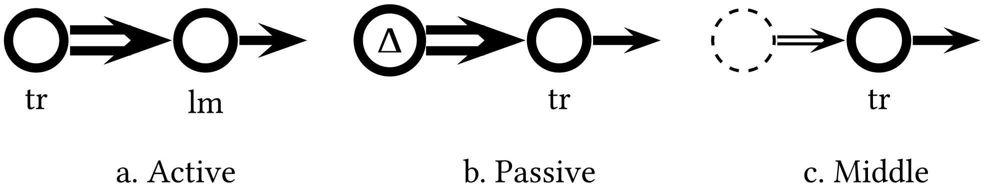
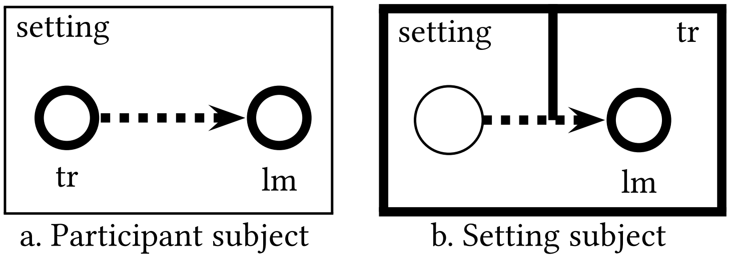


Figure 5: Image-schematic representation of Active, Passive and Middle (Langacker 2008: 396)

of entity existing in the background of the profiled process, unlike LFG's f- and a-structure.

The notion of Trajector is utilized to make generalizations that would involve SUBJ in LFG. As is well known, a subject is more likely to be the controller of verb agreement, the antecedent of reflexive pronouns, the controller of the embedded predicative complement, etc. According to Langacker, such phenomena are *symptoms* of the underlying cognitive salience of the Trajector (Langacker 1987: 235). Thus, Japanese subject honorification, which makes reference to SUBJ in f-structure in LFG analyses (Ishikawa 1985, Matsumoto 1996), is analyzed in CogG in reference to the Trajector of a predicate (participant subject; Kumashiro & Langacker 2003, Kumashiro 2016) (see the trajector in Figure 6a). CogG additionally recognizes the setting subject or the subject of a clause, utilized in sentences like *Friday saw a big event*, represented by the Trajector in Figure 6b. Kumashiro (2016) claims that Japanese reflexivization makes reference to the subject in this sense as an antecedent.



a. Participant subject b. Setting subject

Figure 6: Two notions of subject in CogG (Langacker 2008: 389)

Kumashiro (2016) argues that both are present in the double subject construction in Japanese. The participant subject corresponds to LFG's SUBJ in f-structure, while the setting subject may correspond to TOPIC in i-structure at least in some cases.

The correspondence of Trajector and Landmark to SUBJ and OBJ in LFG helps elucidate a CogG analysis of Subject-to-Object raising (Langacker 1995) in LFG terms. Langacker (1995) represents the semantic structure of the sentence *I expect Don to leave* as in Figure 7.

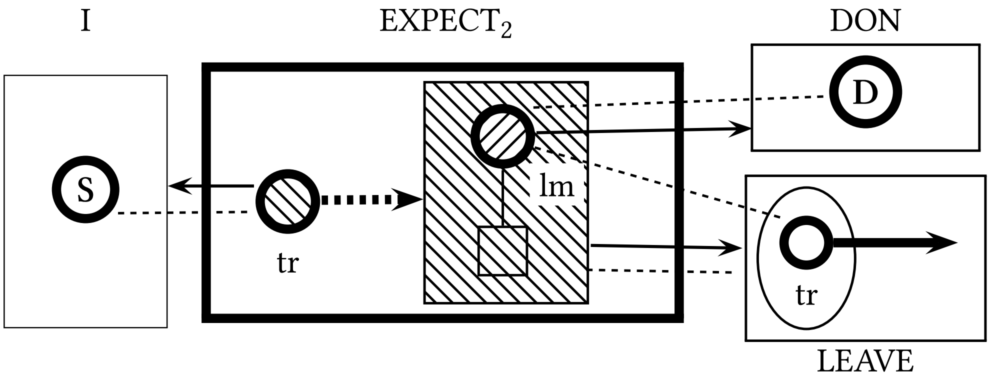


Figure 7: The semantic structure of *I expect Don to leave* (Langacker 1995: 34)

In this structure, the whole process of DON's leaving is the target of the process of the verb *expect*, represented by the dashed arrow pointed at the whole process of DON's leaving rather than the circle representing DON. (In contrast, an arrow representing the process of control verbs such as *persuade* would touch the circle representing DON.) On the other hand, it is DON that is given the Landmark status (indicated by a thick circle) with respect to the process of *expect*, which means that it is an object of the verb.

What is crucial in Subject-Object raising is that the main verb process takes something other than its semantic participant as its Landmark. This discrepancy is allowed since DON is the "reference point" for DON's leaving, which is its "active zone" (indicated by shading, as in Figure 7) with respect to the verb *expect*. An active zone of a reference point with respect to a process is an entity that in fact participates in the process, even though the metonymically related reference-point entity appears in (surface) forms.

One can establish a parallelism of this analysis with the LFG analysis of raising in Bresnan (1982a). The landmark status of DON in the semantic structure of EXPECT corresponds to the OBJ status of *Don,* and the Trajector status of DON in the semantic structure of LEAVE corresponds to its SUBJ status in the embedded structure (XCOMP). The lack of contact of the point of the dashed arrow and the Landmark represents the nonthematic status of the OBJ; the active zone with respect to the raising predicate EXPECT corresponds to an XCOMP (which allows the most salient entity inside it (i.e. SUBJ) to be related to an upper PRED); and the dotted line linking the Landmark of EXPECT and Trajector of LEAVE represents (the conceptual import of) functional control.[7]

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[7] Note the following statement of Croft (1999: 108): "Although Langacker is at pains to demonstrate how radically opposed his theoretical framework is to the formalist research tradition (and to a great extent this is true), nevertheless even a committed formalist should be able to identify the essence of his analysis."

From LFG's point of view, CogG's semantic structure encodes information of different characters, which is factored out in different structures in LFG. From CogG's point of view, information coded in the semantic structures is all of the same sort, since they are conceptual imports of such grammatical notions as grammatical functions and categories.

4 Concluding remarks

In this chapter, I have compared (Cognitive) Construction Grammar and Cognitive Grammar with LFG. We have seen some general differences between LFG and those two theories: emphasis on subregularities (CxG) vs generalizations (LFG) and emphasis on grammatical categories (LFG) vs their semantic import (CogG). We have also seen that information factored out in different structures in LFG are often coded in a single structure in the two theories examined. In spite of such differences in the areas of interest in language and the conceptualization of grammar, I have hopefully shown that a comparison of these two theories with LFG is more fruitful than might have been thought, once the nature of information coded in the structures recognized in each theory is understood.

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Chapter 38

LFG and Dependency Grammar

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This chapter discusses Dependency Grammar from the perspective of LFG. I first introduce the key ideas behind Dependency Grammar and how they relate to LFG concepts. I then show how both LFGs and Dependency Grammars can be translated into Multiple Context-Free Grammars to study formal differences between the frameworks. Next I discuss two recent efforts to translate from LFG analyses to the version of Dependency Grammar adopted in Universal Dependencies. Finally I show how Glue semantics can be applied to dependency structures.

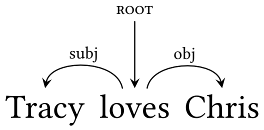
1 Introduction

Dependency Grammar (DG) is a tradition for syntactic analysis based on binary, asymmetric relations (called dependency relations or just *dependencies*) between words. These relations are typically labelled, giving rise to a set of labels that can be thought of as grammatical functions, which are of course also important in LFG. In fact, the correspondence between dependencies in DG and grammatical functions in LFG and their central role in both theories is the main similarity, formally and conceptually, between the two frameworks.

The primacy of dependencies is what holds together work in the DG tradition. As we will see, it is characteristic of almost all DG theories that they acknowledge a level of syntax that we will call the *core dependencies*. This is a set of dependencies restricted so as to form a tree over the words of a sentence, i.e. a structure where each word has exactly one head, except the root word, which has none (or equivalently, is attached to a synthetic root node). (1) shows a very simple example of this.

Dag Haug. 2023. LFG and Dependency Grammar. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 1829–1859. Berlin: Language Science Press. DOI: 10.5281/zenodo.10186040

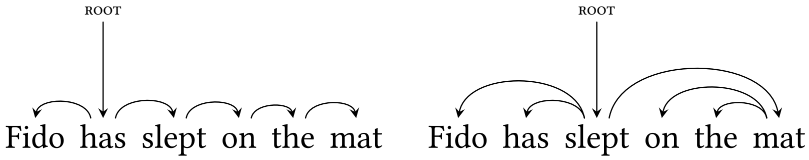
(1)



Most theoretical work and concrete analyses have seen the need to introduce additional mechanisms or levels of structure beyond core dependencies to give the theory more analytical bite; this goes all the way back to Tesnière (1959), the founding work of modern DG. However, there is typically little agreement about the additional mechanisms or levels of structure between individual scholars working in the DG tradition. So, while the core dependency representation is often acknowledged as theoretically inadequate, it has enjoyed considerable popularity as a simplified representation with practical applications in computational linguistics and natural language processing.

But even restricting attention to core dependencies, there are a number of choice points where different dependency frameworks make different decisions. For example, when the core dependencies model structures with a lexical word and one or more function words (for example, articles and nouns, auxiliaries and full verbs, or prepositions and their complements), we must take a stance on whether the lexical or the functional word is the head: the co-head option often used in LFG is not available. (2) shows what the (unlabelled) dependency structure of a simple sentence would look like if we take function words as heads (left) or lexical words as heads (right).

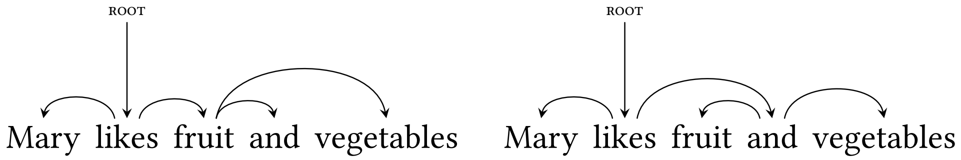
(2)



It is obviously not necessary to treat all function words the same, and so there are intermediate variants between these two extremes, taking for example prepositions and articles as heads, but not auxiliary verbs.

Another point at which dependency grammarians diverge is the treatment of coordination. Because coordination is normally thought of as symmetric, it is not easy to represent with directed dependencies. Here the most common competing analyses, shown in (3), involve taking the first conjunct as the head (left), which entails giving up on symmetry; or to make the conjunction the head (right) and maintain symmetry, but at the cost of dissociating the conjuncts from their normal head (e.g. the verb), which is the basis for most morphosyntactic and semantic constraints.

(3)



Faced with the choices illustrated in (2) and (3) many linguists in the DG tradition have felt that neither analysis is satisfactory, and they have therefore reacted by enriching the dependency formalism in various ways that result in data structures that have more in common with LFG. I discuss some key examples of this in Section 2. Even if much theoretical work in DG assumes such enriched data structures, most practical applications of DG rely on core dependencies, thereby forcing choices that, at least from an LFG perspective, are somewhat arbitrary.

One key difference between DG and LFG is that dependency grammarians typically do not formalize their work and in many cases do not provide (even informal) rules that generate the constructions they are interested in but content themselves with providing analyses of the whole structure. This goes back to the earliest dependency grammarians such as Tesnière, but has become even more prominent with the increasing use of dependency structures in data-driven parsing, where the goal is not to define a grammar that recognizes (or generates strings from) a formal language, but to parse strings into a single plausible structural representation. Nevertheless, it *is* possible to conceive of DGs as formal grammars. In Section 3 I discuss how this can be done using the framework of Multiple Context-Free Grammars. While this is not an approach that most dependency grammarians follow, it yields a useful framework for comparing DG and LFG. Another useful perspective on DG and LFG is offered by recent efforts to translate LFG resources into DG resources, which I discuss in Section 4. Section 5 explores the potential for combining dependency grammars with Glue semantics, the standard semantic framework in LFG.

2 The dependency grammar tradition and LFG

The idea of using binary, labelled, asymmetric relations to analyze syntax is found in the work of Pāṇini, Ancient Greek and Roman grammarians and the speculative grammarians of the Middle Ages (Covington 1984). On its own, this idea is too vague to define a theoretical framework and both Pāṇini and the speculative grammarians have also been seen as forerunners of generative grammar (Kiparsky 1993, Chomsky 1966). What defines the modern dependency grammar tradition, which started with Tesnière (1959), is the attempt to base syntax primarily, or even exclusively, on the concept of core dependencies, as opposed to the concept of constituency developed in American structuralism and the generative tradition. Although there have been a number of attempts to develop dependency grammar into a full-fledged grammatical theory (the most well-known ones being Functional Generative Description (Sgall et al. 1986); Meaning–Text Theory (MTT) (Mel'čuk 1988); and Word Grammar (Hudson 1984, 2010)), none of these are very widespread beyond the environments where they originated and hence there is no single, coherent version of DG as a formal framework. The focus of this section is therefore not to identify assumptions made in specific frameworks, but rather to compare ideas that are common in the dependency grammar tradition with LFG.

2.1 Dependency graphs and f-structures

There is an obvious similarity between dependencies, as found in DG, and the binary, labelled, asymmetric relations between the nodes of an LFG f-structure.[1] In both cases, the relations form a directed labelled graph over nodes corresponding to linguistic material. The similarity even extends to the set of labels used, which in both cases contain traditional grammatical functions such as subject and object. Formally, however, there are two important differences: First, the nodes of the f-structure are not words, but correspond to zero, one or several words/c-structure terminals. This is how LFG escapes the indeterminacy of direction of headedness in constructions which combine lexical and functional words that we saw in (2). Second, labelled dependencies are not necessarily functional, i.e. there may be two or more daughters bearing the same relation to the same head, in violation of LFG's uniqueness condition.[2]

In addition to these two formal differences, there are in practice many more differences, because DG analyses rarely use the full power of a directed graph and instead typically emphasize the core dependencies, which form a tree spanning the words of the sentence. To the extent that e.g. multiple heads are used, one of the heads is typically considered "primary". Even so, the formal similarities

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[1] To emphasize the parallelism between f-structures and dependency graphs, we rely here on the graph-theoretic interpretation of attribute-value matrices, where feature structures and atomic values are nodes, and attributes are labelled edges between these nodes, and not the "official" interpretation of f-structures as functions (Kaplan 1995, Kaplan & Bresnan 1982). The graph-theoretic interpretation is standard in most other unification-based frameworks from Functional Unification Grammar (Kay 1979) onwards, and was, to my knowledge, first formalized by Moshier & Rounds (1987). It is used in HPSG (Richter 2021); see Przepiórkowski 2023: section 4 [this volume] for discussion of the differences between the two views.

[2] LFG can deal with several dependents bearing the same relation by using set-valued attributes e.g. for ADJUNCT; this introduces the concept of sets, which also has no counterpart in DG.

between dependencies and f-structures mean that similar theoretical questions can arise in both DG and LFG and even that one can think of LFG's f-structures as dependency graphs that take a particular view on certain foundational questions in DG.[3]

An overarching question in the DG tradition (see e.g. de Marneffe & Nivre 2019: 199f.) is whether dependency relations are sufficient for analyzing syntax. In one sense, the answer is obviously no. Like f-structures, dependency structures say nothing about word order. This is dealt with in the c-structure in LFG, and scholars within dependency grammar have also seen the need to enrich the theory with a mechanism for constraining word order. I return to this in Section 3. But more fundamentally, one might ask whether core dependencies, tree structures over words, are sufficient to capture functional aspects of syntax like f-structures do in LFG.

In fact, it is not too hard to see that core dependencies cannot fully represent the functional relations of a sentence. Consider for example, the subject in a raising construction.

(4) It seems to rain.

The expletive *it* bears a functional relation to the raising verb *seems* as witnessed by agreement; but the form of the expletive is licensed by the lexical verb *rain* (and would be different in e.g. *There seems to be a problem*), giving evidence for a second functional relation. If one insists on core dependencies, one of the two relations must be privileged.

The alternative is to increase the expressivity of the theory, and this is in fact what Tesnière did when he introduced two other kinds of relations beside dependencies that can hold between words, namely junction (*jonction*) and transfer (*translation*). Junction is the relation that holds between coordinated items that are either dependents of the same head or heads of the same dependent. Translation is the relation that holds between lexical words and functional words that license their appearing in various dependencies. For example, complementizers "translate" verbs so as to license their appearing in object position according to the analysis in Tesnière (1959: 24); similar analyses are given for determiners and adpositions.

Crucially, words that are linked by junction or transfer form a complex node (*nucleus dissocié*) in the dependency graph and jointly contract dependency relations. In this way, their dependents end up having more than one head; and they

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[3] Furthermore, on the implementation side, Bröker (1998) shows how DGs can be encoded as LFGs and implemented in the XLE platform.

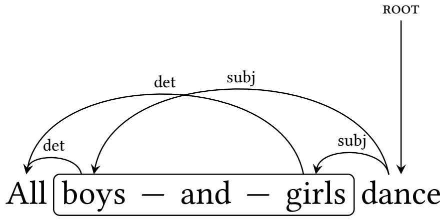
can collectively bear a single dependency relation to their head. In this respect, Tesnière's analyses are in fact quite close to standard LFG f-structures, where coordination is analyzed in terms of a set-valued attribute (5) and function words such as e.g. auxiliaries form a single f-struture node with their lexical verb (6).

(5) a. All boys and girls dance.

b.

$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{dance}\langle\textsc{subj}\rangle\text{’} \\ \textsc{subj} & \left\{ \begin{matrix} \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{boy}\text{’} \\ \textsc{spec} & \boxed{1}\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{all}\text{’} \end{bmatrix} \end{bmatrix} \\ \\ \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{girl}\text{’} \\ \textsc{spec} & \boxed{1} \end{bmatrix} \end{matrix} \right\} \end{bmatrix}$$

c.

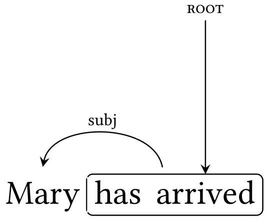


(6) a. Mary has arrived.

b.

$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{arrive}\langle\textsc{subj}\rangle\text{’} \\ \textsc{tense} & \textsc{perfect} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{Mary}\text{’} \end{bmatrix} \end{bmatrix}$$

c.



In this respect, both Tesnière's theory and LFG's f-structure reject the idea that syntactic dependencies can be adequately captured in a tree structure over the words of a sentence. Nevertheless, LFG's approach is much more general than Tesnière's. Tesnière allows many-to-one relations between words and dependency nodes based on relations that are not dependencies, but he maintains the tree structure over dependency nodes. Therefore, the only way a word can have two heads is if those heads form a single node by junction or transfer, as in (5c) and (6c); but LFG also allows for a word to have two heads that do not form a group, as in the analysis of functional control verbs (7).

(7) a. Chris persuaded Mary to come

b. $$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{persuade}\langle\textsc{subj, obj, xcomp}\rangle\text{’} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{Chris}\text{’} \end{bmatrix} \\ \textsc{obj} & \boxed{1}\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{Mary}\text{’} \end{bmatrix} \\ \textsc{xcomp} & \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{come}\langle\textsc{subj}\rangle\text{’} \\ \textsc{subj} & \boxed{1} \end{bmatrix} \end{bmatrix}$$

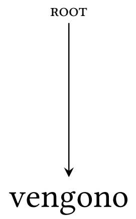
Such dependencies cannot be expressed in Tesnière’s formalism, because *persuade* and *come* share the dependent *Mary*, despite not forming a group. Moreover, *Mary* bears a different syntactic relation to each of them, which again is not possible in Tesnière’s formalism. More recent versions of dependency grammar have typically accounted for control and raising verbs by positing more levels of representation, see Section 2.2.

Finally, an important difference between Tesnière’s dependency graphs and f-structures is that f-structures may contain nodes that correpond to no overt word. A typical case is pro-drop, as in (8) from Italian.

(8) a. vengono
come-PRS.3PL

b. $$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{come}\langle\textsc{subj}\rangle\text{’} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \end{bmatrix} \end{bmatrix}$$

c.



Again, Tesnière’s formalism cannot capture this: dependency nodes may correspond to one word, or more words if they form a group by junction or transfer, but not to zero. The strategy in later versions of DG has been the same as that used to address phenomena where LFG uses structure sharing, namely to introduce more levels of representation.

In sum, one can say from an LFG perspective that Tesnière’s dependency graphs, while certainly more expressive than core dependencies, are insufficiently general to deal with the complex functional relations that exist in natural language sentences.

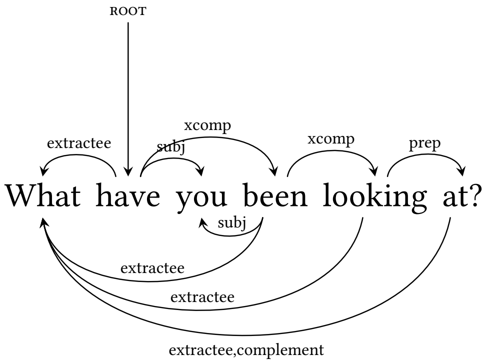
2.2 Other levels of syntactic representation

Tesnière's strategy was to enrich dependency graphs so as to be able to represent more functional relations than core dependencies can do. More recent versions of DG have instead opted to keep the core dependencies simple and instead go beyond a single level of grammatical description to accommodate more information. One prominent example is the so-called tectogrammatical layer found in Functional Generative Description (Sgall et al. 1986) and the associated Prague Treebanks (Hajič et al. 2020). This layer is annotated with an enriched dependency tree that will contain nodes that do not correspond to words (e.g. pro-dropped subjects) and secondary edges capturing multiple head-phenomena such as control.[4]

Melčuk's Meaning–Text Theory explicitly distinguishes a deep syntactic level between the semantic level and surface syntax. However, as pointed out by Kahane (2003), the deep syntactic level is the least defined level of MTT and it is not clear how much information it is supposed to contain. What is clear, however, is that grammatically imposed coreference relations are resolved in deep syntax, opening up a way to deal with, e.g., control.

In Word Grammar (Hudson 1984, 2010), too, control is treated by loosening the tree constraint on dependency structures. Example (9), from Hudson (2003: 521), illustrates how structure sharing is used to analyze raising (*you* shared by *have* and *been*)[5] and extraction (*what* shared by *have*, *been*, *looking* and *at*).

(9)



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[4] The status of the tectogrammatical layer is not entirely clear: the Prague Dependency Treebank annotation guidelines (https://ufal.mff.cuni.cz/pdt2.0/doc/manuals/en/t-layer/html/ch02.html) say that it "represents the semantic structure of the sentence", but Hajič et al. (2020) describe it as "deep syntax". The difference may be merely terminological.

[5] Instead of Hudson's *sharer*, I have used the LFG relation XCOMP which Hudson explicitly mentions as an alternative name for the same concept. The diagram in Hudson (2003: 521) does not have a subject relation between *you* and *looking*, although *looking* is an XCOMP of *been*. It is unclear whether this is just an error.

The dependency graph in (9) is essentially identical to the standard LFG analysis (except that in extraction, LFG usually has structure sharing only between the gap and the filler position, without involving the intermediate f-structures). However, in Word Grammar, the edges above and below the words have different status:

> This diagram also illustrates the notion 'surface structure' […]. Each dependency is licensed by the grammar network, but when the result is structure-sharing just one of these dependencies is drawn above the words; the totality of dependencies drawn in this way constitutes the sentence's surface structure. In principle any of the competing dependencies could be chosen, but in general only one choice is compatible with the 'geometry' of a well-formed surface structure, which must be free of 'tangling' (crossing dependencies – i.e. discontinuous phrases) and 'dangling' (unintegrated words). There are no such constraints on the non-surface dependencies." (Hudson 2003: 521)

This illustrates the point that I made in the introduction: different varieties of dependency grammar may have different notions of "deep syntax", but they all share the idea that there is an interesting representation of syntactic dependencies that is a rooted tree over nodes that stand in a one-to-one correspondence with the words of the sentence. This is very different from LFG: all edges of an f-structure graph are equal. The subject edge that connects the subject of a control construction to the control verb has exactly the same status as the subject edge that connects the subject to the non-finite verb. Thus, there is no "privileged subgraph" of the f-structure that forms a rooted tree over the words. By contrast, Hudson's distinction between the surface structure and the non-surface dependencies gives rise to such a privileged subgraph, although it must be said that the distinction between surface and non-surface dependencies is not further developed in Word Grammar.

Dependency grammars also differ in their treatment of "null words", i.e. cases where LFG would have an f-structure node that does not correspond to any surface word, as in e.g. pro-drop. Most dependency analyses would simply leave out such subjects, as we saw in (8). But here too, many dependency grammars introduce the missing subjects in "deeper" projections, for example in the tectogrammatical layer of Functional Generative Description. In fact, Word Grammar is one of the few dependency grammar frameworks that acknowledge empty elements in the core syntactic graph. Creider & Hudson (2006) present an argument for this that runs along standard lines of LFG thinking. In Ancient Greek, predicate nouns and adjectives agree in case (and adjectives also in number and gender) with their subjects; and subjects of infinitives are in the accusative.

(10) Ancient Greek (Xenophon, Anabasis 1.3.6)
nomízo: gàr humâ:s emoì eînai kaì patrída kaì
think-1.PRS for you-ACC me-DAT be-INF and fatherland-ACC and
phílous
friends-ACC
'For I think you are to me both fatherland and friends'

But crucially, the predicative is accusative also when the accusative subject is absent (11), even in cases where there is a coreferential element in the higher clause (12).

(11) Ancient Greek (Isocrates 2.15)
philánthro:pon eînai deî
humane-ACC be-INF must
'one must be humane'

(12) Ancient Greek (Plato, Alcibiades 2, 141a7)
exarkései soi túrannon genésthai
suffice-FUT you-DAT king-ACC become-INF
'it will be enough for you to become king'

In (12), we observe that the predicate noun *turannon* does not agree directly with its logical subject *soi*, but rather with the unexpressed subject of the infinitive. Since case agreement is generally agreed to be syntactic (whereas agreement in number and gender could potentially be semantic), Creider & Hudson (2006) conclude that the unexpressed subject of the infinitive must nevertheless be present in the syntax. This is unsurprising from an LFG point of view, but does not seem to be generally accepted in DG. It is unclear, for example, how Functional Generative Description would deal with this kind of data, since null words are inserted only at the tectogrammatical layer, where there is no case feature.

3 Word order and generative power in DG and LFG

In most versions of dependency grammar, it is assumed that the nodes of a dependency structure are not linearly ordered in themselves: a dependency relation implies no particular linear order between a head and its dependents, but can be related to different surface linearizations. This view goes back to Tesnière (1959: chapter 7), who distinguishes sharply between structural order (dependencies) and linear order. The main exception to this is Functional Generative Description, which assumes a linear order on the nodes even in the tectogrammatical layer, to capture information structure.

But even if the nodes of the dependency structures are not linearly ordered, it is possible (and in fact necessary for most languages) to constrain the relation between dependency structure and linearization. One much-discussed constraint is *projectivity.*[6]

(13) A dependency graph is projective iff for every edge $n_h \rightarrow n_d$ it contains, n_h dominates all nodes that occur between n_h and n_d (where domination is the transitive closure of the edge/dependency relation)

An early result due to Gaifman (1965) is that projective dependency grammars are weakly equivalent to context-free grammars.[7] This result may in fact have led to a lack of interest in dependency grammar because it was widely believed in the sixties and seventies (and eventually proved in the eighties) that natural languages are *not* context-free. On the other hand, the recognition problem for a dependency grammar with no linearization constraints at all (thus allowing arbitrary discontinuities) is NP complete (Neuhaus & Bröker 1997).[8]

With the increasing popularity of dependency grammars in the 2000s, this led to the search for *intermediate* linearization constraints between strict projectivity and arbitrary non-projectivity. One important class of constraints is based on the notion of *block degree* (Holan et al. 1998). Intuitively, projectivity as defined in (13) ensures that the subgraph of n_h (i.e. n_h and the set of nodes it dominates) forms a single block of adjacent nodes. We can instead allow the subgraph to form *two* blocks of adjacent nodes, interrupted by a continuous set of words. We say that n_h has block degree 2; and the block degree of a dependency tree is the highest block degree of any of its nodes. Equivalently, we can speak of gap degree, which is block degree minus 1 (i.e., the number of allowed gaps). (14) illustrates this with an example from Latin.

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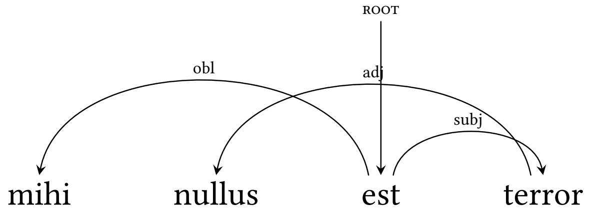
[6] It seems that this term originated with a technical report by P. Ihm and Y. Lecerf "Eléments pour une grammaire générale des langues projectives", Bruxelles 1960, but I have been unable to find this paper.

[7] See also Hays (1964).

[8] As we will see in Section 4, this is not an issue in data-driven parsing, which sidesteps the recognition problem and aims directly at providing a contextually plausible parse.

(14) a. Latin
Mihi nullus est terror
me.DAT none.NOM is fear.NOM
'I have no fear.'

b.


The gap degree of *est* is 0, since its subgraph is continuous; but the gap degree of *terror* is 1, since there is one gap in its subgraph – *est* intervenes between *terror* and *nullus*, but is not dominated by *terror*. As a result, the gap degree of the whole tree is 1.

To study the computational complexity of the dependency grammars that could generate structures like (14), and their relationship to LFG grammars, it is convenient to use phrase structure-based systems that allow discontinuities, so-called Linear Context-Free Rewriting Systems (LCFRS, Vijay-Shanker et al. 1987) or the notational variant Multiple Context-Free Grammars (MCFG, Seki et al. 1991). The MCFG formalism is a generalization of CFG which retains ordinary CFG productions for the expression of categorial structure, but uses explicit *yield functions* to compute the yield of the mother node from the yields of the daughters. In an ordinary CFG, yield computation is conflated with category formation: a rule such as DP → D NP says both that the category DP is formed of a D and an NP, and that the yield of the resulting DP is formed by concatenating the yields of D and NP. In effect, then, a CFG can be seen as an MCFG with concatenation as the only yield function.[9]

To allow for greater expressivity, MCFG allows yields to be *tuples* of strings. For example, we may want to say that the yield of DP is a pair (2-tuple) consisting of the yields of D and NP. This pair will then be the input to further yield functions that apply to productions with DP on the right-hand side. More generally, we may allow yields to be *n*-tuples of strings. The interesting point is that there is a close correspondence between yield components in an MCFG and blocks in a corresponding dependency structure. We can extract MCFG rules from dependency trees, as shown in Kuhlmann (2013), where a formal exposition is given. Here I just provide an intuitive understanding of how the tree in (14b) gives rise to the rules in Table 1.

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[9] See Clark (2014) for an accessible introduction for linguists and Kallmeyer (2010: chapter 6) for a more formal introduction.

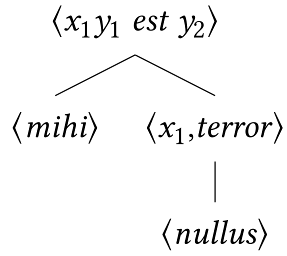
Table 1: Rules extracted from the tree in (14b)

rule	yield function	compact notation
ADJ → $g()$	$g = \langle nullus \rangle$	ADJ → $\langle nullus \rangle$
OBL → $h()$	$h = \langle mihi \rangle$	OBL → $\langle mihi \rangle$
SUBJ → $i($ADJ$)$	$i = \langle x_1, terror \rangle$	SUBJ → $\langle x_1, terror \rangle$ (ADJ)
ROOT → $j($OBL SUBJ$)$	$j = \langle x_1 y_1\ est\ y_2 \rangle$	ROOT → $\langle x_1 y_1\ est\ y_2 \rangle$(OBL SUBJ)

Looking at *nullus* in (14b), we see that it has no dependents, hence the right-hand side of the first rule is a constant function which fixes the yield to the string *nullus*, and similarly for *mihi*. For *terror*, things are more interesting. It takes one dependent, an ADJ, and hence its yield function i depends on the value of that argument. Concretely, the yield of the node *terror* is a tuple, consisting of the yield of the ADJ dependent which is represented as x_1,[10] and the string *terror*. Finally, the verb takes two arguments, SUBJ and OBL. The yield is constructed by concatenating the yield of the OBL (i.e. x_1), the first component of the SUBJ (i.e. y_1), the string *est*, and the second component of SUBJ (y_2).

With the rules in Table 1, we can construct the MCFG derivation tree in (15).

(15)



But notice that because the MCFG grammar is lexical, i.e. each rule introduces exactly one lexical item, the tree in (15) is isomorphic to the dependency tree in (14b). In other words, a lexicalized MCFG can simply be interpreted as a dependency grammar which simultaneously restricts word order.

This allows us to compare the generative capacity and the parsing complexity of dependency grammars with other formalisms. Under a reasonable constraint on discontinuities,[11] the expressivity of an MCFG depends only on the maximal

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[10] The convention is that we use x for the yield of the first dependent and y for the yield of the second dependent, and subscript those variables with an index referring to blocks of the yield.

[11] Namely wellnestedness; a tree is wellnested if there are no disjoint subtrees that overlap linearly.

block degree of the grammar, giving rise to a hierarchy of *k*-MCFGs, where *k* is the block degree of the most complex yield function in the grammar. It turns out that 2-MCFGs (and hence dependency grammars that allow maximally one gap) are weakly equivalent to Tree Adjoining Grammars and 'classical' Combinatory Categorial Grammar, as was proven by Bodirsky et al. (2005).[12]

Even more interesting from an LFG perspective, there is also a result that a subclass of LFG grammars, so-called *finite copying LFGs*, can be translated into weakly equivalent MCFGs/LCFRSs (Seki et al. 1993). Finite copying LFGs are quite restricted in what functional annotations they allow, in particular they do not allow head annotations (↑=↓) or reentrancies, and also impose the crucial constraint that the grammar puts an upper bound on the number of c-structure nodes corresponding to a single f-structure. Wedekind & Kaplan (2020) show that we can impose this upper bound while still allowing head annotations and reentrancies, as long as they are nonconstructive. This allows most functional equations that are used in linguistic work, including functional control equations of the type (↑ F G)=(↑ H). Wedekind & Kaplan (2020) call these grammars *k*-bounded LFGs and prove that for any *k*-bounded LFG, a weakly equivalent *k*-MCFG can be constructed. Moreover, the MCFG rules can be annotated with functional descriptions that allow us to construct the f-structure that the corresponding *k*-bounded LFG assigns to the sentence, yielding a strongly equivalent MCFG.

These results allow us to compare dependency grammars and LFGs in a precise way. First of all, dependency grammars and *k*-bounded LFGs are weakly equivalent. Nevertheless, although strongly equivalent MCFGs can be constructed from both dependency grammars and *k*-LFGs, it is not the case that we can construct a strongly equivalent dependency grammar from an LFG. The interpretation of an MCFG as a dependency grammar relies on unique lexicalization: each rule contains a single lexical item interpreted as the head. The MCFGs that Wedekind & Kaplan (2020) construct from LFGs are not lexicalized in this way. They do contain functional descriptions that allow us to identify the head but, since LFG allows co-heads, the head is not guaranteed to be unique. Moreover, the functional descriptions in the MCFG constructed from an LFG may contain reentrancies, i.e. words having more than one head, which have no interpretation on the dependency grammar side, thus losing information. A final, minor point is that Kuhlmann's interpretation of MCFGs as dependency grammars say nothing about edge labels; it would be natural and straightforward to interpret LFG's ordinary function assignments as such labels.

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[12] See also Kuhlmann (2007, 2010).

In sum, then, the formal analysis tells us that the difference between *k*-bounded LFGs and dependency grammars resides exactly in the availability of co-heads and reentrancies, which provide important information from a linguistic point of view. Finally, it should be noted that the restriction to *k*-bounded LFGs, while preserving coverage of many, perhaps most, linguistic phenomena, is nevertheless not trivial. Rambow (2014) argued that unbounded scrambling as found in German and other free word order languages falls outside the generative capacity of MCFGs (and mildly context sensitive grammar formalisms in general) and hence *k*-bounded LFGs.

The comparison of dependency grammars and LFGs through MCFGs is also interesting from other points of view. As Wedekind & Kaplan (2020) point out, the effect of converting an LFG to an MCFG is to precompute the interaction between f- and c-structure and construct a grammar that recognizes all and only the c-structures whose f-descriptions are satisfiable. From a practical point of view, this may be an advantage in parsing. But from the perspective of theoretical LFG, it can be argued that MCFGs and the dependency grammars they give rise to conflate c- and f-structure, making it harder to state linguistic generalizations. The advantage of LFG's projection architecture is precisely "to account for significant linguistic generalizations in a factored and modular way by means of related but appropriately dissimilar representations" (Kaplan 1989: 309). Seen from the dependency grammar side, the formal results offer a choice: Kuhlmann's translation to MCFGs makes it possible to enrich dependency grammars with an account of word order in a single component; but Wedekind & Kaplan's (2020) results show that MCFGs can be "modularized" into a word order component and a functional component (which is not surprising given that MCFGs generalize CFGs precisely by dissociating dominance and linearization) to give something very close to LFG. Either way, the formal analysis exposes similarities and differences between the frameworks. In principle, this paves the way for cross-fertilization on the theoretical side, but in practice such gains are limited by the fact that, as I pointed out in Section 1, dependency grammarians typically do not think in terms of (formal or informal) rules that generate the constructions they are interested in but content themselves with providing analyses of the whole structure.

4 DG and LFG in computational linguistics

4.1 Data-driven dependency parsing

On the computational side, there is a similar difference between DG on the one hand, and LFG and most other formal linguistic traditions on the other hand, in that there has generally been little interest in developing formal grammars that can generate or parse languages. There are some exceptions to this: in the framework of Constraint Dependency Grammar (Maruyama 1990), there is for example a broad-coverage parser of German (Foth et al. 2005); and Constraint Grammar (Karlsson et al. 1995) is a widely used system in which implemented grammars have been created for a wide variety of languages. Many of these grammars content themselves with assigning syntactic function labels to words, without building a full syntax tree, but even so, many have proven useful in practical tasks.

Nevertheless, the dominant use of DG in computational linguistics is closely associated with machine learning approaches where computers find patterns in human annotated data. For such approaches, it is sufficient that annotators provide case-by-case analyses of the corpus without actually abstracting the rules that would create these analyses. Consistency remains a goal, since it makes the patterns easier to learn, but it is not enforced in the way it would be in grammar-based annotation such as typical scenarios for creating LFG parsebanks, where annotators choose between alternative analyses provided by the underlying grammar.

As we have seen several times so far, the constraints on core dependency syntax, namely the unique mother and the one-to-one correspondence between nodes and tokens, mean that many theoretically relevant distinctions cannot be encoded. On the flip side, this makes the annotation task easier as the annotator does not have to be trained in drawing the distinctions. The result is also often more accessible to end users: while grammar-based treebanks contain much more information than dependency trees, this information is typically encoded in a specific theoretical framework and not always easily accessible to users without training in that framework. In short, core dependency trees offer a tradeoff between practical considerations and theoretical depth, which may be attractive for many applications where the deeper linguistic distinctions do not matter much.

On top of that, the simple target structure makes it possible to train very efficient statistical dependency parsers. This approach is fundamentally different from the formal grammar approach to DG developed by Kuhlmann (2013), which we saw in Section 3. Data-driven parsers learn from human annotation and try to provide the most plausible parse in context, without judging acceptability or enumerating possible parses. In this context, non-projective dependencies are not an issue and can be captured efficiently (McDonald et al. 2005). Nivre (2008) introduced algorithms that could produce projective dependency parses in time linear of the input and algorithms that allow non-projective parses and run in quadratic time. Such results led to a huge increase of interest in dependency parsing, which quickly became dominant in statistical approaches to computational linguistics.

Data-driven parsing requires annotated data and the last decade has seen a large increase in the number of dependency treebanks that are available, especially driven by the Universal Dependencies (UD) initiative.[13] UD developed out of the Stanford dependencies for English (de Marneffe & Manning 2008) (which means that there is a certain amount of LFG heritage) as an effort to create an annotation scheme that can be used across languages. Though it has been driven mainly by practical considerations in NLP research, it has in recent years also been used for linguistic research (e.g. Hahn et al. 2020, Berdicevskis & Piperski 2020).

As of release 2.9 (November 2021), UD contains 217 treebanks from 122 languages. A comparison with LFG's ParGram approach reveals the strengths and weaknesses of the approach.[14] Drawing on the long tradition of using DG to provide case-by-case analyses rather than abstracting grammars has made it possible to achieve an unprecedented breadth of coverage. On the other hand, the analyses are more shallow than those provided by LFG grammars and the lack of underlying grammars makes the UD project much more prone to inconsistencies both within and across treebanks.

4.2 Converting LFG parsebanks to dependency treebanks

The existence of annotated resources in both LFG and DG formats makes it possible to study differences between the two from a different perspective than the formal language approach we adopted in Section 3. In this section, we look at work on converting LFG-based resources to dependency structures to see how the two formats compare and to what extent information can be preserved when converting to the less expressive DG format.

For completeness, we mention that there has also been some work on enriching them to yield LFG-structures, e.g. by Forst (2003) and Haug (2012). However, both Forst and Haug started from relatively rich dependency annotations (with secondary edges), so that the conversion to f-structures was not difficult and

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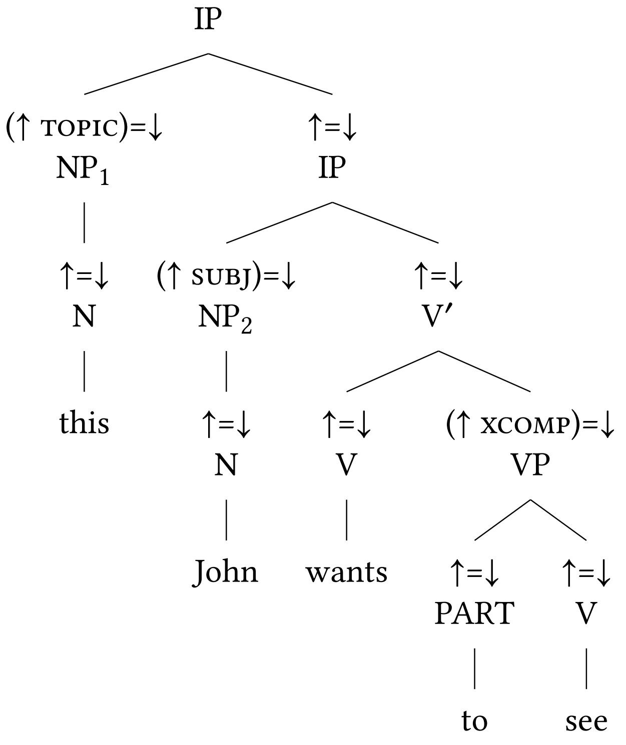
[13] See https://universaldependencies.org/ and de Marneffe et al. (2021).

[14] For more on ParGram, see Forst & King 2023 [this volume].

other issues were more important (e.g. the creation of c-structures from the dependency representations by Haug).

Several conversion algorithms have been developed to convert LFG structures to dependency structures. Here I discuss two recent approaches, by Meurer (2017) and Przepiórkowski & Patejuk (2020),[15] which contrast in interesting ways, since Meurer starts from the c-structure and Przepiórkowski and Patejuk from the f-structure. Both are natural starting points: the f-structure represents grammatical functions, just like the target dependency structure; but the c-structure has the advantage that its terminal nodes are in one-to-one correspondence with the words of the sentence, just like in the dependency structure. Both algorithms target the particular style of dependency annotation adopted in UD, but proceed in two steps, namely first the creation of a dependency structure, and second, the modification of that structure to comply with the exact representation chosen in UD. Here we focus on the first step. To illustrate how the two algorithms work, we consider the LFG structure in (16)–(17).

(16)



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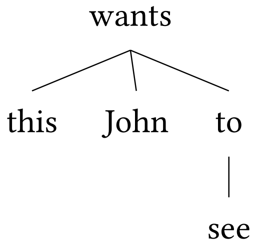
[15] Dione (2020) presents an approach that combines Meurer (2017) and Przepiórkowski & Patejuk (2020). For older work, see Øvrelid et al. (2009) and Çetinoğlu et al. (2010).

(17)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{want}\langle\textsc{subj, xcomp}\rangle\text{'} \\ \textsc{topic} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{pro}\text{'}\end{bmatrix} \\ \textsc{subj} & \boxed{2}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{John}\text{'}\end{bmatrix} \\ \textsc{xcomp} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{see}\langle\textsc{subj, obj}\rangle\text{'} \\ \textsc{subj} & \boxed{1} \\ \textsc{obj} & \boxed{2} \end{bmatrix} \end{bmatrix}$$

In Meurer's approach, the first step is to "lexicalize" the c-structure tree by recursively replacing each non-terminal node with its functional head node, as determined by the annotation $\uparrow=\downarrow$. This is straightforward for IP, NP$_1$ and NP$_2$ in (16): *wants*, *this* and *John* are uniquely linked to these nodes via an unbroken chain of $\uparrow=\downarrow$. But more generally, the challenge here is the same as in lexicalizing an MCFG that results from the Wedekind-Kaplan construction: co-heads and absence of heads mean there might be no unique daughter to lift. To find a unique head in such cases the algorithm proceeds as follows: 1) if no daughter of x is a functional head, attach all daughters to the mother of x and proceed as before; 2) if more than one daughter of x is a functional head, choose the one with the shortest embedding path; 3) if there is a tie, choose the leftmost node. For the VP in our example, case 3 applies and we choose *to* as the head; it is therefore lifted to the VP node, while *see* is only lifted to the V node. These lifting operations yield the tree in (18).

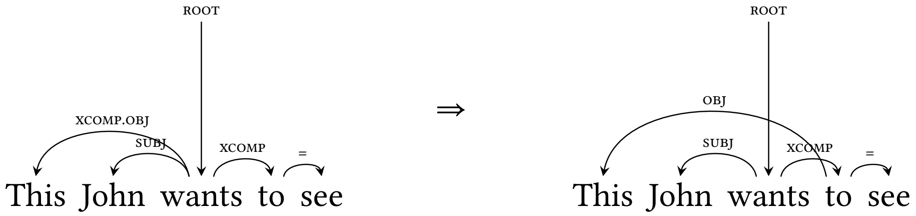
(18)



We then need to label the edges. Meurer's algorithm does that by labelling the edge between nodes x and their daughter y in the resulting tree with the f-structure path from $\phi(x)$ to $\phi(y)$. So, the edge from *John* to *wants* is labelled subj since that is the path from the f-structure of *wants* to the f-structure of *John*. But because of reentrancies in the f-strucure, the path between two f-structures is not always unique: for example, there is a path from the f-structure of *wants* to the f-structure of *this* that is labelled topic, but there is another path that is labelled xcomp obj. In such cases, Meurer chooses the shortest path that contains only grammatical functions (i.e. no discourse functions); in our case that yields the complex label xcomp.obj where the two elements of the f-structure path have been concatenated with a dot. Co-heads present another problem for the labelling approach: *to* and *see* share the same f-structure, so there is no path. In such cases a dummy relation = is used.

This algorithm produces a projective dependency graph with complex labels, as shown for our example in the lefthand side of (19). In the next step, the complex labels are resolved and nodes attached accordingly, potentially introducing non-projectivity. For our example, when the complex relation xcomp.obj is resolved, we obtain the non-projective tree on the right-hand side of (19).

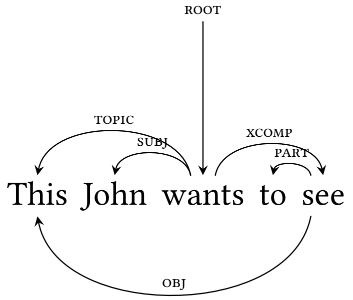
(19)



This then is the input to the final step, where the dependency tree is normalized according to the UD annotation standard.

Przepiórkowski & Patejuk (2020), by contrast, start from the f-structure, which already represents the syntactic dependencies. This means the challenge is different, namely to match the nodes of the f-structure to the words of the sentence, which are the nodes of the target dependency graph. F-structure nodes may correspond to zero, one or several words; they are given by the ϕ^{-1}, which is part of the source annotation. F-structures that correspond to no words (e.g. in pro-drop) may simply be ignored in the dependency structure; but for f-structures that correspond to more than one word, the “true” head that will take the f-structure’s place in the corresponding dependency structure must be identified, and the other words in ϕ^{-1} must be attached with appropriate relations. The basic algorithm is simple: if there is a verbal token in ϕ^{-1}, choose that as the true head; otherwise, choose a nominal or adjectival token; otherwise an explicit lexical conjunction. The other nodes are then attached to the true head with a relation labelled by their own preterminal category. This produces the structure in (20) from the f-structure in (17).

(20)



As we can see, the output from the algorithm of Przepiórkowski & Patejuk (2020) is not a tree, but a graph, where all f-structure relations are preserved, including two incoming edges to *this*. This is exploited to produce enhanced UD, which allows for this kind of graph structure; but the output is also trimmed to produce a basic UD structure.

(19)–(20) illustrate the output of the first steps in the conversions, where the target is to produce the desired data structure, namely a dependency tree or graph over words. As mentioned, the next step is to normalize this structure to the concrete requirements of the UD annotation standard. This is less interesting from our point of view, but it is worth looking at a few topics that display divergences between standard LFG solutions and choices that are made in the dependency grammar community as exemplified by UD.

First, UD subscribes to the primacy of content words. This means that content words are typically heads of function words, for example in structures consisting of auxiliary and verb, adposition and noun, and determiner and noun, as illustrated in the lower graph of (2) in Section 1. Also, there are no nested structures of function words, so e.g. in structures with multiple auxiliaries (*may have been understood*), all the auxiliaries attach directly to the lexical verb. While UD may be extreme among dependency grammar approaches in adopting this principle across the board, similar analyses are found for some of these structures in other frameworks. By contrast, such analyses are non-existing in the LFG literature, except for noun-determiner structures (where the determiner is often analyzed as a SPEC dependent of the noun): function words are typically either co-heads, or lone heads, taking a lexical word as their dependent. For example, there are analyses of auxiliaries as co-heads specifying features of the f-structure where the lexical verb contributes the PRED, and alternative analyses where auxiliary verbs take XCOMP dependents, potentially in a cascading sequence ending in the lexical verb.

In fact, the difference between the co-head analysis and the UD dependent analysis of function words is rather slight, as revealed by the conversion procedure of Przepiórkowski & Patejuk (2020). In f-structures that have functional co-heads, the lexical head will be chosen as the head during conversion, and hence the function words will end up as dependents. And in fact, given that UD uses a flat structure for multiple function words means that the two representations are more or less equivalent, a point made in the UD documentation too,[16] where it is said that function word relations are different from dependency relations between content words and in fact form Tesnière-style nuclei.

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[16] https://universaldependencies.org/u/overview/syntax.html

This in turn opens the door to theoretical cross-fertilization. What are good criteria for choosing between the two analyses? The UD argument is that primacy of lexical words maximizes parallelism across languages, and the exact same argument has been raised in the LFG literature (Butt et al. 1996). On the other hand, Dyvik (1999) has countered that this leads to a stipulative, rather than empirical, notion of language universality and also that it can lead to analyses that are language-internally unmotivated. Recently, Osborne & Gerdes (2019) criticized the UD approach and argued that functional words should always be heads. They were apparently unaware of the LFG literature on the topic, perhaps because it is cast in terms of co-heads vs. XCOMPs. But as we have seen, the difference between a co-head analysis and a UD-style annotation is very slight, and so the arguments made in the LFG context are certainly relevant also for the DG community.

The other main divergence between initial dependencies, as resulting from the conversion algorithms, and the target UD structures concern coordination. Here LFG makes use of an additional data structure, sets, which have no equivalents in standard dependency grammar or in UD. (Although as we saw above, Tesnière's junction comes close.) There are many competing analyses of coordination in the dependency literature,[17] maybe suggesting that the basic data structure of dependency trees is ill-suited to model coordination, as Tesnière argued. The UD choice is to take the first conjunct as the head and attach the other conjuncts to it with a special dependency relation CONJ, whereas conjunctions and punctuation marks are attached to their following conjunct with CC and PUNCT. It is known that this annotation style cannot capture all important structural differences, such as the difference between a dependent of the first conjunct and a shared dependent of multiple conjuncts, or different style of nested coordinations. The conversion procedure exposes this lack of expressivity, but also makes it possible to quantify its effect. As observed by Przepiórkowski & Patejuk (2020), only twelve out of 21,732 utterances in the Polish LFG structure bank are effected.[18]

More generally, Przepiórkowski & Patejuk (2020) conclude that the information loss in converting from LFG to (enhanced) UD is in fact negligible, except in the case of pro-drop structures. As the UD effort continues to expand, there is therefore considerable potential for theoretical cross-fertilization.

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[17] And also in (pre-UD) dependency treebanks, see Popel et al. (2013).

[18] See Przepiórkowski & Patejuk (2019) for a proposal as to how nested coordination could be captured in UD.

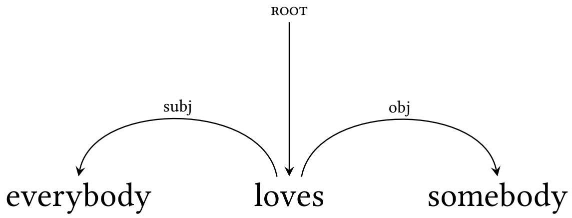
5 Semantics

Tesnière in general pays much less attention to meaning than to structure, but at various points he does talk about semantic dependencies. Several versions of dependency grammars (Functional Generative Description, Meaning–Text Theory) have taken this up and operate with a separate level of semantic structure. There are also various graph-based semantic representation languages such as Abstract Meaning Representation (AMR, Banarescu et al. 2013), which arguably are semantic dependency representations without an accompanying syntactic representation. All such semantic dependency graphs, whether they are coupled to syntax or not, differ considerably from standard logic-based formalizations of meaning as used in LFG and most other formal frameworks. They will not be further discussed here.

Robaldo's Dependency Tree Semantics (Robaldo 2006) is much closer to standard conceptions of formal semantics, as it aims to transform dependency trees into structures that can be interpreted model-theoretically. But for the purposes of comparison with LFG, it is more interesting to observe that Bröker (2003: 308), in his discussion of the formal foundations of dependency grammar, briefly suggested that the similarity between dependency trees and LFG's functional structure could make the application of Glue semantics (Dalrymple et al. 1993, Dalrymple 1999; see also Asudeh 2023 [this volume]) to dependency grammar a promising research area. Gotham & Haug (2018) flesh out this idea and show how to combine Universal Dependencies with Partial Compositional Discourse Representation Theory (Haug 2014).

On the formal side, there are few if any obstacles to such an application. The fundamental idea behind glue semantics is to have linear logic terms guide the composition of corresponding lambda terms. In the first order glue setting, the terms of the linear logic are the f-structures, atomic formulae are formed by applying predicates to the f-structures (in type-theoretic terms, these predicates act like unary type constructors) and complex formulae are formed with ⊸, which acts as a binary function type constructor. Consider (21), which gives the meanings, dependency structure and f-structure for *Everybody loves somebody.* We write e_1 for $e(1)$, i.e. the application of the type constructor/predicate e to the syntactic object/term with index 1.

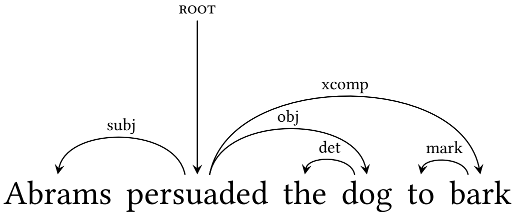
(21)	a.	*everybody*	$\lambda P.\forall x.person(x) \rightarrow P(x)$	$(e_1 \multimap t_2) \multimap t_2$
		somebody	$\lambda P.\forall x.person(x) \wedge P(x)$	$(e_3 \multimap t_2) \multimap t_2$
		loves	$\lambda x.\lambda y.love(x,y)$	$e_1 \multimap e_3 \multimap t_2$

b. 

c. $$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{love}\langle\ \textsc{subj}\ \rangle\text{’} \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{everybody}\end{bmatrix} \\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{somebody}\text{’}\end{bmatrix} \end{bmatrix}$$

Clearly, it makes no difference whether we interpret the glue types in (21a) over the dependency tree in (21b) or the f-structure in (21c): in both cases we just need the same mapping between the indices 1, 2, 3 and the corresponding f-structures or dependency nodes.

However, while the formal properties of the two theories are similar enough that Glue semantics can be used for both LFG and DG, a practical consideration is that dependency trees typically do not contain all the semantically relevant information that we find in the corresponding f-structure. Control structures are a case in point (22).

(22) 

The dependency tree in (22) lacks the information that *the dog* is the subject of *to bark*. However, the label xcomp does tell us that the missing subject of *to bark* is one of the dependents of *persuaded.* As a result, the best we can do is to introduce a discourse referent x_2 that is the subject of the infinitive clause and must be linked to one of the participants in the matrix event, though we do not know which one, unless we have access to the lexical information that *persuade* is an object control verb. We see that it is possible to compensate for some of the information loss in dependency trees, although the result only becomes useful if we have other, lexical information sources available: dependency trees on their own do not typically come with the rich semantic lexical entries that glue (and other formal semantic theories) require. We refer to Gotham & Haug (2018) for more details.

6 Summary

We have seen that the basic relations for analyzing functional syntax, dependencies in DG and grammatical functions in LFG, are very similar, both formally and conceptually. Nevertheless, the focus on core dependencies that is often seen in DG work leaves other levels of analysis less well-developed than in LFG. Word order, in particular, has not received much attention, but we have seen that it can be interestingly restricted through the use of lexicalized MCFGs, offering a point of comparison to LFGs, which can also be translated to MCFGs. Another point of comparison is offered by work on converting LFG parsebanks to dependency treebanks. Finally, we saw that the similarity between DG and LFG also means that they can use the same syntax-semantics interface in the form of Glue semantics.

All in all, the considerable similarities between the two theories suggest there is ample room for mutually benefiting discussion, especially if the increasing use of DG in computational linguistics triggers a corresponding interest in theoretical DG.

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Chapter 39

LFG and HPSG

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This chapter presents and compares Lexical Functional Grammar and Head-driven Phrase Structure Grammar. It concentrates on their fundamental properties rather than on analyses of particular phenomena. After discussing representations assumed in each theory and the kinds of grammars that lead to such representations, the chapter devotes some attention to models explicitly or implicitly assumed in HPSG and LFG: it identifies some problems and suggests possible solutions.

1 Introduction

The aim of this chapter is to juxtapose two highly formalised grammatical theories: Lexical Functional Grammar (LFG; Kaplan & Bresnan 1982, Bresnan et al. 2016, Dalrymple et al. 2019) and Head-driven Phrase Structure Grammar (HPSG; Pollard & Sag 1987, 1994; Müller et al. 2021).[1] LFG was conceived in the late 1970s, HPSG – in the mid-1980s, so both theories have been around for decades. Within both theories, diverse phenomena have been analysed and then re-analysed, and many will undoubtedly receive new analyses in the future. For this reason, rather than compare particular analyses of some phenomena, this chapter focuses on more fundamental issues: on the general representational architecture of the two theories (in Section 2), on the kinds of grammars that lead to these representations (in Section 3), and on models assumed in both theories (in Section 4). Wechsler & Asudeh (2021) offers a comparison of the treatment of various phenomena in the two theories and, hence, complements the current chapter.

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[1] This chapter does not presuppose substantial prior exposure to either LFG or HPSG.

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2 Representations

Outside of their respective communities, both theories are best known as theories of syntax, although already at their conception both were envisaged as theories of multiple linguistic levels, including semantics. Current versions of both theories have well-developed approaches to semantics, as well as proposals for the representation of other linguistic levels: morphological and information-structural in the case of both theories, phonological in the case of HPSG, and prosodic in the case of LFG.

However, the two theories adopt rather different approaches to the representation of the various linguistic levels.

2.1 LFG

Let us have a look at possible representations of the simple sentence (1) in the two theories, starting with the LFG representation in Figure 1.

(1) She loves you.

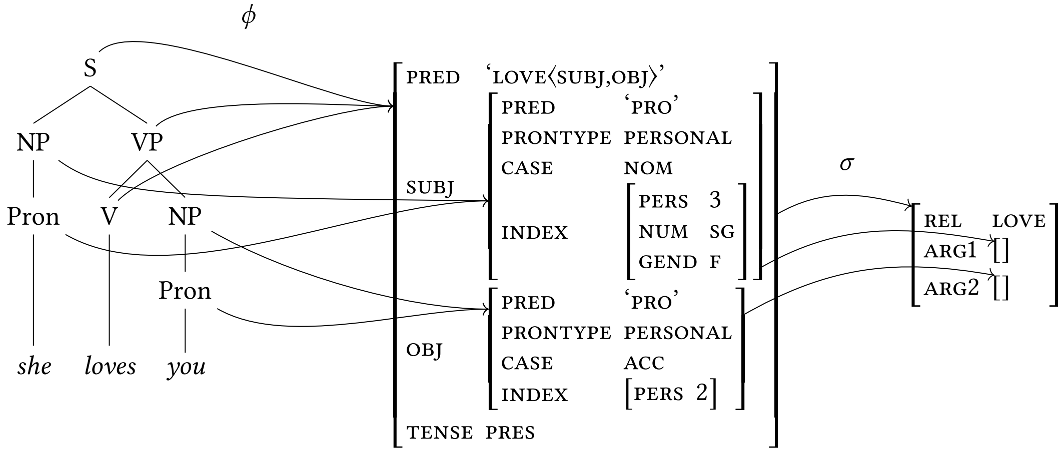

Figure 1: LFG representation of (1)

A prominent feature of LFG representations are the multiple levels. Figure 1 features three such levels: constituent structure (c-structure; the tree on the left), functional structure (f-structure; the attribute–value matrix, AVM for short, in the middle), and semantic structure (s-structure; the AVM on the right). The first two of these levels are syntactic in nature and they are the core of any LFG analysis. The repertoire and exact properties of other levels, including s-structure, is a matter of some debate. Among other prominent levels widely assumed in LFG are prosodic structure (for overviews see Dalrymple et al. 2019: Chapter 11 and Bögel 2023 [this volume]) and information structure (see Dalrymple et al. 2019: Chapter 10 and Zaenen 2023 [this volume]). Also argument structure used to be assumed as a separate level (see, e.g., Butt et al. 1997), but given an appropriately spelled-out approach to semantics, a separate a-structure does not seem to be needed (see, e.g., Asudeh & Giorgolo 2012 and Findlay 2016).

As shown in Figure 1, levels of representation are connected via mapping functions (rendered in the figure with arrows between levels). One such function, usually called ϕ, maps c-structures to f-structures, another, σ, maps f-structures to s-structures. These functions are not necessarily total. In particular, it is often assumed that ϕ maps to f-structures only non-terminal nodes of c-structures. For example, in Figure 1, the leftmost nodes NP and Pron, but not the terminal node *she* that they dominate, map to the f-structure representing the subject (the value of the SUBJ attribute), the rightmost nodes NP and Pron, but not the terminal *you*, map to the f-structure representing the object, etc. Similarly, the domain of σ consists of three f-structures (the ones containing the PRED attribute), with the exclusion of the f-structures which are the values of INDEX. These functions are also not surjective (not onto), for example the values of INDEX in the f-structure are not in the range of ϕ.

Let us take a brief look at particular levels. The c-structure in Figure 1 should be self-explanatory. Unlike derivational theories (see Sells 2023 [this volume]), but like Simpler Syntax (see Varaschin 2023 [this volume]) and HPSG, LFG assumes very simple constituency trees, usually without empty categories – but see Bresnan et al. (2016: Chapter 9) for exceptions – and without an abundance of functional nodes. Constituency structures are assumed to vary considerably between languages, even though their grammars are required to follow some – appropriately relaxed – version of the X′-theory.[2]

On the other hand, functional structures are cross-linguistically more uniform. While they contain morphosyntactic information, which is quite different for different languages, their main function is to represent grammatical functions such as subject and object, and the repertoire of grammatical functions is supposed to be universal.[3] F-structures also contain "semantic forms" – values of

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[2] See, e.g., Bresnan et al. (2016: Chapter 6) and Dalrymple et al. (2019: Section 3.2). LFG versions of X′-theory are relaxed in various ways. While the standard X′-theory assumes at most binary branching, LFG does not make such an assumption. Also, standard derivational versions of X′-theory assume the presence of the head (perhaps subsequently moved to a different tree position or realised as a phonetically empty constituent to start with), while in LFG the head may be optional in a rule and completely absent from the resulting tree. In this sense, LFG versions of X′-theory may be construed as theories of descriptions rather than structures.

[3] See Patejuk & Przepiórkowski (2016) for a critical discussion of this assumption and Kaplan (2017) for a reply.

the PRED attribute – originally designed to encode in syntax the information that maps to semantic representations; as repeatedly noted in the literature, this information is largely redundant in contemporary LFG, given the existence of semantic structures.[4] In the case of Figure 1, the main f-structure represents a present-tense utterance with the semantic form 'LOVE⟨SUBJ,OBJ⟩'. Both the subject and the object of this utterance have the semantic form 'PRO', i.e., they are pronouns, specifically, personal pronouns. Their morphosyntactic information is represented within the values of CASE and INDEX.[5]

Finally, s-structures contain purely semantic information. In the case at hand, it is the information that the meaning of this utterance is modelled by the relation LOVE and that there are two arguments of this relation, corresponding to the subject and the object.

2.2 HPSG

Let us now have a look at the HPSG representation of (1) in Figure 2. HPSG representations are formally more uniform: there is just one contiguous data structure used for the representation of information from all linguistic levels, namely, an attribute–value matrix.[6] In particular, there are no separate levels of representation – all constituency, morphosyntactic, and semantic information is interspersed throughout the structure.

Clearly, the cost of the greater formal uniformity is the diminished perspicuity (or, for an unaccustomed eye, downright unreadability) of representations such as that in Figure 2. For this reason, it is common among HPSG practitioners to use all kinds of abbreviations and representational devices to make representations more readable. For example, the structure of that figure may be presented as in Figure 3, where the constituency structure becomes transparent.

Taking a closer look at the AVM in Figure 2 we may first note that, unlike f-structures (or s-structures) in LFG, feature structures in HPSG are typed. For example, the structure represented by the whole AVM is of type *hd-subj-ph* (i.e., *head-subject-phrase*), and the value of the attribute HD-DTR is of type *hd-comp-ph* (i.e., *head-complement-phrase*).

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[4] See, e.g., Dalrymple et al. (1993: 13–14) and Kuhn (2001: Sections 1.3.3, 1.4.1).

[5] Analyses in both LFG and HPSG often follow Wechsler & Zlatić (2003) and distinguish between INDEX agreement and CONCORD agreement; here I retain INDEX as a separate bundle of features but do not explicitly represent the CONCORD bundle, just the CASE feature within it.

[6] Figure 2 also contains lists, indicated with angle brackets, but this is a shorthand notation for AVMs with attributes such as FIRST and REST (or HEAD and TAIL), whose values are the first element (head) of the list and the rest (tail) of the list.

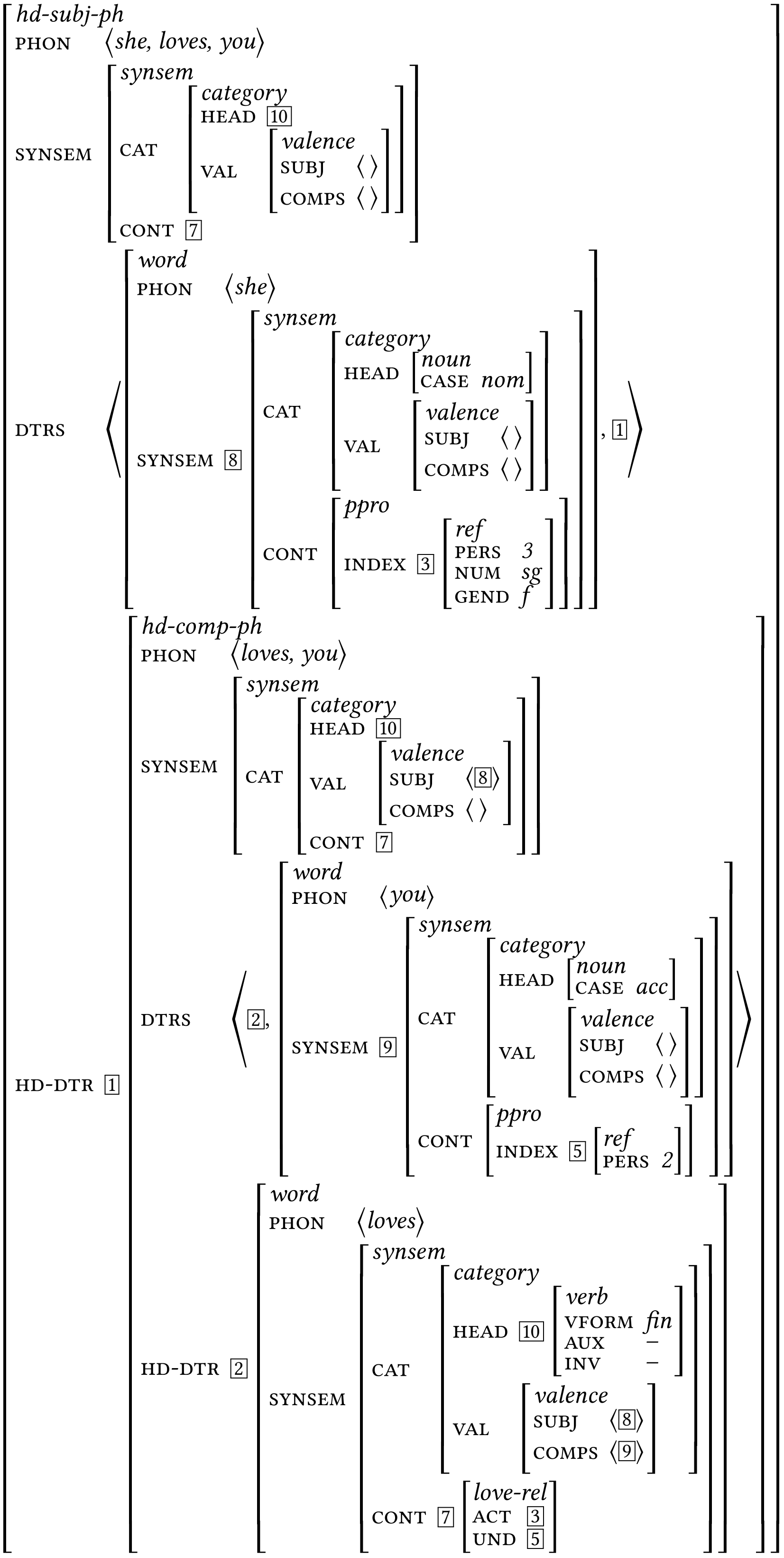

Figure 2: HPSG representation of (1)

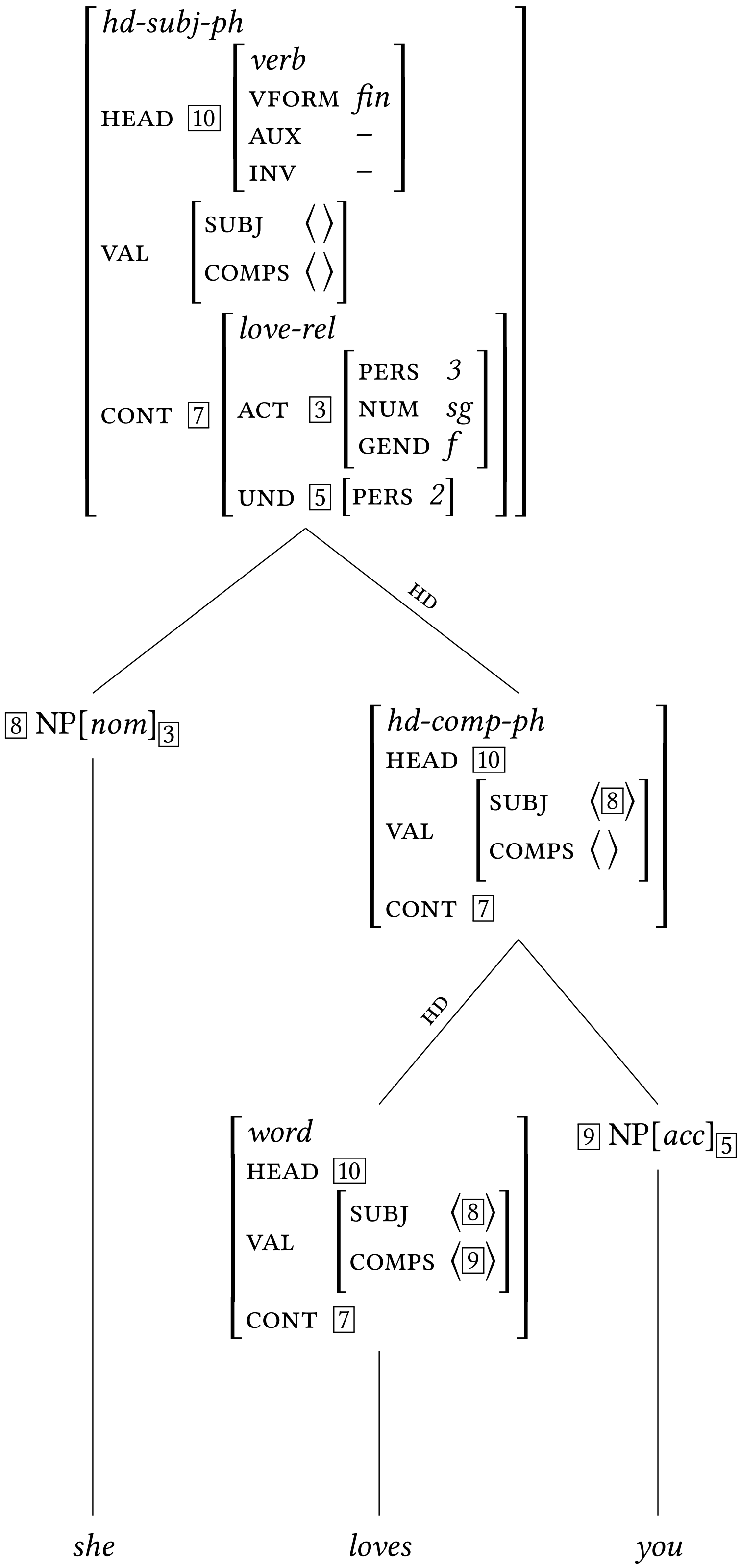

Figure 3: Shorthand HPSG representation of (1)

As discussed in more detail in Section 3.2 below, types determine what attributes may and must appear on the objects described by the AVM (not necessarily on the AVM itself, which may be a partial description of such objects; this point will be crucial below) and what their values may and must be.[7] Types are ordered in an inheritance hierarchy, where subtypes inherit conditions imposed by supertypes and may add more such conditions.[8] For example, both *hd-subj-ph* and *hd-comp-ph* are subtypes of *headed-phrase*, which is a subtype of *phrase*, which in turn – along with *word* – is a subtype of *sign*; see Figure 4.

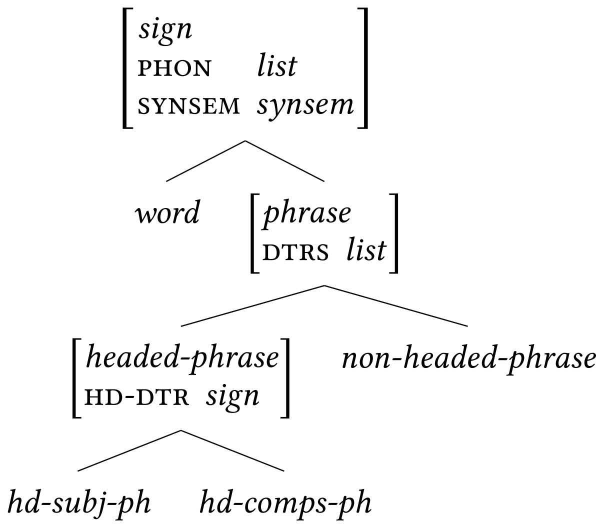

Figure 4: A small fragment of an HPSG type hierarchy

All objects of type *sign* must have two attributes: PHON and SYNSEM (I will explain their role shortly). The *word* subtype does not add any conditions, and all the three subsidiary AVMs of type *word* in Figure 2 have exactly these two attributes and no others. On the other hand, the *phrase* subtype of *sign* requires an additional attribute, namely, DTRS (i.e., DAUGHTERS), whose value is a list of immediate constituents. An important subtype of *phrase* is *headed-phrase*, where one of the immediate constituents is singled out as the syntactic head; this constituent

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[7] In the HPSG lingo, this amounts to saying that feature structures are *totally well-typed* (Carpenter 1992: 94–95; Pollard & Sag 1994: 18).

[8] It is sometimes argued that LFG templates (which are, essentially, possibly parameterised macros, as in programming languages) "can play the same role in capturing linguistic generalizations as hierarchical type systems in theories like HPSG" (Dalrymple et al. 2004: 207); unfortunately, a discussion of similarities and differences between the two mechanisms – especially, the crucial ontological differences – is outside the scope of this fairly introductory chapter.

is the value of the additional HD-DTR (i.e., HEAD-DAUGHTER) attribute. Hence, any object of type *headed-phrase* must have four attributes: PHON, SYNSEM, DTRS, and HD-DTR. As *hd-subj-ph* and *hd-comp-ph* do not add any attributes, the two AVMs corresponding to the phrases *she loves you* and *loves you* have exactly these four attributes.

Let us take a closer look at the encoding of constituency structure via the attributes DTRS and HD-DTR. In the root AVM of Figure 2, the value of DTRS is a 2-element list, whose first element is a *word* structure of *she* and the second element is a *hd-comp-ph* structure of *loves you.* This second element is only marked as $\boxed{1}$ on the DTRS list, but it is fully presented as the value of the HD-DTR attribute; boxed numbers such as $\boxed{1}$ should be understood as bound variables signalling multiple occurrences of a structure in different places (here, in the DTRS list and in the value of HD-DTR). The structure $\boxed{1}$, being (a subtype of) a headed phrase, also has the attribute DTRS, whose value is a pair of structures of *loves* and *you*, and the HD-DTR attribute, which singles out the structure of *loves* as the head. This configuration of attributes DTRS and HD-DTR and their values encodes the syntactic tree of Figure 3.

The other two attributes of *phrase* structures, present also on *word* structures, are PHON and SYNSEM. In work which does not deal with phonology or phonetics the values of PHON are taken to be lists of words, as in Figure 2, but it is clear that in an exhaustive representation values of PHON must be highly structured.[9]

For our purposes, values of SYNSEM are more important – they represent all grammatical information other than constituency structure. Figure 2 presents slightly simplified values of SYNSEM: it omits those parts of *synsem* structures which are responsible for non-local information, i.e., for book keeping related to unbounded dependencies and relative clauses (see Borsley & Crysmann 2021, Arnold & Godard 2021, Chaves 2021, and references therein).[10] Local information is distributed between the attributes CAT(egory) and CONT(ent), as well as CONTEXT, not represented here either (see Pollard & Sag 1994: 332–337, as well as De Kuthy 2021 and references therein). CONT represents semantic information comparable to that distributed between LFG f-structures and s-structures. For example, the two personal pronouns (see the two CONT values of type *ppro*) contribute referential indices, referred to as $\boxed{3}$ and $\boxed{5}$, and the verb contributes the *love-rel*(ation) with the index $\boxed{3}$ of *she* as its ACT(or) and the index $\boxed{5}$ of *you* as

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[9] See, e.g., Bird & Klein (1994) and Höhle (1999) for two very different proposals.

[10] Normally, *synsem* structures contain two attributes, LOCAL and NONLOCAL. Since NONLOCAL and its value is omitted here, also the attribute LOCAL is not mentioned in this chapter, and its values of type *local* are presented as SYNSEM values of type *synsem.*

its UND(ergoer). This verbal semantics is shared along the verbal spine, so the structures of *loves*, *loves you*, and *she loves you* all have the same CONT value $\boxed{7}$.

The other part of SYNSEM values, the *category* structure, models morphosyntactic and combinatorial properties. The former are the value of HEAD: *she* is a nominative (pro)noun, *you* is (here) an accusative (pro)noun, and *loves* is a finite verb (non-auxiliary, not inverted). The values of HEAD are shared between a mother and its head daughter – see the multiple occurrences of $\boxed{10}$. Finally, combinatorial properties are encoded in values of VAL(ence): the verb *loves* requires a subject ($\boxed{8}$ – the SYNSEM value of *she*) and a complement ($\boxed{9}$ – the SYNSEM value of *you*), *loves you* has no further complement expectations but still needs a subject, while *she loves you* is a fully saturated maximal projection – the values of its valency features are empty lists. Such maximal projections are often abbreviated the way illustrated in Figure 3: $\text{NP}[\textit{nom}]_{\boxed{3}}$ stands for (the SYNSEM value of) a structure with empty SUBJ and COMPS, with HEAD indicating a nominative noun, and with CONT|INDEX value $\boxed{3}$.[11]

2.3 Comparison

2.3.1 Levels of representation

The two structures in Figures 1 and 2 look somewhat similar in the sense that they both use complex AVMs, but also very different in the sense that the LFG representation distinguishes multiple levels, each with its own data structure and with a functional mapping between the levels, while the HPSG representation is a monolithic AVM. How important is this difference? My claim is that it is less important than usually assumed. For example, it is possible to define a bijection (a one-to-one correspondence) between LFG representations such as that in Figure 1 and corresponding HPSG-like monolithic AVM representations such as that in Figure 5. In this representation, the c-structure is encoded with the help of attributes LABEL, DTRS, and PHON, the mapping ϕ from the c-structure to the f-structure is achieved with the attribute SYNSEM, and the mapping σ from the f-structure to the s-structure – with the attribute CONT.[12]

Conversely, the HPSG representation of Figure 2 might be taken apart and LFG-ified as in Figure 6. The fact that non-terminal nodes in the c-structure are AVMs is not a problem in itself; in LFG it is often assumed that c-structure node labels

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[11] While in LFG the attribute separator in paths is a space, e.g., “SUBJ CASE ”, in HPSG the vertical bar is used, e.g., “SYNSEM|CAT|HEAD|CASE”.

[12] In fact, this representation makes conspicuous the redundancy – mentioned in Section 2.1 – of PRED values with respect to s-structures (i.e., here, CONT values).

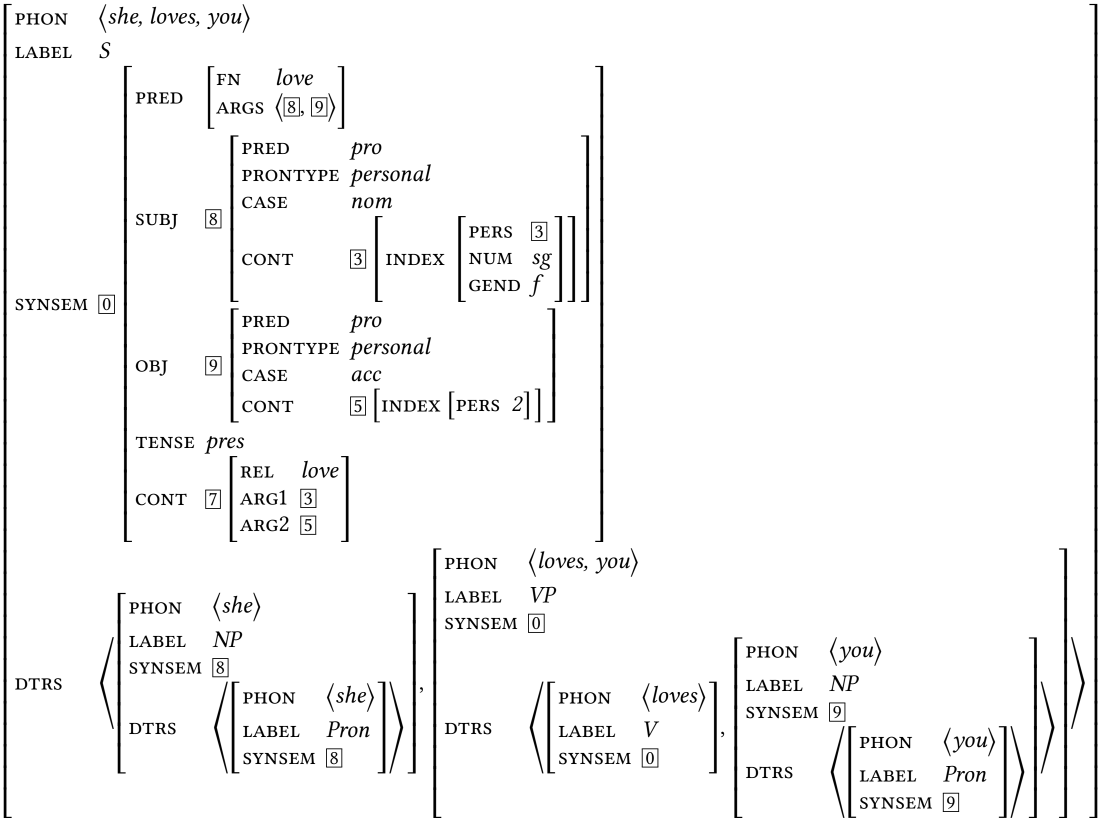

Figure 5: HPSG-like LFG representation of (1)

are really abbreviations of feature matrices (see, e.g., Kaplan 1995, Dalrymple 2017, and Lowe & Lovestrand 2020). What is somewhat unusual is that some of the attributes in these AVMs are list-valued and refer to other AVMs within the same c-structure (rather than to particular values within such AVMs as in, e.g., Lowe & Lovestrand 2020). However, this does not seem to violate any deep LFG principles.

What LFG grammars and the multi-level representations they lead to try to capture is the cognitive modularity and encapsulation of particular linguistic levels; constituency structures, functional structures, semantic structures, etc., each have their own sets of primitives and operations, and the interactions between them are only possible via the mapping functions ϕ, σ, etc. By contrast, no such encapsulation is attempted in HPSG, so it is easy to state constraints in this theory which may simultaneously refer to arbitrary parts of the structure of a sentence, e.g., the phonetic properties of a verb and the semantics of its subject; such a constraint would be much more cumbersome to state in LFG. On the other hand, actual LFG analyses sometimes make use of the converses of ϕ, σ, etc., i.e., refer to c-structures from the level of f-structures and to f-structures

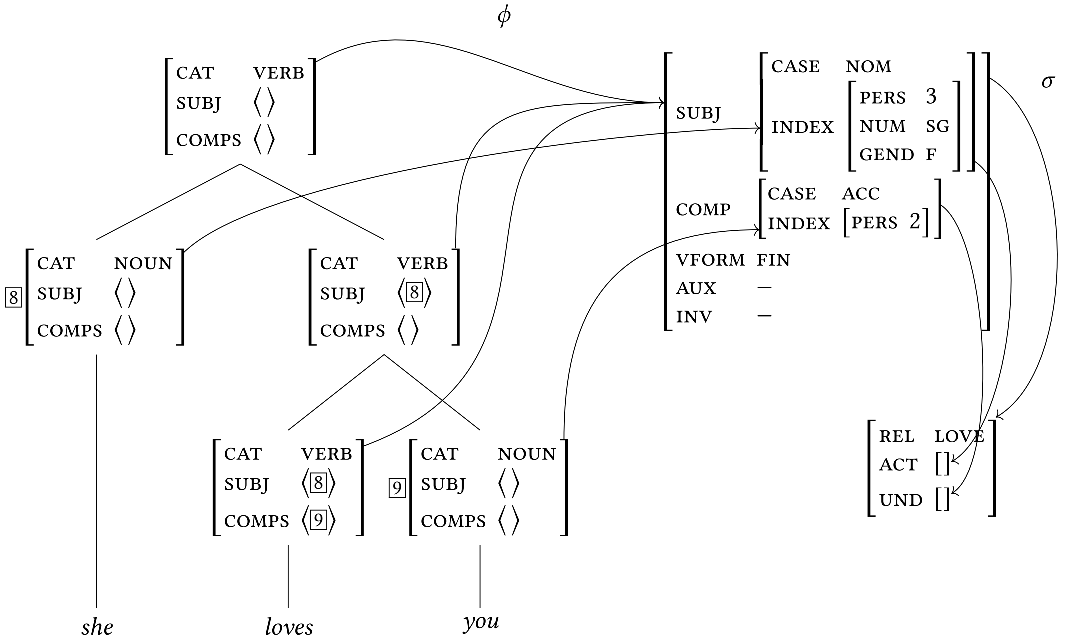

Figure 6: LFG-like HPSG representation of (1)

from the level of s-structures, so, in principle, any level may be referred to from any other level.[13] Hence, the difference between LFG and HPSG when it comes to encapsulation of linguistic levels is one of degree – and relative easiness of stating constraints across grammatical levels – rather than a categorical difference between the complete encapsulation and the total lack thereof.

In summary, while representations with separate linguistic levels such as those in Figures 1 and 6 are certainly more immediately readable than monolithic representations such as those in Figures 2 and 5, it is not clear that there are any fundamental differences in the kinds of linguistic analyses that LFG and HPSG presuppose.[14]

2.3.2 Grammatical functions

Perhaps a more important – and certainly linguistically more contentful – difference between HPSG and LFG regards grammatical functions. In LFG each

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[13] However, as pointed out by Ash Asudeh (p.c.), correspondence functions in LFG are typically not injective (i.e., they are many-to-one), so their converses are proper relations rather than functions. For example, while ϕ maps particular c-structure nodes to particular f-structures, the converse of ϕ will map f-structures to *sets* of c-structure nodes, making it more difficult to refer to *particular* c-structure nodes from the level of f-structures. This "blurring" or "fuzziness" of converses of correspondence functions might be claimed to constitute a substantive hypothesis about encapsulation of grammatical levels.

[14] But see Section 3.3.3, on the expressiveness of formalisms underlying LFG and HPSG.

argument bears a different grammatical function drawn from a repertoire that includes SUBJ(ect) and OBJ(ect), as in Figure 1, but also OBL(ique), COMP(lement) – a closed sentential argument, XCOMP – an open verbal argument, etc. Moreover, at least OBJ and OBL are often indexed with thematic roles, grammatical cases, or particular prepositions. For example, in the case of sentence (2), the f-structure would contain another attribute apart from SUBJ (for *you*) and OBJ (for *me*), namely, $\text{OBJ}_{\text{THEME}}$ (for *your money*). Similarly, in the case of (3), the grammatical function of *to you* could be OBL_{GOAL}, etc. (see, e.g., Dalrymple et al. 2019: Section 10.3 and references therein).

(2) You never give me your money.

(3) But what I've got I'll give to you.

The HPSG approach to naming arguments is radically different: normally only the SUBJ(ect) is distinguished (see Pollard & Sag 1994: Chapter 9 and references therein), often for solely tree-configurational reasons, and all the other arguments are listed within the predicate's COMP(lement)s value. In the case of a 2-argument verb such as *love* this difference is not conspicuous, but in the case of, say, *give*, the two non-subject arguments would be elements of the COMPS list, whether they are realised as a direct object and a theme object, as in (2), or as a direct object and goal oblique, as in (3). Hence, the two attributes, SUBJ and COMPS, suffice for any configuration of arguments.[15]

Note that this is a difference between LFG and HPSG *qua* linguistic theories, not *qua* linguistic formalisms. Either approach can be simulated in the other formalism. For example, within LFG, Alsina (1996) proposes to constrain explicitly named grammatical functions to subject and object, and Patejuk & Przepiórkowski (2016) and Przepiórkowski (2016) further justify this approach and provide an LFG formalisation inspired by HPSG analyses of extended argument structure.[16]

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[15] Also, the SUBJ/COMPS dichotomy is not assumed in some versions of HPSG (including the early versions of Pollard & Sag 1987 and Pollard & Sag 1994: Chapters 1–8, as well as the Sign-Based Construction Grammar of Sag 2012, sometimes perceived as a version of HPSG) and in HPSG grammars of some languages (e.g., German; Stefan Müller, p.c.).

[16] Two further – more formal – arguments for HPSG-like representations of grammatical functions in essentially LFG settings may be found in Johnson (1988: Chapter 4): first, they obviate the need for the LFG principles of completeness and coherence (cf. Section 3.3.4), which are encoded via formally problematic (cf. Section 4.3.3) constraining statements, and second, they lead to an analysis of Dutch infinitive constructions which, unlike the standard – at that time – LFG analysis, does not violate the offline parsability constraint (cf. Section 3.3.3). (Some problems with Johnson's (1988) own analysis of Dutch infinitive constructions are pointed out in Zaenen & Kaplan 1995.)

Conversely, explicit information about grammatical functions of particular arguments could be added to HPSG representations, as in Ackerman & Webelhuth (1998) or Hellan (2019).

2.3.3 Word forms

The final difference between the two representations in Figures 1 and 2 that I would like to point out concerns the place of the word string in these representations. Traditionally, in LFG the sequence of word forms – the form of the utterance – is the yield of the c-structure, i.e., the sequence of leaves. So finding an LFG representation of an utterance amounts to finding a grammatical representation in which the yield of the c-structure is that utterance.

On the other hand, in HPSG the sequence of words in an utterance is the value of that utterance's PHON attribute. This means that finding an HPSG representation of an utterance boils down to finding a grammatical structure in which the value of PHON is the list of words in that utterance. Normally this amounts to the same sequence of words as that read off the leaves of the constituency tree. For example, if – in a simple binary tree – the PHON of the first constituent is ⟨*come*⟩ and the PHON of the second is ⟨*together*⟩, then the PHON of the mother is ⟨*come*, *together*⟩ rather than ⟨*together*, *come*⟩ (or ⟨*drive*, *my*, *car*⟩, or whatever). This correspondence is explicitly present in the representation in Figure 2 and implicitly assumed in the shorthand representation in Figure 3, but there is a well-developed linearisation theory in HPSG which allows for controlled violations to this correspondence.

I will have more to say about the exact role of the string of word forms in both linguistic theories in Section 3.3.1.

2.4 Summary

Let us take stock of similarities and differences between the kinds of representations assumed in LFG and HPSG. The celebrated difference between the multi-level architecture of LFG and the monolithic structures assumed in HPSG is certainly important to many practitioners of both theories and has an impact on readability (of LFG representations) and the need to apply additional conventions and abbreviations (to render HPSG representations), but in my view it is of little substantial consequence. It is trivial to devise a lossless conversion of LFG representations to HPSG-like representations, and also HPSG structures may be converted to LFG-like representations which distinguish between constituency structures, structures representing other syntactic information, and semantic structures.

However, there are at least two more substantial differences conspicuous in the representations in Figures 1 and 2. One concerns grammatical functions: one function per argument in LFG and just one distinguished argument in HPSG. The other concerns the place of the sequence of words which make up an utterance: in LFG this sequence is commonly assumed to correspond to the sequence of leaves in the c-structure, while HPSG allows for dissociation between the string of words and the constituency structure.

3 Grammars

What kinds of grammars lead to representations such as those in Figures 1 and 2? I will first consider LFG, then HPSG, and then I will compare the two approaches.

3.1 LFG

Here is the relevant part of an LFG grammar that produces the structures in Figure 1.[17]

Grammar rules:

(4) $$\text{S} \longrightarrow \begin{array}{cc} \text{NP} & \text{VP} \\ (\uparrow \textsc{subj}) = \downarrow & \uparrow = \downarrow \\ (\downarrow \textsc{case}) = \textsc{nom} & (\downarrow \textsc{tense}) \end{array}$$

(5) $$\text{VP} \longrightarrow \begin{array}{cc} \text{V} & \text{NP} \\ \uparrow = \downarrow & (\uparrow \textsc{obj}) = \downarrow \\ & (\downarrow \textsc{case}) = \textsc{acc} \end{array}$$

(6) $$\text{NP} \longrightarrow \begin{array}{c} \text{Pron} \\ \uparrow = \downarrow \end{array}$$

Lexicon:

(7) *loves* V
$$\begin{array}{l} (\uparrow \textsc{pred}) = \text{‘}\textsc{love}\langle \textsc{subj},\textsc{obj} \rangle\text{’} \\ (\uparrow \textsc{subj index pers}) =_c 3 \\ (\uparrow \textsc{subj index num}) =_c \textsc{sg} \\ (\uparrow \textsc{tense}) = \textsc{prs} \\ (\uparrow_\sigma \textsc{rel}) = \textsc{love} \\ (\uparrow_\sigma \textsc{arg1}) = (\uparrow \textsc{subj})_\sigma \\ (\uparrow_\sigma \textsc{arg2}) = (\uparrow \textsc{obj})_\sigma \end{array}$$

---

[17] Only the core machinery is assumed here, mostly (apart from the σ-projected s-structures) present already in Kaplan & Bresnan (1982). See, e.g., Dalrymple et al. (2019: Chapter 6) for later additions such as functional uncertainty (including inside-out functional uncertainty), off-path constraints, the restriction operator, local names, templates, etc.

(8) *she* Pron (↑ PRED) = ‘PRO’
(↑ PRONTYPE) = PERSONAL
(↑ CASE) = NOM
(↑ INDEX PERS) = 3
(↑ INDEX NUM) = SG
(↑ INDEX GEND) = F

(9) *you* Pron (↑ PRED) = ‘PRO’
(↑ PRONTYPE) = PERSONAL
(↑ INDEX PERS) = 2

LFG grammars may be viewed as Context-Free Grammars (CFGs) with annotations; the purely CFG part of the grammar in (4)–(9) is this:

(4′) S ⟶ NP VP
(5′) VP ⟶ V NP
(6′) NP ⟶ Pron
(7′) V ⟶ *loves*
(8′) Pron ⟶ *she*
(9′) Pron ⟶ *you*

Within annotations, ↑ refers to the f-structure associated (via the ϕ function) with the mother node in the tree (i.e., with the preterminal node, in the case of lexical entries), and ↓ refers to the f-structure associated with the current node. For example, the functional equation (↑ SUBJ) = ↓ under the NP in rule (4) for S says that the f-structure associated with the S node has the SUBJ attribute whose value is the f-structure associated with the NP node. The other equation under the NP, (↓ CASE) = NOM, says that the f-structure for this NP has CASE with value NOM. The head equation ↑ = ↓ under the VP in the same rule says that S and VP are associated with the same f-structure.

These are so-called “defining equations” – they may be thought of as constructively building representations. The statement (↓ TENSE) under VP in rule (4) is a constraining condition requiring the presence of the TENSE attribute within the f-structure associated with the VP node. This constraining condition cannot be replaced with a defining equation such as (↓ TENSE) = PRS because infinitive verbs are assumed not to have the TENSE attribute at all, so the effect of such a defining equation would be to wrongly add the attribute TENSE (and its PRS value) to f-structures of such tenseless forms. Similarly, the constraining equation (↑ SUBJ INDEX PERS) $=_c$ 3 in the lexical entry (7) for *loves* requires that the f-structure associated with the subject of this verb have the attribute INDEX whose value has the attribute PERS whose value is 3, but the verb does not itself assign this value – some other part of the grammar (in this case, the lexical entry (8) for *she*) must take care of that. As we will see in Section 4.3.3, the existence of such constraining statements presents a difficulty for model-theoretic formalisations of LFG.

While the symbols ↑ and ↓ only implicitly refer to the function ϕ mapping c-structures to f-structures, the σ function mapping f-structures to s-structures is mentioned explicitly in some of the statements. For example, the statement $(\uparrow_\sigma$ ARG1$) = (\uparrow$ SUBJ$)_\sigma$ in the lexical entry (7) rather concisely says that there is an s-structure associated with the f-structure related to the preterminal V, this s-structure contains the attribute ARG1, and the value of this attribute is the s-structure associated with the f-structure which is the value of SUBJ within the f-structure related to this preterminal. It is easy to check that the representation in Figure 1 reflects this and all the other statements presented in this subsection.

3.2 HPSG

Theoretical HPSG grammars have a very different feel: they do not have a CFG backbone, but rather contain statements about various types of linguistic objects – not only phrases and words, but also valencies, contents, cases, etc.[18] HPSG grammars consist of two parts: a type hierarchy (already mentioned in Section 2.2, also called "sort hierarchy" and "signature") and a theory proper.

A small fragment of the type hierarchy assumed in the AVM of Figure 2 was given in Figure 4, and a much larger part is presented in Figure 7. This type hierarchy seems to mention all types occurring in Figure 2, but in fact it does not contain types for the word forms which appear within PHON values; on the simplest approach to values of PHON each word form is an atom of a type such as *she* or *loves*. (On a more comprehensive approach such as Höhle 1999, values of PHON are highly structured and contain various kinds of phonological information.) In a more realistic grammar, the type hierarchy would also contain more subtypes of *headed-phrase* (see Abeillé & Borsley 2021: Sections 5–6 and references therein), a much larger type subhierarchy below *content* (see, e.g., Richter & Sailer 1997, 1999 and Davis 2001 for two very different proposals targeting different aspects of semantic representations), a multiple inheritance hierarchy of subtypes of *head* (Malouf 1998), many more subtypes of *vform*, etc. As shown in Figure 7, type hierarchies are more than just plain taxonomies of types: they also

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[18] However, some such statements, namely, Immediate Dominance Schemata (Pollard & Sag 1994: Section 1.5), directly encode some of the effects of phrase structure rules.

determine attributes that may occur in structures of particular types, as well as types of values of such attributes.

Theory proper is a set of statements – often called principles – which impose additional, more complex constraints. For example, the famous Head Feature Principle (HFP) says that, in a *headed-phrase*, the mother has the same value of the HEAD attribute as the head daughter. Formally, this principle may be stated as follows:

(10) Head Feature Principle:

$$\textit{headed-phrase} \Rightarrow \begin{bmatrix} \textsc{synsem}|\textsc{cat}|\textsc{head} & \boxed{1} \\ \textsc{hd-dtr}|\textsc{synsem}|\textsc{cat}|\textsc{head} & \boxed{1} \end{bmatrix}$$

Such principles are understood universally: every linguistic object must satisfy them. For this reason they are usually implicational, with the antecedent defining the scope of the principle. In the case of (10), either an object is of type *headed-phrase*, so the antecedent is true and, hence, the consequent must also be true, or the object is not of this type, in which case the antecedent is false and the whole implication is trivially true.

The AVM in Figure 2 describes a configuration of objects containing two objects of type *headed-phrase*, i.e., satisfying the antecedent of HFP: the root object of type *hd-subj-ph* and its HD-DTR value of type *hd-comp-ph*. Both satisfy HFP – see the three occurrences of $\boxed{10}$ in that figure. All other objects in this configuration satisfy HFP trivially, as they are not described by the antecedent of HFP; this holds for the *word* objects representing *she*, *loves*, and *you*, the *synsem* objects which are values of the SYNSEM attribute, the *list* objects which are values of various occurrences of PHON, SUBJ, COMPS, and DTRS, etc.

There are also constraints relating the values of VAL and DTRS. The role of valency attributes is similar to the role of slashes in Categorial Grammar (Ajdukiewicz 1935, Lambek 1958; see also Kubota 2021 and references therein) – they express information about the combinatory potential of an element. For example, the *word* structure for *loves* in Figure 2 specifies that this word expects a complement and a subject. Once it combines with the complement *you*, the mother phrase of type *hd-comp-ph* needs only a subject in order to be a fully saturated phrase (i.e., a sentence) – its COMPS list is empty ("⟨ ⟩" is a synonym of the *elist* type in Figure 7). Moreover, once this phrase combines with the subject *she*, both valency lists become empty. This behaviour is regulated by principles such as the following:

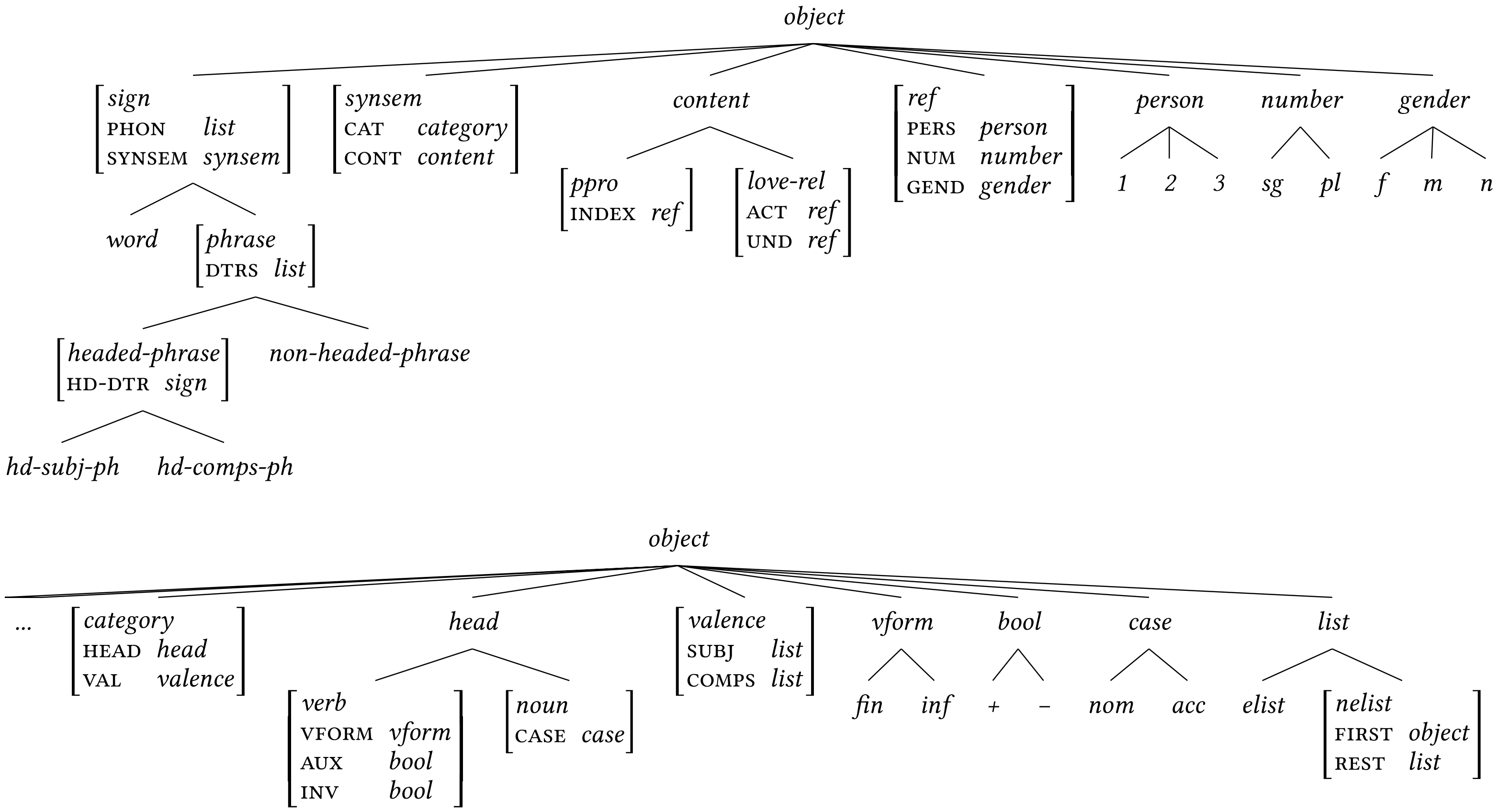

Figure 7: A larger part of an HPSG type hierarchy

(11) Valence Principles (modified and simplified):

a.
$$\textit{hd-subj-ph} \Rightarrow \begin{bmatrix} \text{\textsc{synsem}}|\text{\textsc{cat}}|\text{\textsc{val}} & \begin{bmatrix}\text{\textsc{subj}} & \langle\,\rangle \\ \text{\textsc{comps}} & \langle\,\rangle\end{bmatrix} \\ \text{\textsc{dtrs}} & \left\langle \left[\text{\textsc{synsem}}\ \boxed{2}\right], \boxed{1}\right\rangle \\ \text{\textsc{hd-dtr}} & \boxed{1} \begin{bmatrix}\text{\textsc{synsem}}|\text{\textsc{cat}}|\text{\textsc{val}} & \begin{bmatrix}\text{\textsc{subj}} & \langle\boxed{2}\rangle\\ \text{\textsc{comps}} & \langle\,\rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

b.
$$\textit{hd-comps-ph} \Rightarrow \begin{bmatrix} \text{\textsc{synsem}}|\text{\textsc{cat}}|\text{\textsc{val}} & \begin{bmatrix}\text{\textsc{subj}} & \boxed{0} \\ \text{\textsc{comps}} & \langle\,\rangle\end{bmatrix} \\ \text{\textsc{dtrs}} & \left\langle \boxed{1}, \left[\text{\textsc{synsem}}\ \boxed{2}\right]\right\rangle \\ \text{\textsc{hd-dtr}} & \boxed{1} \begin{bmatrix}\text{\textsc{synsem}}|\text{\textsc{cat}}|\text{\textsc{val}} & \begin{bmatrix}\text{\textsc{subj}} & \boxed{0}\\ \text{\textsc{comps}} & \langle\boxed{2}\rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

The constraint (11a) is saying that, in phrases of type *hd-subj-ph*, the head daughter ($\boxed{1}$) only requires a subject (its comps list is empty), this subject ($\boxed{2}$) is the (synsem value of the) first daughter of the phrase, while the second daughter ($\boxed{1}$) is the head daughter, and the phrase itself is fully saturated (both subj and comps are empty). Similarly, (11b) is saying that, in phrases of type *hd-comps-ph*, the single comps element of the head daughter is realised as its second daughter, the first daughter being the head, and the phrase does not expect a complement anymore. On the other hand, it still expects whatever subject (if any) is expected by the head daughter. The actual Valence Principle assumed in HPSG is more general; in particular, it allows for longer comps lists and the realisation of multiple arguments in a single local tree (see, e.g., Pollard & Sag 1994: 348).

Note that the values of valency attributes are lists of *synsem* structures (see $\boxed{2}$ in (11)), not whole phrases. This is an attempt to encode locality constraints on selection: a predicate may specify its arguments only by providing the kind of information that is encoded in synsem values, so it cannot select an argument on the basis of its phon value or with reference to the internal constituency structure of that argument (as it is encoded in the values of dtrs and hd-dtr).[19]

What about the lexicon? HPSG has full-fledged theories of the hierarchical lexicon, which make it possible to encode various generalisations across lexical items (see Davis & Koenig 2021 and references therein), but for the purpose of this comparison the simple principle in Figure 8 will do. What this principle is saying is that any *word* object must either satisfy the description in the first

---

[19] Note also that these principles do not say anything about values of phon. We will deal with phon values shortly, in Section 3.3.1.

$$
\textit{word} \Rightarrow \begin{bmatrix} \textsc{phon} & \langle \textit{she} \rangle \\ \textsc{synsem} & \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \begin{bmatrix} \textit{noun} & \\ \textsc{case} & \textit{nom} \end{bmatrix} \\ \textsc{val} & \begin{bmatrix} \textit{valence} & \\ \textsc{subj} & \langle\,\rangle \\ \textsc{comps} & \langle\,\rangle \end{bmatrix} \end{bmatrix} \\ \textsc{cont} & \begin{bmatrix} \textit{ppro} & \\ \textsc{index} & \begin{bmatrix} \textit{ref} & \\ \textsc{pers} & \textit{3} \\ \textsc{num} & \textit{sg} \\ \textsc{gend} & \textit{f} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \lor
$$

$$
\begin{bmatrix} \textsc{phon} & \langle \textit{you} \rangle \\ \textsc{synsem} & \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \textit{noun} \\ \textsc{val} & \begin{bmatrix} \textit{valence} & \\ \textsc{subj} & \langle\,\rangle \\ \textsc{comps} & \langle\,\rangle \end{bmatrix} \end{bmatrix} \\ \textsc{cont} & \begin{bmatrix} \textit{ppro} & \\ \textsc{index} & \begin{bmatrix} \textit{ref} & \\ \textsc{pers} & \textit{2} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \lor
$$

$$
\begin{bmatrix} \textsc{phon} & \langle \textit{loves} \rangle \\ \textsc{synsem} & \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \begin{bmatrix} \textit{verb} & \\ \textsc{vform} & \textit{fin} \\ \textsc{aux} & - \\ \textsc{inv} & - \end{bmatrix} \\ \textsc{val} & \begin{bmatrix} \textsc{subj} & \left\langle \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head}|\textsc{case} & \textit{nom} \\ \textsc{val} & \begin{bmatrix} \textsc{subj} & \langle\,\rangle \\ \textsc{comps} & \langle\,\rangle \end{bmatrix} \end{bmatrix} \\ \textsc{cont}|\textsc{index} & \boxed{1} \begin{bmatrix} \textsc{pers} & \textit{3} \\ \textsc{num} & \textit{sg} \end{bmatrix} \end{bmatrix} \right\rangle \\ \textsc{comps} & \left\langle \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head}|\textsc{case} & \textit{acc} \\ \textsc{val} & \begin{bmatrix} \textsc{subj} & \langle\,\rangle \\ \textsc{comps} & \langle\,\rangle \end{bmatrix} \end{bmatrix} \\ \textsc{cont}|\textsc{index} & \boxed{2} \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \\ \textsc{cont} & \begin{bmatrix} \textit{love-rel} & \\ \textsc{act} & \boxed{1} \\ \textsc{und} & \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix} \lor \ldots
$$

Figure 8: Word Principle

disjunct (which defines the word *she*), or the second disjunct (*you*), or the third disjunct (*loves*), etc. Again, it is easy to see that the structure described by the AVM in Figure 2 complies with this principle.

All the principles given or alluded to above constrain the shape of *sign*s – *word*s and *phrase*s – but principles may also refer to other types of objects. For example, the type hierarchy in Figure 7 only says that values of SUBJ and COMPS are lists, but the values of SUBJ cannot be of any length – their maximum length is one (a single predicate cannot have two subjects). This can be regulated with the constraint in (12) or – equivalently (given the type hierarchy in Figure 7) but more concisely – (13).

(12) $\textit{valence} \Rightarrow \left[\textsc{subj}\ \ \textit{elist}\right] \vee \left[\textsc{subj}|\textsc{rest}\ \ \textit{elist}\right]$

(13) $\textit{valence} \Rightarrow \neg\left[\textsc{subj}|\textsc{rest}\ \ \textit{nelist}\right]$

Moreover, values of SUBJ and COMPS cannot be just any lists – they must be lists of *synsem* objects. This may be achieved via constraint (14), whose antecedent is not just a type specification, with the predicate `list-of-synsems` defined as in (15).[20]

(14) $\begin{bmatrix}\textsc{subj} & \boxed{1}\\ \textsc{comps} & \boxed{2}\end{bmatrix} \Rightarrow \texttt{list-of-synsems(}\boxed{1}\texttt{)} \wedge \texttt{list-of-synsems(}\boxed{2}\texttt{)}$

(15) $\texttt{list-of-synsems(}\textit{elist}\texttt{).}$

$$\texttt{list-of-synsems(}\begin{bmatrix}\textit{nelist} & \\ \textsc{first} & \textit{synsem}\\ \textsc{rest} & \boxed{0}\end{bmatrix}\texttt{)} \overset{\forall}{\Longleftarrow} \texttt{list-of-synsems(}\boxed{0}\texttt{).}$$

This simple constraint illustrates an important aspect of contemporary HPSG, namely, the possibility to define and use in constraints any relation (Richter 1999, 2004). The notation for defining such relations is inspired by the programming language Prolog. The definition in (15) consists of two clauses jointly specifying what kinds of objects have the `list-of-synsems` property: the first clause says that the empty list is a list of synsems, and the second (recursive) clause says that a non-empty list whose FIRST element is a *synsem* object is a list of synsems if the REST of this list is a list of synsems. Nothing else is a list of synsems.

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[20] I extend the notational conventions defined in Richter (2004: Section 3.2) in such a way that boxed variables appearing in the antecedents of implications are understood as bound by universal quantifiers scoping over the whole formula. So, the quantificational schema of (14) is: $\forall\boxed{1}\forall\boxed{2}\,(\phi(\boxed{1},\boxed{2}) \Rightarrow \psi(\boxed{1},\boxed{2}))$.

3.3 Comparison

3.3.1 Word order

One clear difference between the two frameworks stems from the fact that LFG grammars – but not HPSG grammars – are based on a CFG backbone. Traditionally (but see below) the sentence string is the yield of the c-structure, i.e., it is read off the leaves of the tree. In the case of free word order languages, this leads to trees in which functionally related constituents – for example, a noun and its adjectival modifier – are not always directly related configurationally.

Consider the Warlpiri sentence (16) from Simpson (1991: 257).

(16) Kurdu-jarra-rlu ka-pala maliki wajili-pi-nyi wita-jarra-rlu.
child-DU-ERG PRS-3.DU dog.ABS chase-NPST small-DU-ERG
'Two small children are chasing the dog.'
'Two children are chasing the dog and they are small.'

In this example, *wita-jarra-rlu* 'small' is a modifier of *kurdu-jarra-rlu* 'children', but on LFG analyses they do not form a constituent, as other constituents linearly intervene between these two words. For example, Austin & Bresnan (1996: 225) propose an analysis which results in the c-structure in Figure 9 (cf. Dalrymple et al. 2019: 112).

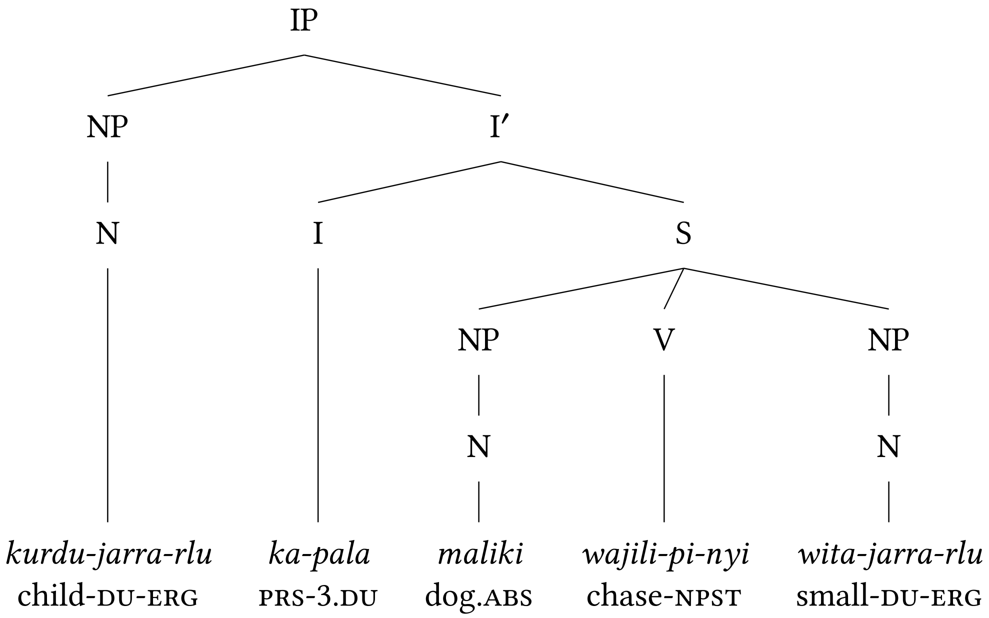

Figure 9: LFG c-structure of (16)

By contrast, it is possible to propose an HPSG analysis of Warlpiri word order on which *wita-jarra-rlu* ‘small’ and *kurdu-jarra-rlu* ‘children’ do form a constituent in (16) (in the sense in which the attribute DTRS represents immediate constituents). A shorthand and very schematic representation of the result of such an analysis is given in Figure 10 (after Donohue & Sag 1999: 13). Note that the order of words within the PHON value of the root of this tree is different from the order of PHON values of the leaves.

This analysis is possible because values of PHON are subject to the same constraints as any other structures. The usual tree behaviour, with PHON values of the mother being the concatenation of the PHON values of the daughters in the order in which they occur on the DTRS list, could be simulated with the constraint in (17), where $\mathsf{append\text{-}phons}(\boxed{2},\boxed{1})$ holds if $\boxed{1}$ is the concatenation of PHON values of the elements of $\boxed{2}$.[21]

(17) $$\begin{bmatrix} \textit{phrase} & \\ \textsc{phon} & \boxed{1} \\ \textsc{dtrs} & \boxed{2} \end{bmatrix} \Rightarrow \mathsf{append\text{-}phons}(\boxed{2},\boxed{1})$$

If the constraint in (17) were included in the grammar of Warlpiri, the representation in Figure 10 would be ill-formed.

However, other definitions are possible, which relax this usual approach. In fact, there is a long history of such linearisation accounts in HPSG, dating back to Reape (1992, 1996), Kathol & Pollard (1995), and Kathol (1995, 2000) (see also Müller 2021b and references therein); such a relaxed approach to word order is commonly assumed in HPSG analyses of ellipsis and coordination (see Nykiel & Kim 2021, Abeillé & Chaves 2021, and references therein). On such analyses, the two sentences in (18) (from Chaves 2008: 286) have exactly the same constituency structures but differ in PHON values.

(18) a. Tim gave a rose to Mary and a tulip to Sue.

b. Tim gave a rose to Mary and Tim gave a tulip to Sue.

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[21] Formally, the relation $\mathsf{append\text{-}phons}$ is defined as in (i), and the relation append it relies on – as in (ii):

(i) $\mathsf{append\text{-}phons}(\textit{elist}, \textit{elist})$.

$$\mathsf{append\text{-}phons}\left(\begin{bmatrix} \textsc{first} & \begin{bmatrix} \textsc{phon} & \boxed{1} \end{bmatrix} \\ \textsc{rest} & \boxed{2} \end{bmatrix}, \boxed{3}\right) \overset{\forall}{\Longleftarrow} \begin{array}{c} \mathsf{append\text{-}phons}(\boxed{2},\boxed{4}) \wedge \\ \mathsf{append}(\boxed{1},\boxed{4},\boxed{3}). \end{array}$$

(ii) $\mathsf{append}(\textit{elist}, \boxed{1}\textit{list}, \boxed{1})$.

$$\mathsf{append}\left(\begin{bmatrix} \textsc{first} & \boxed{1} \\ \textsc{rest} & \boxed{2} \end{bmatrix}, \boxed{3}\textit{list}, \begin{bmatrix} \textsc{first} & \boxed{1} \\ \textsc{rest} & \boxed{4} \end{bmatrix}\right) \overset{\forall}{\Longleftarrow} \mathsf{append}(\boxed{2},\boxed{3},\boxed{4}).$$

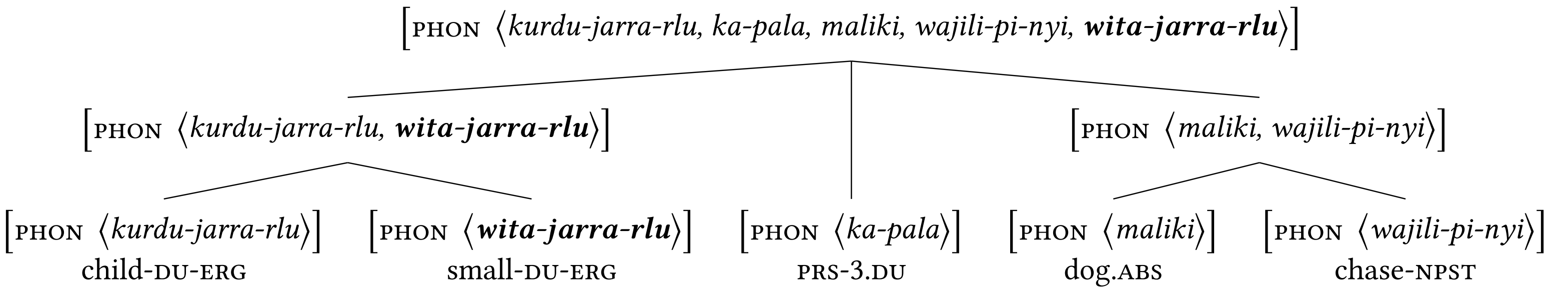

Figure 10: HPSG constituency structure of (16), with the form escaping the default word order constraints marked in bold

In LFG such a relaxed approach to word order is also in principle possible, on the assumption that there is a representation of the sentence string separate from c-structure. Such a separate string structure – sometimes called s-string (Dalrymple et al. 2019: Section 3.5) – is programmatically proposed in Kaplan (1987) and substantiated in Wescoat (2002), Asudeh (2009) and, especially, Dalrymple & Mycock (2011), among other works, but it is commonly assumed that the order of words in this additional string structure is the same as the order of leaves in c-structure. One exception to this common assumption are the analyses of cliticisation in Bögel et al. (2010) and in Lowe (2016), on which the position of clitics in the s-string may differ from their position in the tree.[22] However, to the best of my knowledge, there are no LFG analyses which would make a more substantial use of the possibility of relaxing the mapping between the s-string and the c-structure, analogous to those common in HPSG accounts of ellipsis.

3.3.2 Optionality of attributes

As has already been alluded to above and as will become fully clear in Section 4, grammars may be understood as theories describing certain linguistic objects. Figures such as 1 and 2 are representations of such objects. Both these figures represent all information that follows from all grammatical rules and principles of the respective grammars sketched in this section, but there is a sense in which the LFG representation in Figure 1 is complete while the HPSG representation in Figure 2 is only partial: it represents the effects of all constraints in the grammar proper, but it does not contain all information that follows from the type hierarchy.

Let us have a closer look at the INDEX values within structures corresponding to the word *you*. In both representations in Figures 1 and 2 this value is represented as an AVM with just one attribute, PERS, with a value indicating 2nd person. In the case of LFG, this is a complete description of the underlying feature structure; the linguistic object described by this subsidiary AVM has exactly one attribute: PERS. However, in the case of HPSG, the corresponding AVM is marked as representing a structure of type *ref*(erential index) and – according to the type hierarchy in Figure 7 (and the standard HPSG type system; see Pollard & Sag 1994: 399) – every *ref* object has exactly three attributes: PERS(on), NUM(ber), and GEND(er). Thus, the subsidiary AVM representing the value of INDEX for *you* is only a partial description of a complete linguistic object; any such object must also have specific values of NUM (*sg* or *pl*) and GEND (*m*, *f*, or *n*). That is, this

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[22] Such a mechanism of prosodic inversion is also alluded to – but not provided an LFG formalisation – in Simpson (1991: 69), Kroeger (1993: 140), and Austin & Bresnan (1996: 226).

subsidiary AVM describes six different kinds of linguistic objects, differing in number and gender.

This technical difference between the two formalisms reflects a potentially important linguistic difference between the two theories: to what extent are the described linguistic objects allowed to be partial or indeterminate?[23] Such partial objects were the staple of the original HPSG of Pollard & Sag (1987), where the described objects were understood not as strictly linguistic objects but rather as informational objects – bits of information (including disjunctive and negative information) that competent speakers have about language.[24] But it seems that LFG sides with the latter-day HPSG in describing linguistic objects rather than informational objects. So the difference between the two representations of the INDEX value for *you* seems to be a linguistically contentful – and potentially verifiable – difference: on the LFG view the pronoun *you* is specified for person but *unspecified* or neutralised for number and gender, while on the HPSG view it is *ambiguous* between different values of number and gender.

Interestingly, it is easy to simulate the HPSG approach in LFG, but it is far from obvious how to simulate the LFG approach in HPSG. In LFG, the lexical entry of *you* could be extended from (9) to (19), with the last two statements requiring that NUM and GEND be present and have values within appropriate sets:

(19) *you* Pron (↑ PRED) = ‘PRO’
(↑ PRONTYPE) = PERSONAL
(↑ INDEX PERS) = 2
(↑ INDEX NUM) ∈ {SG, PL}
(↑ INDEX GEND) ∈ {M, F, N}

This leads to six different f-structure representations of the pronoun *you*, differing in the values of NUM and GEND.

Within HPSG, a more complex type subhierarchy could allow for different subtypes of *ref*, one of which would only be specified for the attribute PERS; let us call this subtype *ref-pers*. Then, the pronoun *you* could have the INDEX value of type *ref-pers*, with PERS equal to *2*. Another subtype, let us call it *ref-pers-num*, would be specified for PERS and NUM, and it would be appropriate for INDEX values of pronouns *I* (PERS *1*, NUM *sg*) and *we* (PERS *1*, NUM *pl*). This solution, however, is problematic in view of the following examples:

(20) Creatures, I give you yourselves… (C.S. Lewis, *The Magician’s Nephew*)

(21) Creature, I give you yourself…

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[23] See also Kaplan (2019) for a discussion of this and related issues.

[24] See Richter (2004: Chapter 2) for a discussion of the differences between early and later HPSG.

The anaphoric pronouns *yourselves* and *yourself* are specified for person (2nd) and for number (plural and singular, respectively), but not for gender, so they should have INDEX values of type *ref-pers-num*. But, given the standard HPSG binding theory (cf. Section 4.3.2 below), these INDEX values should be equal to the INDEX values of the binder – the pronoun *you* in both examples above – so they should be of type *ref-pers*. The only way this is possible is that the two types, *ref-pers* and *ref-pers-num*, have a common subtype. But this common subtype would have to inherit the attribute NUM from *ref-pers-num*, so *ref-pers* would have a subtype with attribute NUM. Given that all objects in HPSG models – including all values of attributes – must bear maximally specific types (this will be made clear in Section 4.1 below), the pronoun *you* would be ambiguous: on one interpretation its INDEX would have a value (of this shared subtype) with NUM *sg*, on the other – with NUM *pl*. This would contradict the original motivation for the multiple subtypes of *ref*, namely, to make the pronoun *you* indeterminate with respect to number and gender, rather than ambiguous. It is not clear to me how to simulate within HPSG the behaviour of LFG – that is, how to make the pronoun *you* indeterminate with respect to number by default (i.e., apart from binding contexts such as (20)–(21)) – without complicating the standard HPSG binding theory.

In summary, while either approach may perhaps be simulated in the other theory, HPSG analyses naturally lead to a multiplicity of models differing in ways that linguists often do not care about, while LFG grammars naturally specify fewer linguistic objects, differing only in linguistically relevant aspects. We will return to this issue in Section 4.3.

3.3.3 Expressiveness

What is the relation of LFG and HPSG to the Chomsky–Schützenberger hierarchy of grammar formalisms (Chomsky 1956)? That is, what classes of languages do possible LFG and HPSG grammars describe? This question cannot be answered without making the notion of a "possible LFG/HPSG grammar" more precise. Given that both theories evolve and that at any particular point there are competing proposals about various aspects of the theories, this notion is not fully explicit and perhaps never will be.

Nevertheless, it is possible to ask about the complexity of the underlying formalisms, and it is clear that – without additional constraints – both are equivalent to Turing machines, i.e., they may describe any language that is algorithmically describable at all. There is no space here to formally prove this claim, but it is based on the well-known fact that attribute–value grammars may encode Turing machines (Johnson 1988: Section 3.4.2; see also Kaplan & Bresnan 1982: fn. 32). In particular, the unification grammar schema for simulating the effect of any Turing machine (i.e., for defining the same language as that recognised by that Turing machine) presented in Francez & Wintner (2012: Section 6.2) can be easily encoded in the formalisms underlying LFG and HPSG.[25]

Given this formal power of the underlying formalisms, the recognition problem (given a grammar and a sentence, is this sentence predicted by this grammar?) is undecidable – there is no general algorithm which could take an arbitrary grammar and sentence and always answer that question in finite time. In the case of LFG, this potential problem was recognised very early and a solution was proposed (Kaplan & Bresnan 1982: 266–267) in terms of what later became known as offline parsability (Pereira & Warren 1983: 142): a global condition on constituency structures, namely, that, first, they do not contain unary chains (subtrees with only unary branching) in which the same category appears twice and, second, that they do not use empty productions (i.e., that there are no empty leaves in the tree). The encoding of Turing machines in Francez & Wintner (2012: Section 6.2) violates both conditions (cf. fn. 25). A different way to make LFG grammars tractable is proposed – and references to other attempts are given – in Wedekind & Kaplan (2020).[26]

In the case of HPSG, the dominant underlying formalism (RSRL, Richter 1999, 2004; see Section 4.1) is known to be undecidable (Kepser 2004). A different formalisation, based on an extension of modal logic (namely, polyadic dynamic logic), is proposed and shown to have more desirable complexity properties in Søgaard & Lange (2009) but, to the best of my knowledge, it has remained largely unnoticed within the HPSG community.

Let me reiterate, however, that any less than desirable complexity results mentioned above pertain to formalisms underlying the linguistic theories, not to the

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[25] In the case of LFG, the schemata ρ_1–ρ_8 of Francez & Wintner (2012: 230–232) can be directly translated into LFG phrase structure rules by taking CAT values to be node labels and by encoding all the other information present in the AVMs in ρ_1–ρ_8 via straightforward functional equations. In the case of HPSG, these schemata may be encoded as Immediate Dominance Schemata (Pollard & Sag 1994: Section 1.5), with an additional PHON attribute collecting the terminal symbols (dually to how they are collected in the values of the LEFT attribute in Francez & Wintner 2012). Schemata ρ_1–ρ_8 are essentially – appropriately annotated (which is the source of the additional complexity) – right-linear grammars with binary branching rules for reading the terminal symbols and with unary branching rules – including an empty production – for simulating a Turing machine. It is easy to modify this encoding to get rid of the empty production (the unary rules encoding transitions of a Turing machine could be used at the top of the tree instead of at the right-hand bottom), but the use of effectively unary rules with possible repetitions of non-terminal symbols along unary chains is non-negotiable.

[26] Simplifying, Wedekind & Kaplan (2020) require of grammars that there be an upper bound on the number of different c-structure nodes that may map to the same f-structure.

theories themselves. As has been repeatedly noted in both frameworks (see, e.g., Kaplan & Bresnan 1982: 271–272, Johnson 1988: 94–95, and Richter 2004: 242–243), it is very well possible that linguistic constraints sufficiently delimit the space of possible grammars to make the recognition problem decidable and efficient, and – conversely – it is also possible that human languages are in fact undecidable. That means that high complexity results for a formalism underlying a linguistic theory should not necessarily be held against that theory.

3.3.4 Generative-enumerative or model-theoretic?

Pullum & Scholz (2001) divide syntactic frameworks into "generative-enumerative" (GE) and "model-theoretic" (MT). GE frameworks have a derivational feel: at their centre are instructions for rewriting certain strings or structures into other strings or structures. Typical examples are formal grammars in the sense of the Chomsky hierarchy, for example, CFGs such as that in (4′)–(9′), where particular rules are such instructions. In the top-down mode, one starts with the string "S" and uses the rules to rewrite any non-terminal symbols – e.g., the rule (4′) to replace "S" with "NP VP" – until the resulting string contains only terminal symbols, e.g., "*she loves you*". In the bottom-up mode, one starts with a string of terminal symbols, e.g., "*she loves you*", and uses the rules in the other direction, until the resulting string "S", e.g.: "*she loves you*" → "*she loves* Pron" → "*she loves* NP" → "*she* V NP" → "*she* VP" → … → "S". The language defined by a grammar is the set of those strings of terminal symbols for which this procedure succeeds. Examples of GE systems are various transformational grammars, Categorial Grammars, Tree-Adjoining Grammars, etc. GE frameworks have an analogue in syntactic – proof-theoretic – aspects of logic.

By contrast, MT frameworks have an analogue in semantic – model-theoretic – aspects of logic. Grammars are sets of logical formulae which may be understood as defining models (namely, those models in which all the formulae are true). An early – historical – example is Arc-Pair Grammar, but currently HPSG seems to be the most clear case of an MT framework (Pullum 2019: 60). We will have a closer look at models of HPSG grammars shortly, in Section 4.1.

Some GE frameworks have a somewhat mixed character: they have a GE backbone but they also impose certain constraints on the resulting structures.[27] Two examples are the transformational grammar of the 1980s (GB; Chomsky 1981, 1986) and, to some extent, Generalized Phrase Structure Grammar (GPSG; Gazdar et al. 1985). It seems that, at least as originally conceived, LFG belongs in

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[27] Thanks to Geoff Pullum for discussion and for the clarification that such "mixed" frameworks should still be classified as unambiguously GE.

the same category: there is a generative CFG backbone responsible for building c-structures (Kaplan & Bresnan 1982: 175), but also for generating functional statements which act as constraints on f-structures associated with particular c-structure nodes (Kaplan & Bresnan 1982: 181). The following quote makes this dual nature of the original LFG particularly clear:

> A string's constituent structure is generated by a context-free c-structure grammar. The grammar is augmented so that it also produces a finite collection of statements specifying various properties of the string's f-structure. (Kaplan & Bresnan 1982: 180–181)

If such statements – i.e., functional equations – cannot be satisfied, then the whole description for a given input fails, even if the c-structure rules produced an appropriate constituency tree for this input. The functional component thus acts as a filter on the output of the c-structure component (as explicitly stated in Kaplan & Bresnan 1982: 203–204).

Also some general LFG principles are formulated as constraints on possible f-structures (Kaplan & Bresnan 1982: 178–179, Dalrymple et al. 2019: Section 2.4.6): completeness and coherence jointly state that, simplifying a little, grammatical functions mentioned in PRED values must be exactly the grammatical functions occurring as attributes. The main f-structure in Figure 1 satisfies this constraint: PRED mentions SUBJ and OBJ and these are exactly the attributes which characterise grammatical functions in this f-structure. Similarly, f-structures which are values of SUBJ and OBJ satisfy this constraint: their PRED values do not mention any grammatical functions and none appears as an attribute in these f-structures.

Generative-enumerative frameworks may often be given model-theoretic reformulations. McCawley (1968) is usually credited with the observation that phrase structure rules may be understood as conditions on trees,[28] and fully-worked out MT equivalents of various GE formalisms were proposed by Rogers (1997, 1998). While there is no comprehensive MT formalisation of LFG, the description of the general architecture of LFG in Kaplan (1989: Section 2) is formulated in terms of conditions on particular structures, also on c-structures, and on correspondences between them,[29] and this view is prevalent in contemporary LFG.[30] For this rea-

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[28] But cf. Pullum (2007: Section 1.7).

[29] The slightly modified version of Kaplan (1989) published a few years later explicitly invokes "model-based approach" as "of course, the hallmark of LFG" (Kaplan 1995: 11). An earlier model-theoretic formalisation of an LFG-like formalism (but without the distinction between defining and constraining statements) is Johnson (1988). See also Blackburn & Gardent (1995) for another attempt (also limited to defining statements; cf. Börjars & Payne 2013).

[30] For example: "In LFG, phrase structure rules are not rewrite rules, rather they are 'node admiss-

son, Pullum & Scholz (2001: 20) classify “recent LFG” as “perhaps” MT. I will have much more to say about model-theoretic aspects of LFG and HPSG in Section 4.

3.4 Summary

In this section we looked at two rather specific differences between LFG and HPSG grammars and two more general aspects. One specific difference concerns word order: in HPSG, but not in LFG, the string is often – especially, in analyses of ellipsis – assumed to be dissociated from the constituency structure. The other concerns determinacy: HPSG analyses often lead to multiple structures, i.e., to ambiguity, while LFG analyses more naturally lead to more compact indeterminate structures. Interestingly, despite the expressive power of the two theories, it is not always clear how to elegantly simulate in one theory the analysis commonly assumed in the other.

The two more general issues are expressivity and relation to the generative-enumerative vs. model-theoretic dichotomy postulated in Pullum & Scholz (2001). Underlying formalisms of both theories, unless additionally constrained, have the expressive power of Turing machines; such additional constraints were proposed in LFG right at the beginning and are the topic of ongoing work, while much less attention is devoted to the matter of complexity in HPSG. Finally, HPSG is a prototypical model-theoretic theory, while the place of LFG in this dichotomy is less clear, as no explicit model theory has ever been proposed for LFG. This is the issue to which I turn next.

4 Models

Grammars like those discussed in Section 3 are *descriptions* of collections of linguistic objects, pictures like those in Figures 1 and 2 of Section 2 are *representations* of particular configurations of such objects, but what exactly are these *objects* themselves? That is, what are the models of LFG and HPSG grammars? The two theories differ considerably in the extent to which answers to these question are provided: fully explicit model theories are proposed in HPSG, but only sketches and intuitive ideas may be found in LFG. For this reason, in this section I start with HPSG. First, however, a few words about models in general.

Take the following formulae of first-order logic:

(22) $\forall x.\, \mathit{black}(x) \leftrightarrow \neg \mathit{white}(x)$

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ability conditions’ (McCawley, 1968); they are constraints rather than procedures.” (Snijders 2015: 61).

(23) $\forall x \forall y.\, bw(x, y) \rightarrow black(x) \wedge white(y)$

(24) $\forall x.\, black(x) \rightarrow \exists y.\, white(y) \wedge bw(x, y)$

(25) $\forall x.\, white(x) \rightarrow \exists y.\, black(y) \wedge bw(y, x)$

Together they are saying that everything is either *black* or *white* (see (22)) and that there is a relation, *bw*, which holds between *black* things and *white* things (see (23)) such that every *black* thing is in this relation with some (at least one) *white* thing (see (24)) and every *white* thing is related to some (at least one) *black* thing (see (25)). Informally speaking, the previous sentence is a description of possible models of formulae (22)–(25). One model is a two-element set such that one element is black, the other is white, and they are related. Another has two black elements and two white elements such that they are pairwise related, i.e., the relation *bw* denotes two pairs of elements. Another – one that also has two black elements and two white elements – is illustrated in Figure 11. The empty set is also a model, and there are infinitely many other models, both finite (of any cardinality apart from 1) and infinite (of any transfinite cardinality).

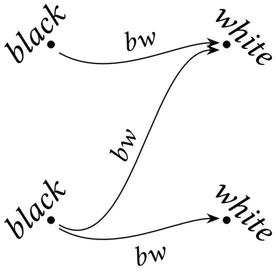

Figure 11: A model – one of many – of (22)–(25)

The meaning of the theory (22)–(25) may be equated with the collection of all models of that theory. However, we may want to exclude some models as not interesting or not really capturing what the formulae (22)–(25) are meant to capture. For example, perhaps we want models to be non-empty and – while possibly arbitrarily large – finite. The first condition may be stated by extending the theory with the formula $\exists x.\, x = x$.[31] However, the second condition, arbitrary finiteness, cannot be stated within first-order logic, so it must be stated meta-theoretically, as an additional constraint on permitted models.[32] As we will see below, both theories make use of such meta-theoretical conditions on models.

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[31] Given the formulae (22)–(25), the same effect may be achieved, e.g., with $\exists x.\, black(x)$ or with $\exists x.\, white(x)$.

[32] Alternatively, a more expressive logic could be adopted.

4.1 HPSG

Of all linguistic theories, HPSG is perhaps unique in its concentrated attention to the issue of what grammars actually describe – what the models of HPSG theories are. There is no place here to summarise the different proposals found in the HPSG literature; some of them are critically discussed in Richter (2004: Section 2.2). Here, I will describe informally – and in terms which facilitate comparison with standard logical models and with potential LFG models – what I assume to be the standard HPSG approach, namely, the model theory of RSRL (Richter 1999, 2004).[33]

As in mathematical logic, RSRL models are sets of objects which may have various properties and relations defined on them. The properties correspond to the maximal types – called species – of type hierarchies: each object is assigned exactly one species.[34] For example, assuming the hierarchy of Figure 7, it is not enough for an object to have the property *list*; it must be either *elist* or *nelist*. Similarly, any *sign* object must actually be either a *word*, or a *hd-subj-ph*, or a *hd-comps-ph*, or a *non-headed-phrase*. In other words, species of HPSG type hierarchies partition sets of objects in HPSG models, just like the properties *black* and *white* partition sets of objects in models of the first-order theory (22)–(25).

Attributes correspond to relations. For example, still assuming the type hierarchy in Figure 7, the attribute REST is modelled as a relation between *nelist* objects and *list* (i.e., *elist* and *nelist*) objects. Similarly, SYNSEM relates *sign*s (i.e., objects of one of the species: *word*, *hd-subj-ph*, *hd-comps-ph*, and *non-headed-phrase*) to objects of type *synsem* (which is a species, according to this type hierarchy). This is similar to the possible interpretations of the relation *bw* as defined in (22)–(25): the domain of that relation is the set of black objects, and the co-domain – the set of white objects. However, the meanings of HPSG attributes are not just any relations; they are total functions on sets of appropriate species (*nelist*, in the case of REST) with values in the set of objects of appropriate species (*elist* and *nelist*, in the case of REST).

Additional constraints on objects and relations between them are provided by the theory proper, i.e., by principles such as the HFP in (10), repeated below as (26), and the principles in (11)–(14).

(26) Head Feature Principle:

$$\textit{headed-phrase} \Rightarrow \begin{bmatrix} \textsc{synsem}|\textsc{cat}|\textsc{head}\ \boxed{1} \\ \textsc{hd-dtr}|\textsc{synsem}|\textsc{cat}|\textsc{head}\ \boxed{1} \end{bmatrix}$$

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[33] RSRL – Relational Speciate Re-entrant Language – adds relations and quantification to SRL – Speciate Re-entrant Language – of King 1989, 1999 (see also Pollard 1999). See Richter 2021 for an overview.

[34] That is, in the HPSG lingo, objects are *sort-resolved* (Pollard & Sag 1994: 18).

For example, HFP is saying that whenever there is an object of type *headed-phrase* – i.e., of species *hd-subj-ph* or *hd-comps-ph* – there must be other objects related via functions corresponding to HD-DTR, SYNSEM, CAT, and HEAD as illustrated in Figure 12. In this case, the value of the variable $\boxed{1}$ of (26) is the object number 7.

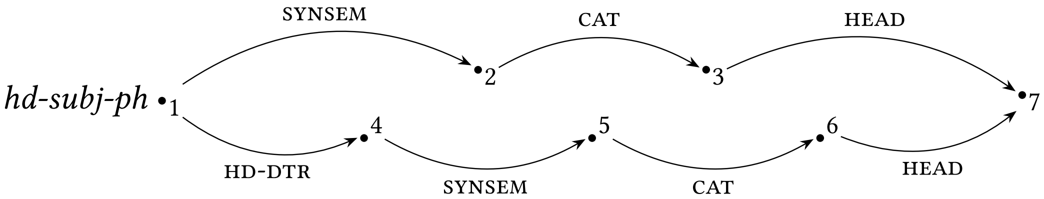

Figure 12: Configuration of objects satisfying the Head Feature Principle

Given the other principles and the type hierarchy, we know much more about this configuration of objects than is explicitly said in Figure 12. For example, the type hierarchy implies that the species of object 4 must be a maximal subtype of *sign*, the species of objects 2 and 5 must be *synsem*, etc. Additional constraints on configurations involving objects of type *hd-subj-ph* are imposed via one of the Valence Principles (namely, (11a)), etc.

Now, HPSG models are simply collections of objects such that each object satisfies all constraints following from the type hierarchy and the theory proper. For example, all seven objects in Figure 12 must satisfy HFP, not just object 1. And they all do, albeit – apart from object 1 – trivially: since objects 2–7 are not of type *headed-phrase*, the antecedent of HFP is false of them and the whole statement is true. But the configuration in this figure is not a complete model. For example, according to the type hierarchy in Figure 7, object 7, which is a value of HEAD, must be of type *head*, i.e., of species *verb* or *noun*. If it is a *verb*, there should be *vform* and *bool* objects in the model related to object 7 via attributes VFORM, AUX, and INV. If it is a *noun*, there should be an object related to object 7 via CASE. Similarly, according to the type hierarchy, object 1 should be related to two more objects via PHON and DTRS, and according to the Valence Principle (11a), the value of DTRS should be a two-element list, etc.

Since the late 1980s, all approaches to HPSG models agree with this general view of models, but they all impose additional – technical and sometimes philosophical – constraints on what counts as an interesting model. For example, the empty set is a model (all elements in this set satisfy all constraints), but a trivial one. Also a set consisting of just one object of species *elist* is a model, but it is not interesting. The common view is that HPSG models should be models of whole languages, that they should be exhaustive; in particular, a single exhaustive model contains configurations corresponding to all utterances licensed by the grammar. A little more technically but still very informally, exhaustive models simulate all other models: if there is a structure in some model, then this (or rather, an isomorphic) structure must also occur in an exhaustive model (King 1999). So, within a single exhaustive model, there are configurations of objects corresponding to the AVM in Figure 2,[35] other configurations corresponding to the utterance (2) (*You never give me your money*), and similarly for any other structures licensed by the grammar. This is a somewhat unusual approach to modelling; an analogous exhaustivity requirement in the case of the first-order theory (22)–(25) would mean that only infinite models are admitted, namely those which contain all possible correspondences of black and white objects.[36] We will return to this issue in Section 4.3.

The above considerations still leave open the question: What exactly are the objects in these models? For King (1999) they are bits of reality, actual linguistic tokens (e.g., every utterance of *She loves you* by anybody, ever), but also non-actual – potential – linguistic tokens, i.e., grammatical utterances which have the bad luck of never being actually uttered. This last notion is ontologically dubious, and also leads to proliferation of isomorphic structures within a single model, so it is not frequently subscribed to within the HPSG community.[37] Rather, it is often assumed that the objects in HPSG models are set-theoretic objects – or abstract feature structures – which only stand in conventional correspondence to actual or possible utterances (Pollard & Sag 1994, Pollard 1999). These abstract objects are designed in such a way that – simplifying again – any two isomorphic structures must actually be the same structure. Alternatively, the issue of what exactly these objects are is left unspecified, but an additional requirement is imposed that exhaustive models are minimal in the sense that they contain only one copy of any relevant configuration (Richter 2007).

4.2 LFG

While Kaplan (1995: 11) characterises LFG as “model-based”, no explicit and worked-out model theory has ever been proposed for LFG, as far as I know. Let us,

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[35] Recall that the AVM in that figure is still an underspecified description, as it does not fix values of NUM and GEND within the *ref* object marked as $\boxed{5}$. It is also underspecified in other respects, to be discussed in Section 4.3.2.

[36] In fact, such models would be so large that they would not be sets anymore, but would rather be proper classes.

[37] Also, apart from the curious notion of non-actual tokens, it is not clear what counts as a single utterance token. For example, when John Lennon and Paul McCartney sing together *She loves you*, is this a single token, or two tokens (or perhaps none, because they are singing rather than speaking)? Does the answer depend on whether they sing in unison or in harmony? How many linguistic tokens are there when the song is broadcast on the radio, if any? Does that depend on the number of listeners at different locations?

nevertheless, try to construct a possible model corresponding to the representation in Figure 1, a model that is consistent with informal descriptions in Kaplan & Bresnan (1982) and Kaplan (1995).

First of all, the model must contain a collection of objects representing the nodes of the c-structure, as well as a collection of node labels (Kaplan 1995: 10). I assume that both grammatical categories (e.g., S or Pron) and orthographic forms (e.g., *she*) are labels. There are three relations defined on these objects: M (mother) is the partial function from nodes to nodes, defined on all nodes apart from the root; $<$ is the partial ordering relation on nodes, and λ is a function from nodes to labels. So a part of the model for the representation in Figure 1, one that corresponds to the c-structure, may look as in Figure 13 (with the linear relation $<$ not represented explicitly). There are 18 objects in this model: eight labels (S, VP, V, NP, Pron, *she*, *loves*, *you*) and ten nodes (objects whose exact nature is left unspecified). For an LFG grammar to lead to such models, it must be translated into appropriate formulae, appropriate tree axioms must be stated explicitly, and these axioms should be formulated in such a way that they apply to tree nodes and not to labels or objects corresponding to feature structures.

Kaplan & Bresnan (1982) and Kaplan (1995) are much more explicit about the kinds of objects that correspond to feature structures. There are three types of objects involved in models of feature structures: atoms (e.g., PRED, SUBJ, NOM, 3, etc.), semantic forms (to the first approximation, strings such as 'LOVE⟨SUBJ,OBJ⟩'), and sets. In particular, feature structures are modelled as finite functions – sets of pairs such that the first element of a pair is an atom and the second element is either an atom, or a semantic form, or a feature structure (i.e., a set again).[38] For example, the AVM in (27) is a representation of the set of pairs in (28), i.e. – given the commonly assumed Kuratowski's encoding of a pair $\langle a, b\rangle$ as the set $\{\{a\}, \{a, b\}\}$ (see, e.g., Enderton 1977: 36) – the set in (29).[39]

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[38] Together with Kaplan & Bresnan (1982) and Kaplan (1995), I do not take into consideration sets other than those which model feature structures, i.e., I ignore here coordinate structures, values of the attribute ADJUNCT, etc.

[39] One potential problem with this standard LFG understanding of f-structures as sets is that, given the possibility of cyclic f-structures – naturally occurring in analyses of various types of modification, e.g., Johnson (1988: 19–20), Zweigenbaum (1988), and Haug & Nikitina (2012: 298), and in other contexts, e.g., Fang & Sells (2007: 209), Przepiórkowski & Patejuk (2012: Section 4.3.2), and Dalrymple et al. (2020) – sets that are used for modelling f-structures are not the well-founded sets of the standard (Zermelo–Fraenkel) set theory, but must rather rely on the non-standard notion of non-well-founded sets (see Aczel 1988: 103–112 on the history of this notion). To the best of my knowledge, this has not been noticed in the LFG literature so far.

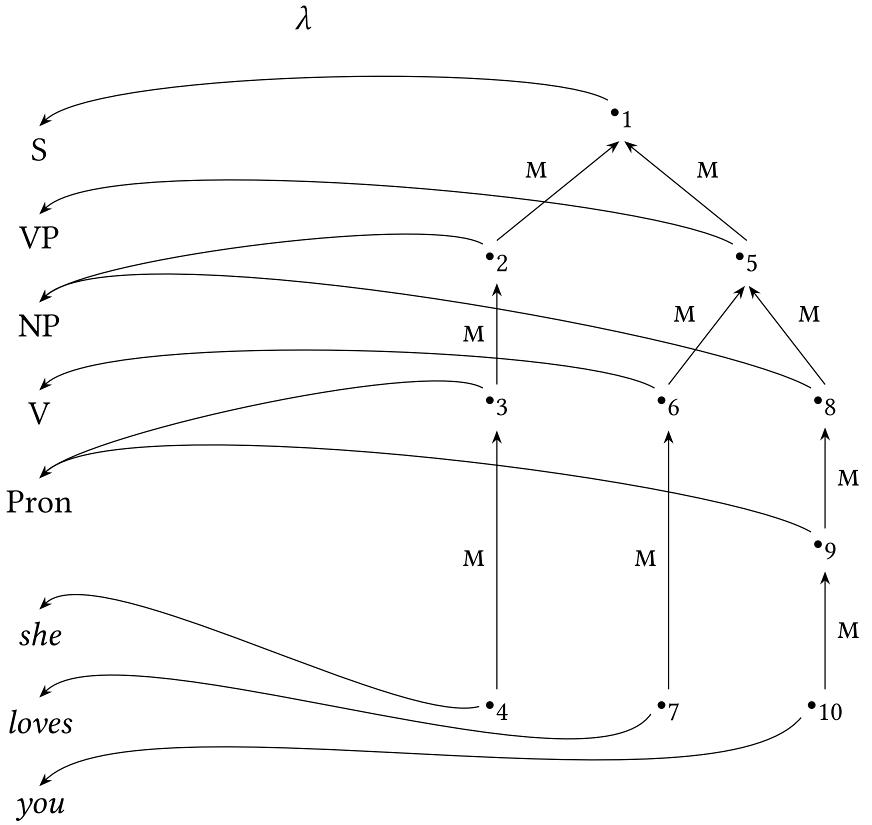

Figure 13: A possible LFG model of the c-structure of *She loves you* (without explicit representation of <)

(27) $\begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{f} \end{bmatrix}$

(28) $\{\langle \textsc{pers}, 3\rangle, \langle \textsc{num}, \textsc{sg}\rangle, \langle \textsc{gend}, \textsc{f}\rangle\}$

(29) $\{\ \{\{\textsc{pers}\}, \{\textsc{pers}, 3\}\},\ \{\{\textsc{num}\}, \{\textsc{num}, \textsc{sg}\}\},\ \{\{\textsc{gend}\}, \{\textsc{gend}, \textsc{f}\}\}\ \}$

Since some parts of f-structures (values of particular attributes, as well as attributes themselves) may be directly referred to in functional equations, they must all be direct elements of the model. That is, sets representing f-structures cannot be considered unanalysable elements of models; rather, the subsets and atoms within such sets must also be elements of LFG models, so they should be explicitly related by the (converse of the) membership relation $\in$. Hence, the set in (29) corresponding to the f-structure (27) translates into the configuration of model objects in Figure 14. There are 10 nodes in this configuration that encode particular sets (with node 1 representing the whole f-structure (27)) and six nodes are atoms.

The model in Figure 14 is rather complex, when compared to the simplicity of the AVM in (27). Why not assume the model in Figure 15 instead?[40] Unfortunately, as explained in more detail presently (in Section 4.3.1), this simpler model is incompatible with the LFG idea that attributes and atomic values are ontologically the same kinds of entities, namely, atoms. By contrast, according to the model in Figure 15, atomic values are atoms – objects of the universe of the model – but attributes are binary relations on such objects, i.e., ontologically very different entities. Hence, in the following I will assume the model in Figure 14 as most directly reflecting the LFG view that f-structures are finite functions.

Le me finish this section by noting that configurations in Figures 13 and 14 are fragments of a larger model corresponding to the representation of *She loves you* given in Figure 1. The complete model would also contain strings representing semantic forms, as well as more atoms, many more sets representing the full f-structure, sets representing the s-structure, and relations ϕ and σ.

4.3 Comparison

4.3.1 Modelling feature structures

It should be clear from the above discussion that AVM representations correspond to very different model configurations in the two theories. For example, while the HPSG model of the AVM in (30), shown in Figure 16, contains just four nodes corresponding directly to the whole index (object 1 of species *ref*), to 3rd person (object 2 of species *3*), to singular number (3 – *sg*), and to feminine gender (4 – *f*), the LFG model of the corresponding AVM in (27), shown in Figure 14, contains 16 nodes modelling not only the whole f-structure and the respective values of the three attributes, but also the attributes themselves and various intermediate sets.

(30)
$$\begin{bmatrix} \textit{ref} & \\ \textsc{pers} & \textit{3} \\ \textsc{num} & \textit{sg} \\ \textsc{gend} & \textit{f} \end{bmatrix}$$

This is not an incidental difference between the two theories. In HPSG, attributes such as PERS, NUM, and GEND and types such as *3*, *sg*, and *f* have very different interpretations: attributes denote relations (partial functions) between

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[40] Compare the HPSG model of (30) in Figure 16 below. Such simpler models, in which feature structures are represented as objects and attributes as relations on objects, are also common in other theories working with AVMs (see, e.g., Blackburn & Spaan 1993: 132–133).

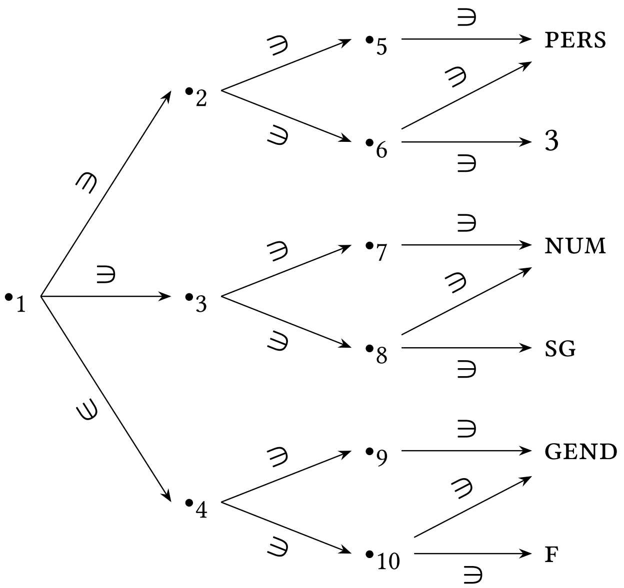

Figure 14: A possible LFG model of the f-structure in (27)

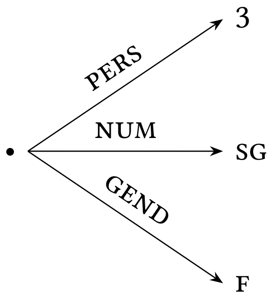

Figure 15: A hypothetical simpler model of the AVM in (27)

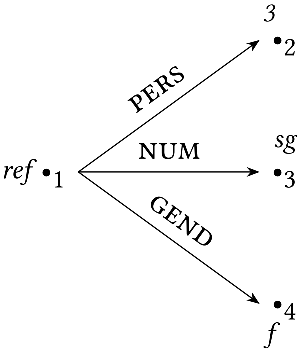

Figure 16: An HPSG model of the AVM in (30)

objects in the model, while types denote properties that objects may have. In particular, different objects may – and often do – have the same species, so there can be many objects of type *sg*, etc. This difference between attributes and types is rendered typographically by using small capitals for attributes and italics for types.

On the other hand, in LFG, attributes such as pers, num, and gend and their atomic values such as 3, sg, and f are the same kinds of objects, namely atoms, each of which may occur in the model just once (there is only one atom sg, etc.). Hence, there is also no typographic distinction between attributes and atomic values of attributes.

This ontological uniformity of attributes and atomic values is taken advantage of in some LFG analyses. For instance, according to the analysis of oblique arguments in Kaplan & Bresnan (1982: 196–201), a "case-marking" preposition which may introduce such an oblique argument defines the value of the attribute pcase to be the oblique function homonymous with this preposition, e.g.:

(31) *to* P (↑ pcase) = to

This feature and its value are also present in the f-structure corresponding to the resulting PP constituent. Verb forms like *handed*, as used in (32) from Kaplan & Bresnan (1982: 196), expect – apart from any subject and objects – an argument bearing this grammatical function, see (33).

(32) A girl handed a toy to the baby.

(33) *handed* V (↑ pred) = 'hand⟨subj,obj,to⟩'
(↑ tense) = pst

Finally, an appropriate VP rule – simplified here to (34) – contains the crucial equation (35) on the PP:

(34)
$$\begin{array}{llll} \text{VP} \longrightarrow & \text{V} & \text{NP} & \text{PP} \\ & \downarrow = \uparrow & (\uparrow \text{obj}) = \downarrow & (\uparrow (\downarrow \text{pcase})) = \downarrow \\ & & (\downarrow \text{case}) = \text{acc} & \end{array}$$

(35) (↑ (↓ pcase)) = ↓

Applied to the sentence (32), with the PP *to the baby*, (↓ pcase) in equation (35) evaluates to to, so the whole equation is equivalent to (↑ to) = ↓. Note that to, the atomic value of pcase of the preposition *to*, is used here as an attribute indicating an oblique grammatical function. While such double use of atoms as values and attributes is rare in actual LFG analyses, it is not unique to the account of obliques in Kaplan & Bresnan (1982); for example, it also occurs in the formalisation of information structure in Dalrymple & Nikolaeva (2011: Sections 4.3.3–4.3.5).

The above considerations do not imply that not distinguishing attributes from atomic values necessarily leads to such complex models as that partially illustrated in Figure 14. For example, Johnson (1988: Section 2.1.3) defines models of f-structures as consisting of a set of atoms, a set of objects directly modelling particular feature structures, and a 2-argument partial function δ whose first argument is an f-structure, second argument is an atom *qua* attribute, and the value is the value of this attribute in this f-structure. On this approach the AVM in (27) receives a model that may be represented pictorially as in Figure 17. Note, however, that on this view feature structures are no longer sets of ⟨attribute, value⟩ pairs, contrary to Kaplan & Bresnan (1982) and Kaplan (1995).

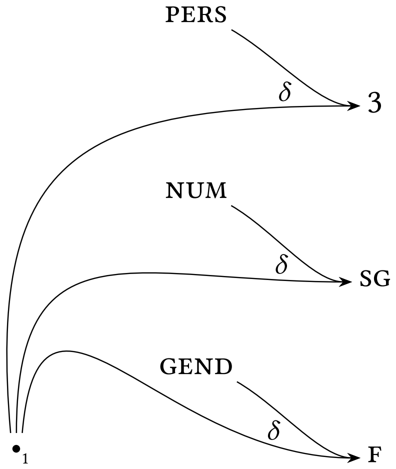

Figure 17: A model of the f-structure in (27) as in Johnson (1988)

4.3.2 Identity of indiscernibles?

Both theories have trouble with indiscernible structures. Let us illustrate this with sentence (36).

(36) She says she loves you.

Consider the LFG f-structure for this sentence in Figure 18. In the model configuration corresponding to this AVM there are single objects representing particular atoms: just one object NOM, one SG, one PRS, one TENSE, etc. Moreover, since feature structures are sets of ⟨attribute, value⟩ pairs, the two INDEX values – the substructures marked as $\boxed{2}$ and $\boxed{4}$ – are the same set (namely, the one in

(29)), so they should be modelled with the same single object in the model (or, more precisely, with a single configuration of objects shown in Figure 14, rooted in the same object 1). The problem is that nothing in our reconstruction of the intended LFG model theory guarantees this: two different models are possible, one in which $\boxed{2} = \boxed{4}$, and one in which $\boxed{2} \neq \boxed{4}$. Only the first of these models properly encodes the idea that feature structures are sets.[41] We will return to this issue below, when discussing HPSG models.

$$
\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{say}\ \langle\textsc{subj},\textsc{comp}\rangle\text{’} \\
\textsc{subj} & \boxed{1}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{pro}\text{’} \\
\textsc{prontype} & \textsc{personal} \\
\textsc{case} & \textsc{nom} \\
\textsc{index} & \boxed{2}\left[\begin{array}{ll}
\textsc{pers} & 3 \\
\textsc{num} & \textsc{sg} \\
\textsc{gend} & \textsc{f}
\end{array}\right]
\end{array}\right] \\
\textsc{comp} & \left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{love}\ \langle\textsc{subj},\textsc{obj}\rangle\text{’} \\
\textsc{subj} & \boxed{3}\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{pro}\text{’} \\
\textsc{prontype} & \textsc{personal} \\
\textsc{case} & \textsc{nom} \\
\textsc{index} & \boxed{4}\left[\begin{array}{ll}
\textsc{pers} & 3 \\
\textsc{num} & \textsc{sg} \\
\textsc{gend} & \textsc{f}
\end{array}\right]
\end{array}\right] \\
\textsc{obj} & \left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{pro}\text{’} \\
\textsc{prontype} & \textsc{personal} \\
\textsc{case} & \textsc{acc} \\
\textsc{index} & \left[\textsc{pers}\ \ 2\right]
\end{array}\right] \\
\textsc{tense} & \textsc{pres}
\end{array}\right] \\
\textsc{tense} & \textsc{pres}
\end{array}\right]
$$

Figure 18: F-structure for (36)

The bigger problem is that, if f-structures are sets, the two f-structures representing *she*, i.e., $\boxed{1}$ and $\boxed{3}$ in Figure 18, are the same set-theoretical object. (In the modelling of f-structures suggested above they may be the same object, but – as discussed in the previous paragraph – they do not have to be.) But LFG requires that they be different objects – we do not want to say that the two ‘PRO’ values

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[41] Interestingly, the XLE platform for implementing LFG grammars (Crouch et al. 2011), normally very faithful to the LFG theory, does not treat f-structures as (standard) sets: there, two indiscernible f-structures are assumed to be different objects, unless there is a statement in the grammar that explicitly requires their identity.

in these f-structures necessarily refer to the same person. The way LFG deals with this problem is to assume that PRED values – semantic forms – come with unique indices (normally not shown in AVMs), i.e., that whenever an equation like (↑ PRED) = ‘PRO’ is used, a new index is assigned to the semantic form. So the two references to the lexical entry for *she* in (8) that are made in the process of constructing the f-structure in Figure 18 result in two different equations, as if the following two statements were used:

(37) a. (↑ PRED) = ‘PRO’$_1$
 b. (↑ PRED) = ‘PRO’$_2$

Unfortunately, this mechanism, as it stands, seems to be inherently procedural: at the relevant step of the derivation it must be known which indices have already been used so that a new index can be assigned to a new semantic form. It is not immediately clear how to translate this mechanism to the model-theoretic view of LFG.[42]

Also HPSG has a problem with stating when exactly indiscernible structures should be treated as being the same structure.[43] In HPSG, not even atoms are guaranteed to be unique, so one of the models of sentence (36) (*She says she loves you*), whose partial AVM is given in Figure 19, might involve the configuration in Figure 20, with single objects of type *3* and *sg* and two different objects of type *f*. Given two different *ref* objects, there are eight possible configurations of this part of the model, and given also the possibility of two different *nom* objects, two different *she* objects (in PHON values), different *elist* objects, etc., there are billions of different models of sentence (36), all described by the AVM in Figure 19, differing in ways that linguists do not care about.[44] This contrasts with the efforts

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[42] Given that PRED values are largely redundant (cf. Section 2.1 and fn. 12), this problem may be solved by removing PRED from f-structures altogether. Another – perhaps more conservative – possible solution, suggested by Ash Asudeh (p.c.), is to provide indices with sufficient inherent structure to guarantee their uniqueness. In the simple case of (36), it would suffice to take indices to be the relevant c-structure nodes, but a more complex solution is required to also apply to ‘PRO’ values of PRED in the case of pro-dropped constituents (especially in languages which allow pro-dropping of multiple arguments of a single predicate).

[43] The problem to be described presently is sometimes called “Höhle’s problem” (Pollard 2001, 2014: 113).

[44] Each word introduces three lists (values of PHON, VAL|SUBJ, and VAL|COMPS), and there are five words in this sentence, so there are 15 *elist* objects stemming from words alone. The number of different ways to partition a set of *n* elements into equivalence classes is given by Bell numbers B_n, and B_{15} = 1,382,958,545 (see https://oeis.org/A000110/list). This should be multiplied by the eight configurations of the two *ref* objects, etc. Richter (2007) proposes a constraint to the effect that all *elist* objects are the same object, but the problem of the other spurious ambiguities remains.

within HPSG (Pollard & Sag 1994, Pollard 1999, Richter 2007) to make models of various interpretations of utterances unique (at least up to isomorphism).

Now, it is possible to formulate within RSRL a constraint that makes sure that all indiscernible structures are in fact the same structure (Sailer 2003: Section 3.1.4), but such a constraint, if applied indeterminately, would be incompatible with various HPSG analyses – most importantly, with the standard HPSG binding theory (Pollard & Sag 1994: Chapter 6).[45] There is no space to present that theory here (see Müller 2021a for an overview), but suffice it to say that the traditional generative notion of coindexation is understood here literally: as identity of INDEX values. For example, the sentence (36) is assumed in HPSG to have two different structures corresponding to the following two indexations:

(38) a. She$_i$ says she$_i$ loves you.
b. She$_i$ says she$_j$ loves you. $(i \neq j)$

So while any model of (38a) should equate INDEX values within the two words *she* in this sentence, these INDEX values must be different objects in any model of (38b), even though they are indiscernible.

To the best of my knowledge, the problem of avoiding spuriously distinct models in a way that does not conflict with existing HPSG analyses (in particular, with the standard binding theory) remains unsolved.

4.3.3 Conditions on models

Both theories impose meta-theoretical conditions on what counts as an intended model. As mentioned in Section 4.1, the common constraint on HPSG models is that they be exhaustive, i.e., informally speaking, simulate all other models: they should contain all structures admitted by the grammar. The intuition behind this requirement is that a single model corresponds to the whole language described by the grammar.

LFG apparently assumes the more common view of models, where each model corresponds to a single utterance, and it is only the collection of all such models that corresponds to the whole language. However, meta-theoretical conditions on LFG models are in a way more complex than conditions imposed on HPSG models.

First of all, LFG models are required to be minimal. For example, functional equations in the lexical entry of *she* (see (8)) involving the attribute INDEX, i.e.

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[45] Also the architecture for phonology proposed in Höhle (1999) crucially relies on not all indiscernible structures being the same structure. Sailer (2003) formulates the relevant constraint in such a way that it only applies to one type of structures.

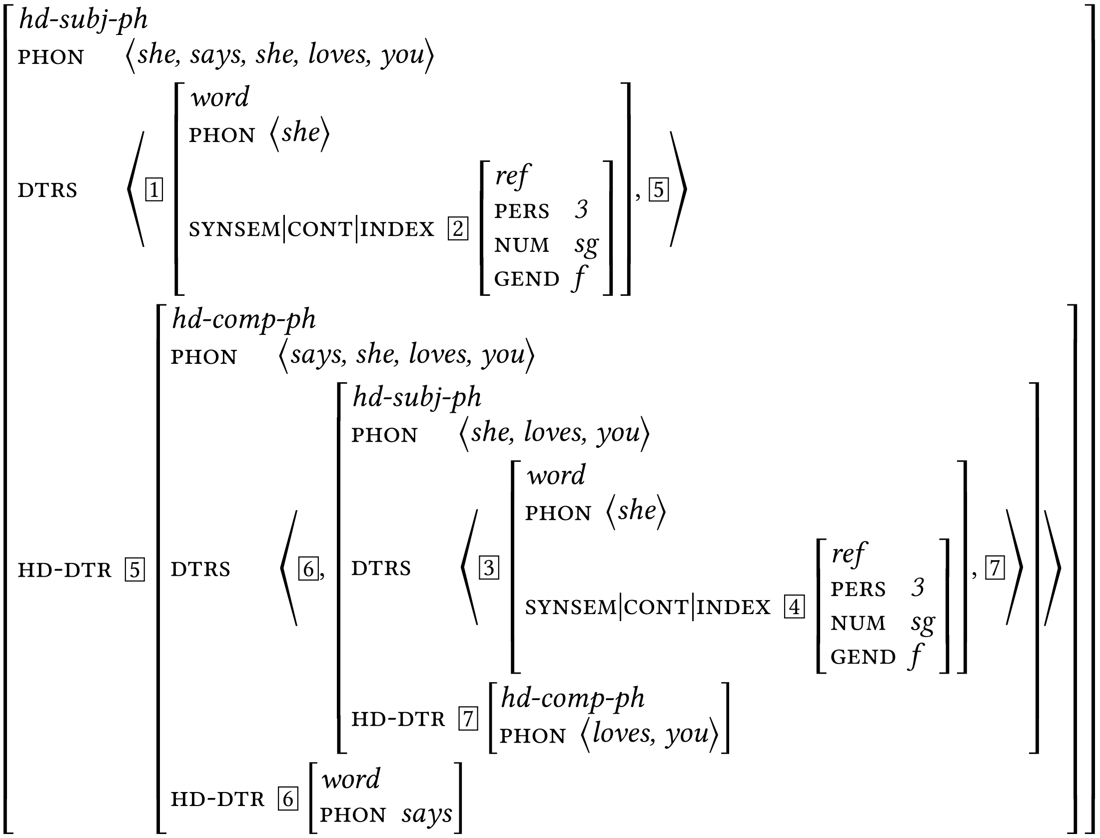

Figure 19: Partial HPSG representation of (36)

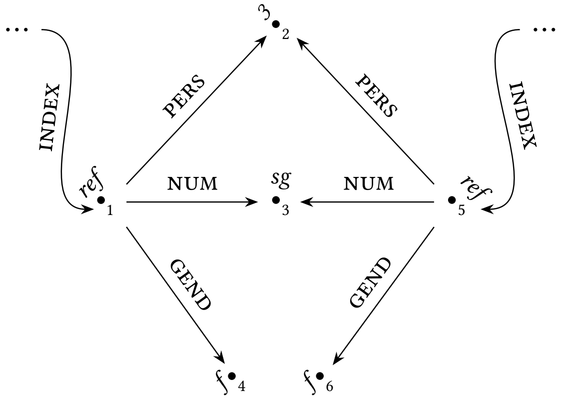

Figure 20: A fragment of a possible HPSG model of the AVM in Figure 19

equations repeated below in (39), describe as a possible value of INDEX not only the feature structure in (27), repeated below as (40), but also the one in (41) and infinitely many others, including infinite feature structures (both infinitely embedded and – on the assumption that the set of atoms may be infinite – with an infinite number of attributes).

(39) $(\uparrow \textsc{index pers}) = 3$
$(\uparrow \textsc{index num}) = \textsc{sg}$
$(\uparrow \textsc{index gend}) = \textsc{f}$

(40) $$\begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{f} \end{bmatrix}$$

(41) $$\begin{bmatrix} \textsc{pers} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{f} \\ \textsc{arbi} & \textsc{trary} \\ \textsc{non} & \begin{bmatrix} \textsc{sen} & \textsc{se} \end{bmatrix} \end{bmatrix}$$

Other constraints in the grammar do not preclude such values of INDEX, so a meta-theoretical constraint is needed to the effect that only minimal feature structures satisfying the grammar are admitted within models. Technically, this amounts to defining a partial order on models and admitting only the minimal elements of this order.

The second condition on models is more complex and concerns constraining statements such as (42a) (from the grammar rule (4)) and (42b) (from the lexical entry (7)).

(42) a. $(\downarrow \textsc{tense})$
b. $(\uparrow \textsc{subj index pers}) =_c 3$

Such statements are understood as additional filters on the minimal models of a grammar, or – more precisely – on the minimal models of the version of the grammar with all such constraining statements removed.

The precise model-theoretic nature of this mechanism has never, to the best of my knowledge, been specified. Constraining statements of this kind are not mentioned in the model-theoretic view of LFG of Kaplan (1995), and they are explicitly excluded in previous attempts to provide LFG (or LFG-like) formalisms with a model theory (see Johnson 1988: Section 4.2 and Blackburn & Gardent 1995: Section 6; see also Börjars & Payne 2013). But once meta-theoretical quantification over models and relations on models are permitted – and they are already inherent both in the HPSG notion of exhaustive models and the LFG notion of minimal models – it is possible to understand constraining statements in model-theoretic terms. One possibility is this:[46]

- Let θ be an LFG grammar, understood as a set of logical formulae. Some of the (sub)formulae are marked as constraining, the others are understood as defining.
- Let θ_{all} be the whole grammar θ without any division of (sub)formulae into defining and constraining, and θ_{def} – the same grammar with all constraining (sub)formulae removed.
- Let M_{all} be the collection of all models of θ_{all}, and M_{def} – the collection of all *minimal* models of θ_{def}.[47]
- Then $M \overset{\mathrm{df}}{\equiv} M_{def} \cap M_{all}$ is the collection of admitted models of θ.

The idea here is that M_{def} is the collection of all minimal models before the constraining filters are applied, and the intersection with M_{all}, i.e., with models in which all constraining statements are satisfied, removes from M_{def} those models which do not satisfy some constraining statements.

4.4 Summary

This section, aiming to present and compare model theories assumed in HPSG and LFG, is more speculative than the previous sections. The reason is that one object of comparison exists and the other does not, so it was necessary to reconstruct a possible model theory of LFG from informal and very partial suggestions.

Perhaps surprisingly, it turns out that the idea that f-structures are sets of ⟨attribute, value⟩ pairs does not translate into elegant models, but rather creates an overhead of the need to represent these sets as objects within models. Also, additional care needs to be taken to ensure that co-extensional sets are really the same model objects. Moreover, it is not immediately clear how to formally

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[46] Given that statements may contain disjunctions, and that different constraining statements may occur in different disjuncts, the actual definition would have to be more complex: grammars would have to be converted to a disjunctive normal form and collections of models would have to be defined for each disjunct of this normal form. Then the final collection of models of the grammar would be the sum of all such collections.

[47] Formally, minimal models are the minimal elements of the subsumption relation defined on models as in Johnson (1988: Section 2.8).

and non-procedurally ensure unique indexation of semantic forms. Nevertheless, despite these difficulties, and despite the fact that constraining statements were excluded from previous attempts to construct a model theory for LFG, it is not difficult to imagine how to construct such a model theory, if only appropriately powerful meta-theoretical operations on candidate models are permitted (as – to some extent – they already are, given the minimality requirement).

Also somewhat surprisingly, while much attention has been devoted to model theory within HPSG, there are still unsolved problems there, concerning the multiplicity of different models admitted by typical HPSG grammars, differing in ways that linguists often do not suspect, and certainly do not care about.

Let the conclusion of this section be that, despite their age and stability, both theories would benefit from more work on their formal foundations.

5 Conclusion

So how similar are LFG and HPSG? I agree with Carl Pollard that in some ways they are more similar than sometimes perceived:

> I believe that the difference between LFG and so-called PSG [i.e., theories such as GPSG and HPSG; AP] is no greater than the differences among various theoretical proposals within PSG, or even within HPSG itself. As far as I am concerned, then, the separation between PSG and LFG exists more at a sociological level than at the level of scientific content – but I am aware that not everyone agrees about this. (Pollard 1997: 4)

In particular, the difference between the multi-level representations of LFG and the monolithic AVMs assumed in HPSG is – in my view – of little formal consequence, although it is certainly important for the compactness and readability of resulting structures.

In fact, LFG and HPSG converge in many respects. As emphasised above, both theories are highly formalised and – unlike derivational theories or Categorial Grammar – both are self-described as constraint-based or model-theoretic, although HPSG may boast of much more developed model theories. Importantly, both have well-developed computational platforms for implementing grammars: XLE (Crouch et al. 2011) in the case of LFG and LKB (Copestake 2002) and Trale (Carpenter et al. 2003) in the case of HPSG, with XLE allowing for very direct implementations of theoretical analyses.[48] In both cases, large-scale grammars of multiple languages have been developed.

Also, unlike some of the other highly formalised and implementable theories, both LFG and HPSG are empirically rich. A plethora of analyses of multiple phenomena in typologically varied languages have been offered within each theory, in a great many articles appearing in the best linguistic journals and in numerous monographs published by the most prominent publishers. Both have very well developed semantic components, and both make it possible to formulate precise analyses encompassing multiple linguistic levels. As emphasised in Wechsler & Asudeh (2021), many phenomena receive similar accounts in the two theories.

In summary, it is clear that LFG and HPSG are close neighbours in the linguistic theoretical landscape of the early 2020s, and it is my hope that this chapter encourages more neighbourly collaboration between the two theories.

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[48] More precisely, XLE makes it possible to faithfully implement syntactic and – with extensions described in Dalrymple et al. (2020) – semantic parts of LFG analyses. In the case of HPSG, Trale seems to be closer to its constraint-based nature, while LKB is more efficient and well-developed.

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Chapter 40

LFG and Minimalism

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I compare and contrast LFG and the Minimalist Program (Chomsky 1995) with regard to different overall aspects of the frameworks: fundamental design properties, the representation of phrase structure, the representation of clausal grammatical information, the nature and role of syntactic features, and the analysis of agreement.

1 A framework for comparison

LFG and the Minimalist Program (MP; Chomsky 1995, 2000) are not straightforwardly comparable, as they are articulated in quite different ways. Going back to the 1980s, it could be said that LFG and Government-Binding Theory (Chomsky 1981) had a certain amount of commonality of approach, but as MP has developed from the earlier Government-Binding theory (GB), more and more emphasis has been placed in MP on derivation (see e.g. Hornstein et al. 2006, Hornstein 2018), rather than on information and representation, which are of course cornerstones of LFG.

As both LFG and GB were responses to theoretical concerns about "classical" transformational grammar, which was developed during the 1970s, it is useful to start with the legacy of the early transformational period, which I summarize in (1):

(1) a. the overt part of syntax is represented in a phrase structure tree
    b. all information in syntax is structured
    c. different parts of a syntactic representation may share information

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As GB has developed into MP, it has been assumed that (1b-c) refer to the same structure as (1a): that only the structures of phrase structure represent syntactic information, and that relationships are expressed in that structure, being established by movement operations. For instance, topicalization of an object creates a relationship between a topic position and an object position, as a result of a derivational operation in the MP.

LFG is a framework which is also based on the principle that all syntactic information is structured, but importantly that not all syntactic information is structure in the sense of phrase structure, and so it embodies (1) by having (at least) three aspects to the overall representation of a sentence:

(2)
  a. overt phrase structure (c-structure)
  b. a clause-level representation of the information it conveys (f-structure)
  c. an argument-structure representation for predicate-argument structure (a-structure)

All syntactic frameworks have a means to represent argument structure, and for any given predicate, its argument structure is structured according to the Thematic Hierarchy (e.g. Jackendoff 1972) or something equivalent. This is a-structure in LFG (see Findlay et al. 2023 [this volume]). There is a mapping between this structure and the surface grammatical properties, f-structure, which is the representation of (2b). These properties include the GFs such as SUBJ and OBJ. The representation of clausal grammatical information (2b) is not part of the phrase structure representation (2a), but rather is the information that the overt structure conveys. This clausal representation is nevertheless structured in the sense that the information it contains is organized and grouped, according to principles of organization pertinent to this level.

This is different to the approach to clausal information in the MP, where information may start out quite distributed throughout the overall derivation, but can be aggregrated through successive movements, but also modified (e.g. a feature specification being used to drive one operation, then being deleted subsequent to the application of that operation; see Section 4.2). The core arguments of a predicate are merged first into a vP-VP structure (see Chomsky 1995: 315ff.) and this is the representation of argument structure; the internal argument(s) merge into VP and the external argument is the specifier of vP. Then further functional structure such as TP or CP is projected above vP. Functional or relational properties such as ‘subject’ and ‘object’ are characterized by the particular ‘Agree’ relations between v and Obj and between T and Subj.

Broadly speaking, the "subjecthood" properties identified by Keenan (1976) divide into those which properly refer to argument structure, and those which refer to clausal grammatical information (Manning 1996). Different syntactic phenomena may relate to either representation. For instance, anaphor binding is determined by the argument structure hierarchy in some languages (e.g. Schachter 1976 on Tagalog; Wechsler & Arka 1998 on Balinese). In other languages, the hierarchy of grammatical functions holding over f-structure is most relevant (see e.g. Bresnan 2001: 212–213; Bresnan et al. 2016: 217 on 'syntactic rank').

The representations of argument structure and of clausal information are largely language-invariant, though the mapping between them shows more variation, as do the ways in which different syntactic phenomena refer to them. The information that they represent is carried by the overt phrase structures, (2a), which are of course subject to the most variation, and therefore the least revealing about "deep" properties of language.

In this chapter I evaluate different aspects of the LFG and MP approaches to grammatical theory. In Section 2 I consider overall "design features" of the frameworks, and what motivates them. In particular I outline how LFG took a different direction from transformational grammar. In Section 3 I contrast the approaches of the frameworks to phrase structure, and how the balance of analysis between c-structure and f-structure falls in LFG. Finally in Section 4 I compare the role(s) that features play in LFG and in MP, and how featural specifications participate in agreement.

2 Design features of a grammatical framework

Kaplan (2019a) gives a personal statement of how the passage below from Chomsky (1965) inspired his research which became part of the foundation of LFG (see e.g. Kaplan & Bresnan 1982: 173–174):

> No doubt, a reasonable model of language use will incorporate, as a basic component, the generative grammar that expresses the speaker-hearer's knowledge of the language; but this generative grammar does not, in itself, prescribe the character or functioning of a perceptual model or a model of speech production. (Chomsky 1965: 9)

Kaplan also pursued the idea that linguistic complexity will be best modelled through (possibly complex) interactions of different (relatively simple) components, different representational dimensions, inspired by Simon (1962).

In this section I will consider how LFG addresses the core aims of a generative grammar, and how it has done so according to certain key foundational properties which set it apart from the procedural approach which has characterized the GB/MP approach led by Chomsky.

2.1 Levels of adequacy

One way to approach how a given framework takes up the agenda for Generative Grammar is to consider how the framework concerns itself with Chomsky's successive levels of adequacy:

> To summarize briefly, there are two respects in which one can speak of "justifying a generative grammar." On one level (that of descriptive adequacy), the grammar is justified to the extent that it correctly describes its object, namely the linguistic intuition – the tacit competence – of the native speaker. In this sense, the grammar is justified on external grounds, on grounds of correspondence to linguistic fact. On a much deeper and hence much more rarely attainable level (that of explanatory adequacy), a grammar is justified to the extent that it is a principled descriptively adequate system, in that the linguistic theory with which it is associated selects this grammar over others, given primary linguistic data with which all are compatible. In this sense, the grammar is justified on internal grounds, on grounds of its relation to a linguistic theory that constitutes an explanatory hypothesis about the form of language as such. The problem of internal justification – of explanatory adequacy – is essentially the problem of constructing a theory of language acquisition, an account of the specific innate abilities that make this achievement possible. (Chomsky 1965: 26–27)

Since the GB era, Chomsky has taken explanatory adequacy to be the focus of syntactic theorizing (Rizzi 2016; D'Alessandro 2019). Yet to do this presupposes that there is a core of facts and generalizations so that there is a stable set of grammars which satisfy descriptive adequacy. Hornstein (2018: 55) presents a list of structural properties that syntacticians might agree are the "mid-level generalizations" of grammar; see also D'Alessandro (2019: 8) for a summary. For instance, data as in (3)–(4), from Chomsky (1973: 261), lead to well-established generalizations to classify verbs as being raising or control predicates, and binding conditions on anaphors and pronouns:

(3) a. They appeared to John to like each other.
    b. * They appealed to John to like each other.

(4) a. * We appeared to John to like us.
b. We appealed to John to like us.

At the level of what facts and what kinds of facts are in the domain of syntax – such as those just given – frameworks such as GB/MP, LFG, and HPSG (Pollard & Sag 1987, 1994) are roughly commensurate, and so can be compared as to how they embody descriptive adequacy. Of course the formal details of a syntactic system which is intended to have a good "correspondence to linguistic fact" vary between each framework, but these are the easiest points of comparison. I take up this kind of comparison in Sections 3 and 4 below.

LFG is a framework which has been developed to address descriptive adequacy, and which can be part of broader cognitive or computational approaches to human language, following the first Chomsky quote above. In this sense, it perhaps could be argued that LFG committed 40 years ago to what has become known in the MP literature as Chomsky's "third factor" (Chomsky 2005: 6) for explaining the format of grammatical knowledge:

(5) "… we should, therefore, be seeking three factors that enter into the growth of language in the individual:

1. Genetic endowment, apparently nearly uniform for the species, which interprets part of the environment as linguistic experience, …
2. Experience, which leads to variation, within a fairly narrow range, …
3. Principles not specific to the faculty of language …
    - principles of data analysis that might be used in language acquisition
    - principles of structural architecture
    - principles of efficient computation"

The GB perspective on the language faculty put a great burden on an innate Universal Grammar which is essentially a parameterized blueprint for any individual grammar. This corresponds to Chomsky's first factor. Over the last 25 years, the trend in the development of the MP has been to reduce reliance on this purely innate component of grammar, in favor of the third factor. The reference in that factor to principles of data analysis and of structural architecture is quite salient as these are the principles at the basis of the considerations I raise in the next subsection, though of course this is not to imply that frameworks such as LFG deny that there are any ‘first factor’ properties or principles of our language capacity. However, as O’Grady (2012: 498) comments: “… the shift of focus to third-factor effects in generative grammar marks a milestone of sorts. Not because the idea is new, for it is not. Broadly speaking, the rest of the field has been committed to the primacy of third-factor explanations for decades.”

2.2 Foundational properties of syntactic systems

What kinds of property are fundamental to syntax, to be emergent from a theory which “constitutes an explanatory hypothesis about the form of language”, as in Chomsky’s notion of explanatory adequacy? From the Minimalist perspective, the key notion here is the binary merge of abstract syntactic elements – ‘External Merge’ for initial structure-building, and ‘Internal Merge’ for movement from an existing position to another one. The structure is built up incrementally, with steps in the derivation driven by categorial requirements of combination or by features (see Section 3.2 and Section 4.2 below); the terminal nodes of the structure are spelled out morphologically after the syntactic operations have taken place.

LFG has taken a different starting point as to what the key properties of syntax are; in the rest of this subsection I highlight the consequences of a few examples which determine the ‘lexicalist’ and ‘functional’ (that is, information-based) aspects of LFG.

2.2.1 Lexicalist

LFG is a lexicalist framework, built on the assumption that the terminals in the phrase structure are word-level entities, the X^0s of X′-theory. The roots of this approach are in the Lexicalist Hypothesis of Chomsky (1970). Chomsky argued that the shared properties of different words based on the same lexeme could be accounted for without recourse to transformation (a nominalization transformation for the specific examples considered in that paper), and he introduced X′-theory to account for structural similarities across categories. LFG, like other declarative frameworks, expands on this perspective, using other syntactic information not directly represented in the phrase structure (cf. (2)) to capture the appropriate similarities. An X^0 may be internally complex, carrying the same kinds of information as may be expressed by other elements or configurations in the syntax, but formed according to its constraints on morphology, not on syntax.

The following Swedish example from Müller & Wechsler (2014: 29) illustrates several properties which motivate the lexicalist analysis. It involves coordination of an active and a passive verb:

(6) Swedish
Golfklubben begärde och beviljade-s marklov för
golf.club.DEF requested and granted-PASS ground.permit for
banbygget efter en hel del förhandlingar och kompromisser
track.build.DEF after a whole part negotiations and compromises
med Länsstyrelsen och Naturvårdsverket.
with county.board.DEF and nature.protection.agency.DEF
'The golf club requested and was granted a ground permit for track construction after a lot of negotiations and compromises with the County Board and the Environmental Protection Agency.'

Müller and Wechsler argue that this example does not involve Right-Node Raising, but rather coordination of two finite verbs at the X^0-level (*begärde och beviljades*). Each verb is a syntactic word, marked for past tense (the *de* part of each), and the second one is marked for passive (the *s*). Hence the voice alternation active/passive is represented on single words, and does not involve spans of structure involving separate heads such as V, v, and Voice. Additionally, the second verb is a straightforward counterexample to the 'Mirror Principle' (Baker 1985), which is supposed to diagnose a close relationship between syntactic structure and word-internal morpheme structure. Swedish passive *-s* always appears external to other tense or aspectual suffixes on the word, even though in an expanded MP-style clausal structure the Voice head would be taken to be lower than and therefore closer to the lexeme stem with respect to Aspect or Tense heads.

The French example in (7) also motivates both the lexicalist approach, as well as the design feature that agreement is not directional.

(7) French
Je suis heureuse.
I am happy.F.SG
'I am happy.' (spoken by a female)

Neither the subject pronoun *je* nor the inflected verb *suis* are categorized or marked for gender – as in English and many other languages – yet the predicate adjective is marked as feminine (and singular). The non-formal linguistic intuition that the adjective agrees with its subject, or "agrees with a noun", has been the basis of many formalized linguistic analyses: the predicate adjective is a target and the subject should be its controller. Yet there is no plausible source in the lexical content of (7) for a feminine gender specification except for the adjective. It is certainly true of the *sentence* (7) that it expresses a meaning involving a feminine subject, but the morphosyntactic basis of that meaning could not be *je* or *suis*, under any plausible analysis of those words.

This example is very powerful. From it, it follows then that *heureuse* is a lexical item marked for feminine gender independently of the syntactic structure in which it appears, as there is no source for feminine in the rest of the structure. This entails the Lexicalist Hypothesis, as each X^0 in the syntactic structure has properties that do not refer to any other X^0 in the structure – usually referred to as 'Lexical Integrity' (e.g. Bresnan 2001: 92; Bresnan et al. 2016: 92).

2.2.2 Information-based clausal representation

Next, from the same example, it follows that "agreement" is the name we give to a situation in which two or more syntactic elements put constraints on a single informational unit, but that there is no priority of one element over the other(s). In (7), all three such elements (the words in this case) put constraints on what the subject is; and as the combination of those constraints is not contradictory, the example is well-formed. The f-structure contribution of each word is shown in (8). (9) shows the f-structure for the full example.

(8)

a. $\begin{bmatrix} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \end{bmatrix}$ = je

b. $\begin{bmatrix} \textsc{subj} & \begin{bmatrix} \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \end{bmatrix} \\ \textsc{tense} & \textsc{pres} \\ \textsc{pred} & \text{`}\textsc{be}\langle(\uparrow \textsc{subj})(\uparrow \textsc{xcomp})\rangle\text{'} \\ \textsc{xcomp} & \begin{bmatrix} \textsc{subj} & [\ ] \end{bmatrix} \end{bmatrix}$ = suis

c. $\begin{bmatrix} \textsc{subj} & \begin{bmatrix} \textsc{gend} & \textsc{fem} \end{bmatrix} \\ \textsc{pred} & \text{`}\textsc{happy}\langle(\uparrow \textsc{subj})\rangle\text{'} \end{bmatrix}$ = heureuse

(9)
$$\begin{bmatrix} \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{pers} & 1 \\ \textsc{num} & \textsc{sg} \\ \textsc{gend} & \textsc{fem} \end{bmatrix} \\ \textsc{tense} & \textsc{pres} \\ \textsc{pred} & \text{‘}\textsc{be}\langle(\uparrow \textsc{subj})(\uparrow \textsc{xcomp})\rangle\text{’} \\ \textsc{xcomp} & \begin{bmatrix} \textsc{subj} & [\ ] \\ \textsc{pred} & \text{‘}\textsc{happy}\langle(\uparrow \textsc{subj})\rangle\text{’} \end{bmatrix} \end{bmatrix}$$

Local syntactic relationships indicated by the structure-sharing seen above are typically located in a predicate – these will involve what kind of arguments the predicate takes, possibly specifications of case, whether it is a raising or control predicate, agreement information, and so on. The apparent directionality of agreement seen in canonical examples has nothing to do with "agreement" itself – as a mechanism of agreement does not exist – but rather comes from the second property of *suis*, that it is effectively a raising predicate, and so whatever is true of its complement's subject is true of its subject. In (9) the information shown as the value of SUBJ is the minimal amount of which the constraints coming from each of the entries in (8) is true.

With regard to the implications for explanatory adequacy, this simple example shows that the format of grammars is only consistent with those that lack derivation and directionality – in other words, if the hypothesis space is restricted to declaratively stated grammars, we expect that languages will quite generally show examples like (7). In Section 4.3, I take up in more detail the key information-based properties of what we informally refer to as "agreement".

Other examples also show the importance of the information that an item carries over its phrase structure properties. (10) (originally from Hudson 1977; see also Gazdar et al. 1985: 64; Bresnan 2001: 19, Bresnan et al. 2016: 14) illustrates one of the "paradoxes of movement":

(10) a. * I aren't happy.
b. Aren't I happy?

An initial positioning of an internally-negated auxiliary is taken as evidence in movement analyses that the auxiliary has undergone several movements, combining with Neg and then with T[ense] before moving to C. However, from the notional analytic source *I am not happy* there is no pre-T-to-C version **I amn't happy*, as in (standard) English there is no form *amn't*, and (10a) is also ungrammatical. In this use, then, the form *aren't* is a word which can only appear in the C, or inverted-aux, position, but not in any other position. In terms familiar from the early days of transformational grammar, (10b) would have to be analyzed as a grammatical example derived from an ungrammatical source.

The contrast in (10) shows that the syntactic properties that an item has (being a tensed negated auxiliary in this case) are not inexorably associated with structural derivations which aggregate information. A movement-based account of (10) would have to assume that the syntactic features of *aren't* can be assembled on T, and from there moved to C, but that there is no lexical item which can spell out those features on T, but only on C. In other words, what actually matters is the surface position of the realization of a set of syntactic properties, not where (or where else) those properties came from. This is exactly what a declarative framework such as LFG provides, with the same implication for explanatory adequacy – if an element in a higher position must correspond to a derivationally related version of itself in a lower position, pairs like (10) should not exist. But they do exist, and they show that the format of grammars should recognize that words have bundles of features which are associated with (sets of) syntactic positions. Within the broader Miminalist approach, the realizational account of morphology in the Distributed Morphology framework (Halle & Marantz 1993; see Bobaljik 2017 for a recent overview) has the same sensitivity to syntactic position: for *aren't*, a rule of vocabulary insertion could be made sensitive to the collection of relevant syntactic features in the context of C, but not of T.

2.3 Rules and representations

As syntactic frameworks have developed since the 1980s, they have diverged as to whether the focus is on constraints stated on representations, or on steps in a procedural derivation. Government-Binding theory has a mix of properties: conditions on rule application and conditions on representations. For instance, the examples above in (3)–(4) involve *appear* as a raising predicate which requires an operation of the rule Move-α, while *appeal* is a control predicate which requires a representational check involving a PRO subject (see e.g. Haegeman 1994 for a summary of GB). More recently, the "movement theory of Control" (e.g. Hornstein & Polinsky 2010) eliminates the representational condition on the empty category subject in favor of a derivational analysis similar in the relevant ways to the one for the raising predicate.

The GB Binding Theory Principles A and B were originally each stated as a condition on a representation. For instance, Principle A looks for a specific relationship of coindexing between antecedent and anaphor within a certain domain; reinterpreted as a condition on rule application, the principle must involve an operation of movement up to (near) the antecedent, within a certain domain, following an idea first proposed in Lebeaux (1983).

In the development of the MP, Chomsky has taken the view that as some aspects of the grammar are procedural, and so require conditions on rule application, parsimony would dictate that all grammatical conditions are of that type, with no conditions on representation. Hence the levels of GB over which representational conditions were stated were eliminated. The MP is an attempt to deconstruct GB along purely procedural aspects (see e.g. Hornstein 2018: 54) – in the limit, there is no "stopping off" at any point to evaluate a representation. In fact, though, each step in a derivation must involve a local representation – but one within which or to which some further operation should take place. The proposed operation of 'Minimal Search' for the operation *Agree* (Chomsky 2007: 9) must inspect a structure to find something within it – here, an element W probing within a structure Z – and the outcome of that will constrain what (procedurally) can happen next: "Since W contains all information relevant to further computation involving Z, W is also necessarily the probe that selects a goal in any internal modification of Z. Minimal search conditions limit the goal of the probe to its complement, the smallest searchable domain."

The output of syntax is fed to the 'interfaces'. On the semantic side, the end of the syntactic derivation corresponds to the GB level of Logical Form (LF), which feeds to the 'conceptual-intentional' interface. On the phonetic side, the overt output of the derivation is spelled-out to Phonetic Form (PF), which feeds to the interface known as 'articulatory-perceptual' or 'sensorimotor' (see e.g. Chomsky 1995: 2, Chomsky 2007: 5). One leading idea of the Minimalist Programme is that LF and PF have no properties specific to them; rather, any apparent well-formedness conditions are due entirely to properties of the interfaces.

Within the core domain of syntax, there seem to be several phenomena which bear on the issue of rules vs. representations, and which appear to favor the latter – because their analysis seems irreducibly representational. I will mention two different instances and then go on to two others in more detail. First, as just noted, the MP operation of Agree has to access a representation, in order to establish a relation between Probe and Goal (see also Section 4.2). Second, the approach to case marking known as 'Dependent Case' (e.g. Baker 2015) calculates the case values of NPs by referring to larger structure – the underlying intuition being that in a clause containing two NPs, a subject c-commanding an object, the marked case value of Accusative for the object is the value assigned to an NP c-commanded by another, and in a typologically different system, the marked case value of Ergative for the subject is the value assigned to an NP which c-commands another. Hence the computation of case values must refer to a structural representation.

I now go in more depth into two instances which illustrate a different kind of representational condition – a negative condition. It is difficult to imagine how such conditions could successfully be captured procedurally. Returning to the binding conditions of GB, for Principle A, there have been different proposals to reinterpret it derivationally, for instance Lidz & Idsardi (1998), Hornstein (2001) and Boeckx et al. (2007), though others take a more traditional view, such as Safir (2008) and Charnavel & Sportiche (2016). While Principle A requires two elements to have a certain relationship, Principle B forbids two elements from having a certain relationship – it is a negative condition. A procedural reinterpretation does not seem directly possible for Principle B, as it requires disjointness (unless perhaps the system of recording contra-indexing of Chomsky 1980 is revived), though Reuland (2011) presents a revised Binding Theory which refers to properties of predicates and semantic constraints on the interpretation of their arguments.

Principles A and B as they apply to English are familiar. In some languages, with anaphoric systems more complex than that found in English, conditions on the various elements of the system may involve both positive and negative constraints – such as in Norwegian (Dalrymple 2001: 279–288, Bresnan et al. 2016: 259–261). Norwegian has four relevant anaphor/pronoun forms, shown in (11) with their LFG binding properties. The content of the binding properties is given in (12):

(11) Featural analysis of Norwegian pronouns:
  a. seg [+sbj, −ncl]
  b. ham [−ncl]
  c. seg selv [+sbj, +ncl]
  d. ham selv [−sbj, +ncl]

(12) a. [+sbj, −ncl] – The antecedent must be a subject in the minimal finite domain outside of the minimal nucleus containing the pronoun.
  b. [−ncl] – The antecedent must be outside of the minimal nucleus containing the pronoun.
  c. [+sbj, +ncl] – The antecedent must be a subject in the minimal nucleus containing the pronoun.
  d. [−sbj, +ncl] – The antecedent must be a nonsubject in the minimal nucleus containing the pronoun.

The negative conditions here seem to refer crucially to representations – to check that a relationship does not hold in a certain local domain, or to check that a relationship does hold, but not with a subject.

A different consideration about the role of representations comes from the distribution of the depictive *sisxoli* 'alone' in Tsez, a language of the Caucasus which has an ergative-absolutive case marking system. The depictive may be associated with a preceding NP, but may not itself precede its NP associate (Polinsky 2000). Hence the depictive has two possible associates in (13a), one in (13b), and none in (13c).

(13) Tzez

a. kid-bā ziya sisxoli bišer-si
girl-ERG cow.ABS alone feed-PST.EVID
'The girl$_i$ alone$_i$ fed the cow.'
'The girl fed the cow$_i$ alone$_i$.'

b. kid-bā sisxoli ziya bišer-si
girl-ERG alone cow.ABS feed-PST.EVID
'The girl$_i$ alone$_i$ fed the cow.'
*'The girl fed the cow$_i$ alone$_i$.'

c. * sisxoli kid-bā ziya bišer-si
alone girl-ERG cow.ABS feed-PST.EVID

The linear precedence condition is reinterpreted as one of c-command in later discussions of these same examples in Polinsky & Potsdam (2006) and Fukuda (2008) – the associate must c-command the depictive.

The distribution of the depictive becomes more interesting in the context of raising and control predicates. In Tsez the predicate *yoq-* 'begin' is ambiguous between control and raising, and in fact is a backward control predicate in its control use or a forward raising predicate in its raising use (Polinsky & Potsdam 2006). In LFG, the higher and lower SUBJ values of control or raising are structure-shared in f-structure, and as discussed in Sells (2006) that f-structure property is consistent with c-structure expression of the relevant argument in the matrix clause ('forward') or in the embedded clause ('backward'). (14a) is an interesting example regarding the syntax of the depictive, as it is grammatical even though the depictive apparently precedes its associate. Polinsky & Potsdam (2006) analyze this as a backward control structure: a null (absolutive) subject of 'begin', indicated by ∅ in (14b), controls the lower (ergative) subject of 'feed'. ∅ is used here as a notation to suggest the analysis of the example, but it has no actual correspondent in the c-structure, as is standard in the LFG analysis of control and raising. In this example, it is the null matrix argument indicated by ∅ which is the associate of the depictive, and both are constituents of the main clause (see the f-structure in (17) below):

(14) Tzez

a. sisxoli kid-bā ziya bišra yoq-si (backward control)
alone girl-ERG cow.ABS feed begin-PST.EVID
'The girl$_i$ alone$_i$ began to feed the cow.'
*'The girl began to feed the cow$_i$ alone$_i$.'

b. ∅$_i$ sisxoli [kid-bā$_i$ ziya bišra] yoq-si
alone [girl-ERG cow.ABS feed] begin-PST.EVID

The other use of *yoq-* is as a regular forward raising predicate. Its subject is in absolutive case as the predicate is not formally transitive, and the subject in the lower clause is the empty position, again indicated here by ∅. As seen in (15a), with the syntactic analysis in (15b), the same order of elements as in (14a) is ungrammatical in this instance, as the depictive does indeed precede its associate:

(15) Tzez

a. * sisxoli kid [ziya bišra] yoq-si (forward raising)
alone girl-ABS [cow.ABS feed] begin-PST.EVID

b. * sisxoli kid$_i$ [∅$_i$ ziya bišra] yoq-si
alone girl-ABS [cow.ABS feed] begin-PST.EVID

The LFG account of these data requires the concepts of f-command, which is like c-command but stated on f-structure, and of f-precedence (see Glossary for f-command and f-precedence). This latter concept makes reference to the c-structure expression(s) – if any – of f-structure elements. Crucially, an element such as a null argument which is present only in f-structure, but not in c-structure, has no (f-)precedence relations defined on it (Bresnan 2001: 195; Bresnan et al. 2016: 213). The LFG analysis of the Tsez depictive can be stated simply as in (16):

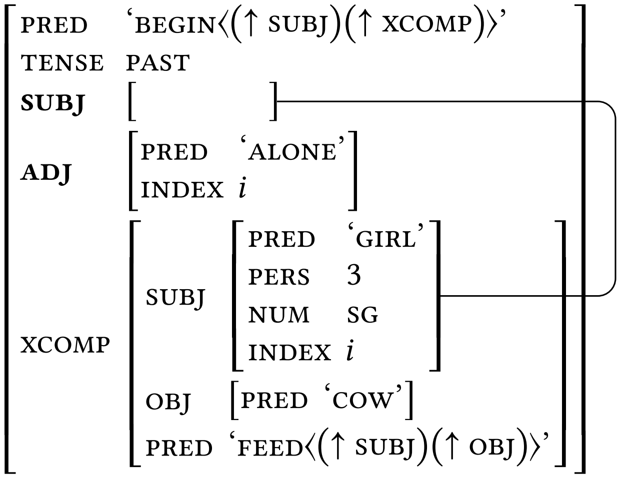
(16) a. The associate and the depictive f-command each other.

b. The depictive must not f-precede the associate.

(16a) is essentially a clause-mate condition, and (16b) is a negative condition. It does not require that the associate f-precede the depictive, but rather that the depictive does not f-precede the associate.

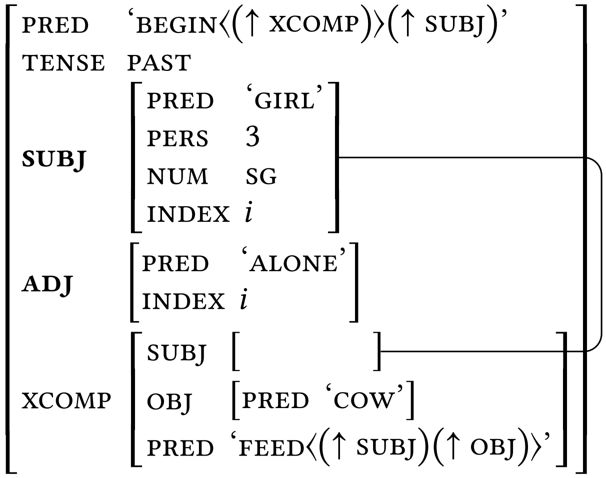
The f-structure of (14) is shown in (17), leaving out the case values of the arguments, which would formally conflict under straightforward structure-sharing (i.e. formal equality in LFG terms). The case values require a slightly nuanced analysis, whatever the framework (see Polinsky & Potsdam 2002, Sells 2006). For presentational purposes, I assume here that the formal relation between depictive and associate is that they share an INDEX value. Their GFs which f-command each other are indicated by the boldface GF names, in the matrix nucleus. The matrix SUBJ is structure-shared with the embedded SUBJ as the predicate is backward control. While there is a matrix SUBJ in f-structure, it has no c-structure expression (there is no '∅' in the c-structure); only the embedded subject is present in c-structure. Consequently, limited to the matrix f-structure in which the associate and depictive f-command each other, no precedence relation is defined on the boldface SUBJ, and so the condition in (16b) is also satisfied.

(17) F-structure of (14), ignoring the case values. **ADJ** does not f-precede **SUBJ**:



In contrast, for (15), involving a forward raising use of the predicate, the constraint in (16b) is not satisfied, because the SUBJ is overt in the matrix clause, and so f-precedes the depictive ADJ.

(18) F-structure of (15), ignoring the case conflict. **adj** f-precedes **subj**:



The Minimalist account in Polinsky & Potsdam (2006) (see also Fukuda 2008) is stated in terms of positive conditions, of which (19b) is the important one.

(19) a. The associate and the depictive are clause-mates.
b. The associate c-commands/binds (≡ precedes) the depictive.

What is interesting about (19b) is that it can only be successfully interpreted representationally. Suppose that at one point in the derivation, the associate (whether overt or covert) c-commands the depictive, and the relevant syntactic relationship is established, satisfying (19b). However, what is to prevent some later operation which scrambles the depictive higher, so that it c-commands its associate, in violation of (19b)? To prevent this possibility, (19b) must be interpreted as an output condition on the "final" representation, regardless of when during the derivation the relation between associate and depictive has been established. Hence even though (19b) is a positive condition, not a negative one, it is necessarily representational.

In the LFG analysis, (16b) is necessarily a negative condition, as the null subject in backward control is only represented in f-structure (14), and so could never be evaluated against a positive precedence condition like (19b). Evidence from other languages supports the position that null arguments are present in f-structure but absent from c-structure. Null pronouns in Malayalam are not sensitive to f-precedence conditions, unlike overt pronouns (Mohanan 1983: 664–665). Kameyama (1985) presents a similar argument for Japanese (summarized in Dalrymple 2001: 171ff. and 288ff.). For Malayalam, Mohanan observes that an overt pronoun may not precede its antecedent – compare (20) and (21a) with (21b) –

while a null pronoun (indicated for presentational purposes by *pro* in (21b)) may ‘precede’ its antecedent:

(20) Malayalam
  a. [kuṭṭiyute ammaye] awan n̲uḷḷi
    [child.GEN mother.ACC] he.NOM pinched
    ‘He$_i$ pinched the child$_i$’s mother.’
  b. * [awante ammaye] kuṭṭi n̲uḷḷi
    [he.GEN mother.ACC] child.NOM pinched
    ‘The child$_i$ pinched his$_i$ mother.’

(21) Malayalam
  a. [awan aanaye n̲uḷḷiyat̲inə s̄eeṣam] kuṭṭi$_i$ uraŋŋi
    [he.NOM elephant.ACC pinched.it after] child.NOM slept
    ‘The child$_i$ slept [after he$_{*i/j}$ pinched the elephant].’
  b. [*pro* aanaye n̲uḷḷiyat̲inə s̄eeṣam] kuṭṭi$_i$ uraŋŋi
    [elephant.ACC pinched.it after] child.NOM slept
    ‘The child$_i$ slept [after he$_{i,j}$ pinched the elephant].’

The overt pronoun ‘he’ in (21a) may not take ‘child’ as its antecedent, as the former precedes the latter, but this restriction is not there with the null pronoun in (21b). Why would overt and null pronouns have different precedence conditions on them? Mohanan (1983: 664) proposes that the correct analysis is that a pronoun cannot precede its antecedent, where precedence is defined on c-structure elements, such as overt pronouns, but is not defined for null pronouns, which are present only in f-structure.

Consider the c-structure relationships of the relevant parts of the examples, shown in (22a), with the f-structure of the example shown in (22b). The subscript numbers show the c-to-f-structure correspondences:

(22) a. C-structure:
    (pronoun$_1$) pinched$_2$ child$_3$
  b. F-structure:

$$\left[\begin{array}{ll} \text{SUBJ} & {}_3\left[\text{PRED}\ \text{‘CHILD’}\right] \\ \text{PRED} & \text{‘SLEEP}\langle(\uparrow \text{SUBJ})\rangle\text{’} \\ \text{TENSE} & \text{PAST} \\ \text{ADJ} & {}_2\left[\begin{array}{ll} \text{PRED} & \text{‘PINCH’} \\ \text{SUBJ} & {}_1\left[\text{PRED}\ \text{‘PRO’}\right] \\ \cdots & \cdots \end{array}\right] \end{array}\right]$$

In both examples in (21), the adjunct clause 2 f-precedes 3, ‘child’, because the c-structure correspondent(s) of 2 precede the correspondent(s) of 3. However with regard to 1 and 3, 1 f-precedes 3 only if 1 is present in c-structure, which is only the case in (21a). Hence the apparently different binding properties of pronouns reduce to their different properties in different parts of the syntactic analysis.

The implications of this analysis are far-reaching: if certain syntactic elements can have a range of grammatical properties without being represented in phrase structure – and the above is positive evidence that they are not represented in phrase structure – then every aspect of grammatical analysis which can or must refer to those properties must also be independent of any phrase structure representation, including phenomena such as subjecthood, agreement, binding, and so on.

Declarative frameworks have different dimensions of analysis – such as c-structure and f-structure as described below – but not different levels in the sense that GB had (e.g. D-structure, S-structure). As there are no rules or operations, there are no conditions on rules, and so all conditions are stated over representations, as constraints.

3 Phrase Structure

3.1 Heads and headed structures

LFG c-structures have some similarities with the S-structures of late GB. A canonical clause (for an SVO language) is structured around what I refer to as a ‘skeleton’ with a ‘spine’ (Sells 2001: 17). (24) below shows the skeleton, and the spine corresponds to all the non-argumental parts, V, I, C and their projections. These are separate categories which participate in the familiar clausal extended projection (Grimshaw 2000: 116ff. Bresnan 2001: 100), often now referred to as the ‘Hierarchy of Projections’ (Adger 2003).

The formal relation in the c-structure between V and I and C is usually developed from the idea of ‘extended projection’ of Grimshaw (2000); see also Bresnan (2001: 100–101), Bresnan et al. (2016: 103). The clausal categories are all projections of the category verb, which is specified by the traditional labels [+V, −N] (Chomsky 1970).

(23) Extended Projections

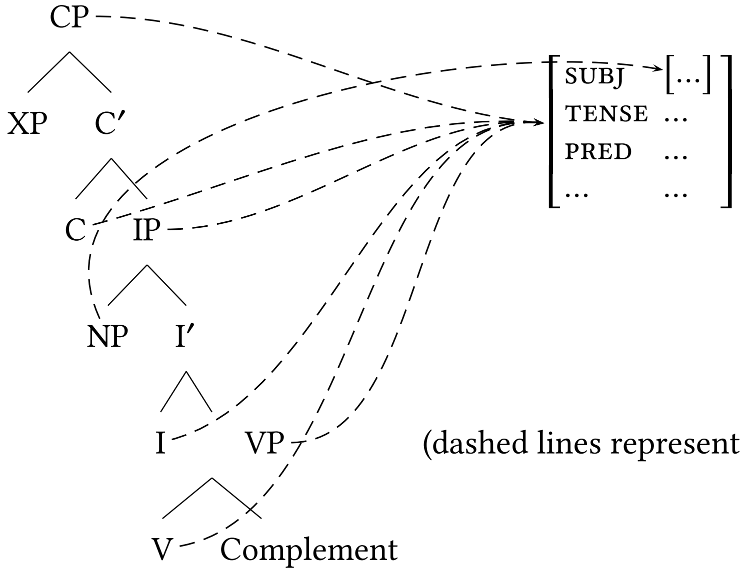
a. V = [+V, −N, P0] (the zeroth-level projection of V)

b. I = [+V, −N, P1] (the first-level projection of V)

c. C = [+V, −N, P2] (the second-level projection of V)

The outline clause structure has specifiers of CP and IP, and complement position(s) within VP, schematized here with the placeholder label Complement.

(24)



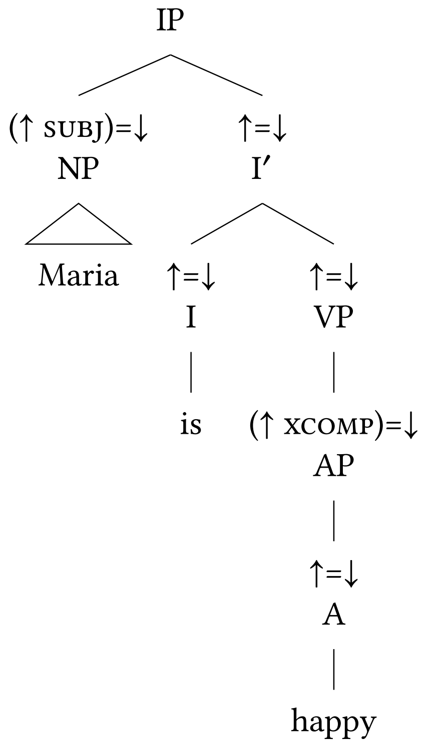
(dashed lines represent information flow)

Each node in the c-structure is annotated as to how it contributes to the f-structure. The formal annotations on nodes are not shown in (24), for simplicity, but the dashed lines represent the way that information flows from the c-structure to the f-structure.

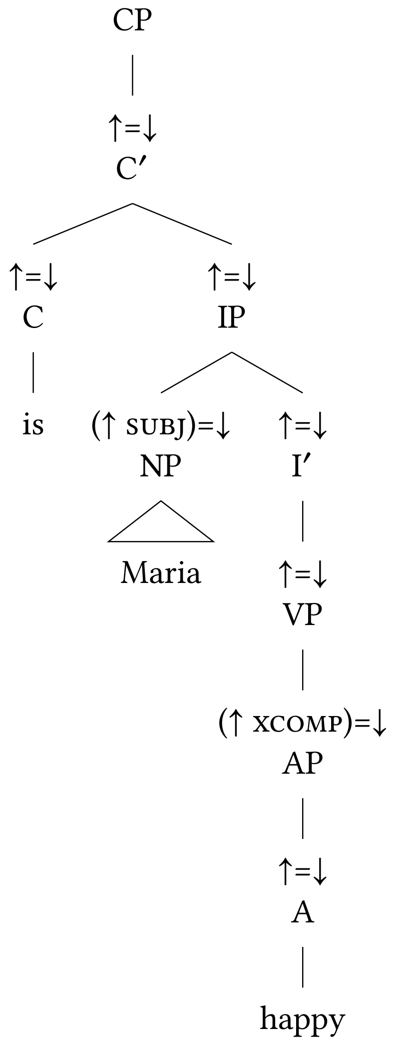
Every node in the clausal spine contributes its information to the main f-structure, as can be seen from the several lines converging on the outer f-structure, which represents the grammatical information of the clause (again for simplicity, I omit lines from the X′ nodes). The other nodes, XP, NP, and Complement, have different annotations on them, as they contribute to parts of the overall f-structure. For instance, the annotation on the node NP would indicate that its contribution is as the subject – in other words, NP as specifier of IP is the subject position. This is indicated by the dashed line going from NP in the c-structure to the value of SUBJ in the f-structure.

As far as clausal information is concerned, the verb itself contributes identically to the clause whether it is in V or in I or in C, a property usually referred to as 'head mobility' (see e.g. Bresnan 2001: 126ff. Bresnan et al. 2016: 129ff.). For instance, unless extra information is associated with the C node in (25b), both c-structures in (25) would determine the same f-structure:

(25) a.



b.



Head mobility can be illustrated with the c-structures above. On the assumption that the only VP can be the c-structure complement of I, then for the example *Maria is happy* in (25a) the VP lacks a c-structure head V, for the verb *is* is in I; and in (25b), for the string *Is Maria happy*, both IP and VP lack their X^0 heads. In these structures the finite form of *be* acts as an auxiliary verb, and so does not head a surface VP, but appears in a higher functional head position (in contrast *be* as a non-finite form would head VP, as in *Maria could [be happy]*).

Formally, the theory requires that every XP either has a c-structure head in the standard X′ sense, or that it maps to an f-structure shared with at least one YP which is headed in c-structure. Such a Y^0 is known as the 'extended head' of XP (the notion is originally due to Zaenen & Kaplan 1995: 221, revised to the formulation given here by Bresnan 2000: 353). So in (25a), I is the extended head of VP, and in (25b), C is the extended head of IP and of VP, leading to the illusion that the head is “moving”. Different verbal categories may be restricted, though, to particular c-structures positions: finite auxiliaries in English may only appear in I or C, not in V; finite non-auxiliaries must appear in V. Hence finite auxiliaries have the category [+V, −N, P>0] and finite verbs have the category [+V, −N, P0].

The discourse in the MP literature over the past 25 years as to whether head movement exists or whether it is part of ‘narrow syntax’ (see e.g. Roberts 2011; Harizanov & Gribanova 2019 for overviews) is quite puzzling from the perspective of declarative frameworks such as LFG or HPSG, as heads are central to the syntactic analysis. The issue arose in the development of the MP as position-occupying head movement does not obey the Extension Condition of Chomsky (1995), requiring that every operation of Merge extends the root node of the current tree. Head movement violates this condition, as it formally involves adjunction to a node lower than the root node (in contrast to XP adjunction, which does adjoin at the root). Consequently Chomsky raised the issue of the status of head movement (e.g. Chomsky 2000: 136–137; Chomsky 2001: 38) within the MP approach.

As the mapping from c-structure to f-structure in LFG suggests, the crucial fact about a clausal spine is that head positions share information, each being a functional co-head (see e.g. (25)). This is directly evidenced in various core cases of multiple expresssion of the same grammatical information in a single domain, as first described in LFG by Niño (1997). The same properties of clausal information are expressed on more than one head (see also Sells 2004, Lødrup 2014). The Finnish examples in (26) and (27) (Niño 1997: 135, 137) show the phenomenon:

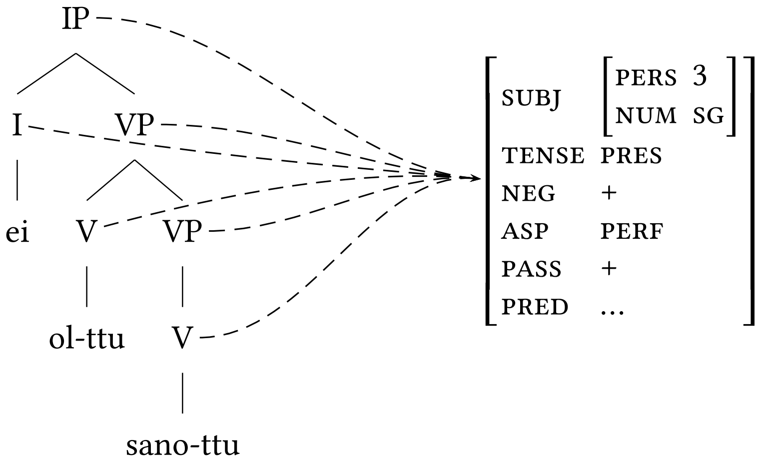
(26) Finnish
Äl-kää puhu-ko.
NEG.IMP-IMP.2.PL speak-IMP
‘Don’t (you pl.) speak!’

(27) Finnish
a. Ei ol-lut sano-ttu
NEG.3.SG PRF-PST.PTCP.SG say-PASS.PST.PTCP.SG
‘It has not been said.’
b. Ei ol-ttu sano-ttu
NEG.3.SG PRF-PASS.PST.PTCP.SG say-PASS.PST.PTCP.SG
‘It has not been said.’

(26) involves a special form of negation restricted to imperatives, as well as imperative marking on both the auxiliary and the main verb. In (27), singular

marking appears on all three words: the negative, which is a kind of auxiliary; another auxiliary; and the main verb. These examples also indicate that ‘passive’ is a feature in f-structure which can be accessed – see also Lødrup (2014) for evidence in Norwegian for the same conclusion. (27b) is a colloquial variant of (27a), in which the passive marking on the main verb also appears on the medial auxiliary. The c- and f-structure of (27b) are shown in (28). It can easily be seen that the constraints coming from each of the words in (27b) – using the glosses as a guide – are satisfied by this f-structure:

(28)



The co-head approach of LFG allows for different sources of the same constraint (e.g. that the value of NUM is SG) which will be true of just a single object (e.g. the subject). Hence feature exponence may be distributed or apparently multiplied. In the MP approach, each feature necessarily originates in only one position in the structure, and then must be copied or spread onto other positions, for data such as that above. In MP analyses, ‘imperative’ corresponds to a high position in the clause, so the IMP feature in (27) must spread downwards. However in (27b), the PASS feature would originate on the lowest verb, the only one marked in (27a), and so would have to spread upwards.

The distribution of morphological exponence is probably not related to direction of spreading, but rather concerns morphological constraints on each type of word as to what features it must express, might express, or cannot express. This can be seen clearly in the examples in (30) from Livonian (Niño 1997: 131), which obey the generalizations in (29):

(29) a. verbs are marked for number
  b. participles are not marked for person

(30) Livonian

a. ä-b u-m and-ên-∅
NEG-1 be-1.SG give-PST.PTCP-SG
'I have not given.'

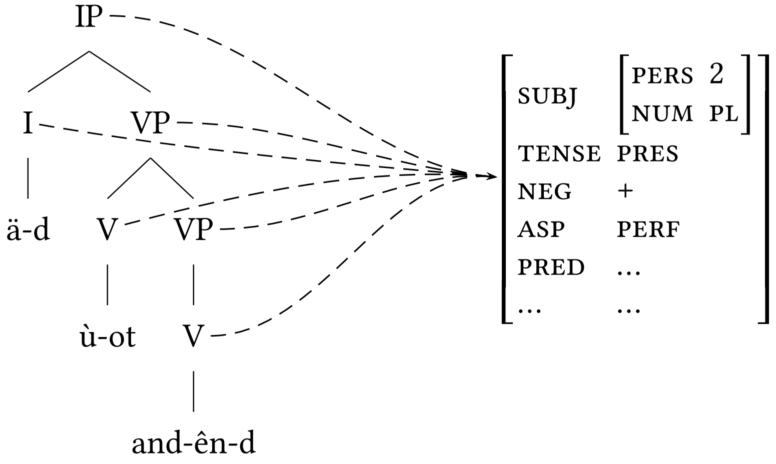
b. ä-b ù-om and-ên-d
NEG-1 be-1.PL give-PST.PTCP-PL
'We have not given.'

c. ä-d ù-od and-ên-∅
NEG-2 be-2.SG give-PST.PTCP-SG
'You have not given.'

d. ä-d ù-ot and-ên-d
NEG-2 be-2.PL give-PST.PTCP-PL
'You have not given.'

(31) shows the c- and f-structure of (30d). Again following the gloss, it can be seen that the PERS value of the subject is identically constrained by the first two words, while the NUM value is constrained by the last two words:

(31)



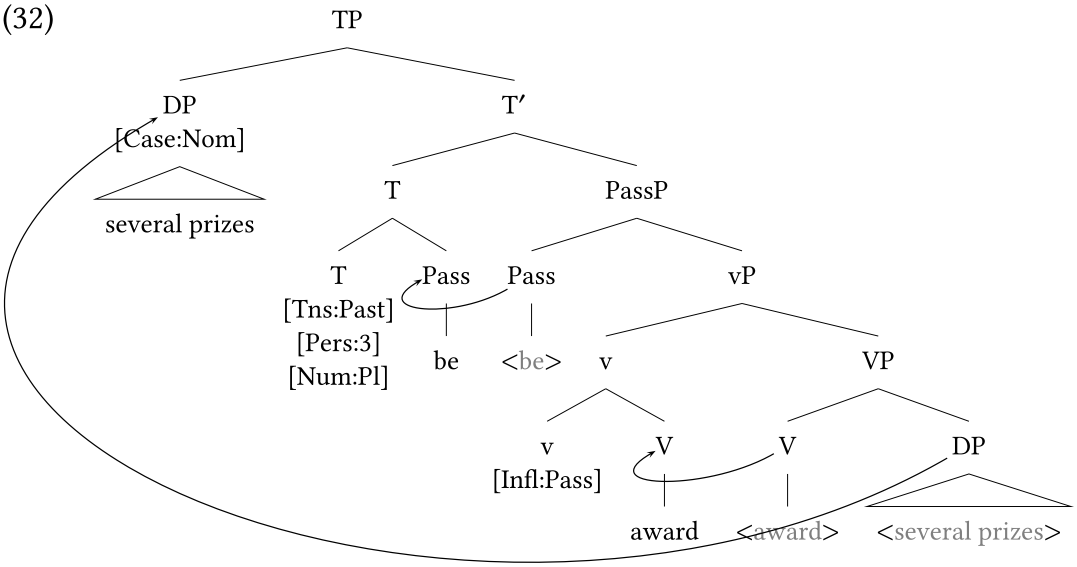
These patterns of multiple expresssion extend beyond simple clauses, into various kinds of complex predicate (see e.g. Sells 2004, Lødrup 2014), which might require a more nuanced syntactic analysis than simple embedding of f-structure nuclei – as argued for on the basis of entirely different data by Andrews & Manning (1999). The multiple expression data could profitably be analyzed in a realizational framework (as suggested in Sells 2004) – every informational element within a certain domain must have at least one rule of realization applying to it (this idea is formalized explicitly in Crysmann & Bonami 2016), but in certain circumstances one piece of information can be referred to more than once, as the generalizations in (29) suggest. Crucially, again, it is not that one piece of morphological exponence on a c-structure head is copied to another head, but rather that different (co-)heads are acting as exponents of the same grammatical information.

3.2 The MP approach to phrase structure: Merge

The legacy of the Government-Binding model of syntax into the MP is a procedural approach to structure and structure-building. Binary structures are built up by Merge of two elements, often known as External Merge or 'first merge'. The GB idea of movement is reinterpreted in the MP as Internal Merge – one element from within a given structure is (re-)merged near the top of the structure. As noted in Section 1, the argument structure of the predicate is represented in a vP-VP structure, above which there are further projections such as TP and CP. By the time the structure has built up at least to TP, this structure effectively codes clausal information.

Strictly speaking, the syntactic derivation is abstract, with syntactic relationships referring to the structural notion of c-command but not linear order, which comes in the mapping from syntax to Phonetic Form (PF). The relevant terminal nodes of the structure are spelled out as words via the principles of Distributed Morphology (for an overview of this framework, see Harley & Noyer 2003 or Embick & Noyer 2007). Consider the derivation in (32) of the example *several prizes were awarded*, which will also feature later on:

(32)



The internal argument of a transitive verb is merged with V (a kind of root) within VP, at the lower right of the structure. The structure builds from the bottom up via successive applications of Merge. The VP is immediately the complement of a "little v" vP, which introduces the external argument in a canonical transitive. The particular example here is a passive, with the external argument suppressed. The two components of the verb, V and v, are combined by head movement of V to v, as the structure shows. The notation <award> indicates the original position of V before movement.

The passive is indicated here by PassP, following the analysis of English auxiliaries in Adger (2003). The Pass head *be* merges with vP as its complement. Next, above that, a T′ is created with a formative for past tense in its T head. The auxiliary verb *be* also undergoes head movement, to combine with T. Finally, following X′-theory, T′ has a specifier which hosts the surface subject. In the case of a passive example, a DP is raised from a VP-internal position to fill the subject position.

The arrows in (32) indicate movement. Standardly in the Minimalist approach, movement leaves behind a "copy" of the moved constituent (Chomsky 1995), which the notation such as <award> etc. is intended to convey. Principles of realization at PF determine which copy is overt (pronounced) – usually the highest copy, as in the earlier versions of transformational grammar where moved constituents leave behind a trace, which is by definition unpronounced. The formalization of MP syntactic derivations due to Collins & Stabler (2016) captures the 'copy' idea by treating each operation of movement as creating a multidominance structure from a single terminal element; that formalization is extended to head movement by Bleaman (2021). However, for presentational purposes, I show the more familiar movement-with-copies structures here.

There are complex heads in T and v in (32), both formed via head movement. They also have a representation of the various features which are present or which are valued during the course of the derivation (see Section 4.2). These complex heads will realize their lexical and featural information as the words *were* and *awarded*.

Hence, the phrase structure derivation in the Minimalist approach represents all the clausal information, somewhat like LFG's f-structure, which is then spelled out as the overt form, which corresponds to some extent to LFG's c-structure.

3.3 Phrase structures are not isomorphic to clausal information

One difference between LFG and MP concerns how far the phrase structure is a direct representation of the clausal information. As just noted, the representation of clausal information in a Minimalist approach is encoded within the phrase structure (in its configuration and its derivation), while in LFG the relation between f-structure and c-structure is fundamentally more flexible. The Mandarin Verb Copy Construction (Li & Thompson 1981, Huang 1982) serves as a good example of how clausal information at f-structure can exist independently of any particular c-structure property. Postverbal arguments and adjuncts appear to be in competition within a single VP: in order to express an argument and an adjunct, the main verb must be duplicated to form a second VP, as in (33b).

(33) Mandarin

a. * Zhangsan tan gangqin de hen hao
Zhangsan play piano LNK very well
'Zhangsan plays piano very well'

b. Zhangsan tan gangqin tan de hen hao
Zhangsan play piano play LNK very well
'Zhangsan plays piano very well'

Huang (1982) proposed a phrase structure filter which essentially disallows arguments and adjuncts in the same VP. Fang & Sells (2007) note that both arguments of a ditransitive verb appear in the first VP (underlined in (34a)), and that an object may be displaced from within the first VP, otherwise preserving the phrase structure:

(34) Mandarin

a. wo song ta zhe jian liwu song de hen hao
I give him this CL gift give LNK very well
'I gave him this gift and it turned out to be a very good idea.'

b. zhe jian liwu wo song ta _ song de hen hao
this CL gift I give him _ give LNK very well
'This gift, I gave (it) him and (it turned out to be) very good.'

However, if an object is displaced from a monotransitive VP, verb "copying" is no longer an option (also see Huang 1982: 53):

(35) Mandarin

a. * gangqin Zhangsan tan _ tan de hen hao
piano Zhangsan play _ play LNK very well

b. gangqin Zhangsan tan _ de hen hao
piano Zhangsan play _ LNK very well
'The piano, Zhangsan played (it) very well.'

If we take (36) to be the basic f-structure of what should be expressed in one structure of (33), given the constraint that arguments and adjuncts cannot be in the same c-structure VP, it follows that (33b) is the only possible expression.

(36)
$$\begin{bmatrix} \textsc{pred} & \text{`}\textsc{play}\langle(\uparrow \textsc{subj})(\uparrow \textsc{obj})\rangle\text{'} \\ \textsc{subj} & [\textsc{pred}\ \text{`}\textsc{Zhangsan}\text{'}] \\ \textsc{obj} & [\textsc{pred}\ \text{`}\textsc{piano}\text{'}] \\ \textsc{adjunct} & [\textsc{pred}\ \text{`}\textsc{very well}\text{'}] \end{bmatrix}$$

On the other hand, if 'piano' appears as a structural TOPIC, in clause-initial position, only a single VP is required to express the in-situ material, which consists of the PRED and its ADJUNCT in (37), as in example (35b). The identification of TOPIC and OBJ takes place only at f-structure (Kaplan & Zaenen 1989).

(37)
$$\begin{bmatrix} \textsc{topic} & [\textsc{pred}\ \text{`}\textsc{piano}\text{'}] \\ \textsc{pred} & \text{`}\textsc{play}\langle(\uparrow \textsc{subj})(\uparrow \textsc{obj})\rangle\text{'} \\ \textsc{subj} & [\textsc{pred}\ \text{`}\textsc{Zhangsan}\text{'}] \\ \textsc{obj} & [\quad\quad] \\ \textsc{adjunct} & [\textsc{pred}\ \text{`}\textsc{very well}\text{'}] \end{bmatrix}$$

Examples such as (35b) show that the competition between arguments and adjuncts for the same VP is a phrase-structure phenomenon, and is not relevant for the level of clausal grammatical information: a verb in Mandarin can perfectly well have a full array of arguments and any adjuncts, but only some of those can be expressed within a single VP. Following a careful survey of the research on this topic, Bartos (2019) proposes an MP analysis which has to appeal to haplology of V to derive (35b) from (35a) (already suggested in Huang 1982: 99), but this is merely symptomatic of an underlying misanalysis, for the core relations between a predicate and its arguments and adjuncts are not isomorphically represented in phrase structure.

4 Features and agreement

4.1 Feature theory and LFG

LFG is built on the foundation that featural specifications in morpho-syntax are of the form [attribute value], and that well-formedness requires every attribute in a given representation to have an appropriate value. The attribute-value format is used in LFG to represent functional structure, which represents the relational and featural content of a clause, but not constituent structure. F-structure is deliberately designed to not look like a phrase structure, to signify that it represents a different kind of syntactic information, and also that the parts within it are unordered. (The concept of f-precedence in LFG (see Glossary) crucially makes reference to the c-structure realization of f-structure elements.)

Adger (2010) considers features and the format of features in MP. He also concludes that features should be represented as attribute-value pairs, but rejects the idea that feature names can have structured values, because that re-creates the hierarchical structure within the phrase structure (e.g. a structured value for SUBJ corresponds to a DP in the phrase structure with internal constituency). Of course, there is no claim in LFG that every attribute in f-structure is the name of a feature – ‘f’ stands for ‘functional’, not ‘feature’. Hence the closest comparison will be the atomically-valued attributes in f-structure, which will correspond most closely to features in MP, and which also accord with the general notion of morpho-syntactic features. More precisely, these will be the ‘syntactic’ features identified by Sadler & Spencer (2001) (see also Spencer 2013), which are the target of morpho-syntactic exponence (as in the discussion of Finnish and Livonian above in Section 3.1). In this subsection I compare the LFG and MP approaches to such features. An extended discussion of features in the MP in comparison to other frameworks can be found in Asudeh & Toivonen (2006: 409–420).

Featural information associated with each word introduces constraints on the well-formedness of the whole structure, within a ‘monotonic’ system: information cannot be selectively ignored, nor can it be changed. Hence declarative frameworks such as LFG necessarily have a property which has come to feature in MP discourse – the ‘No Tampering Condition’ (Chomsky 2007), which does not allow information on an item to be changed as it is merged in as part of the derivation (see also Section 5).

For instance, (38) is ungrammatical as not all the constraints coming from the lexical items can be satisfied simultaneously, and no part of the information can be ignored:

(38) * You am happy.

In this example, *you* will specify the value of PERSON of the subject as 2, but *am* will specify that same value as 1. There is no way to satisfy the requirements of these first two words in a single structure.

LFG introduces featural information either via lexical items or by the rules which license phrase structure. Every well-formed feature specification in f-structure is of the form [attribute value], by definition (see e.g. Kaplan & Bresnan 1982: 181–182). If any lexical item specifies a feature but without a value, that is an 'unvalued feature'; some other element in the structure must introduce the value for that feature, or else the overall structure will be ill-formed. Unvalued features play a significant role in MP analyses (because their function goes beyond that of simply representing information; see Section 4.2); they also find their place in declarative analyses, as described below, although valued features tend to be the norm.

The basic way for information to be specified is as a defining equation – for instance the information carried by the appropriate lexical entries to give the f-structures in (8). There is another kind of informational contribution, the constraining equation of LFG. Kaplan & Bresnan (1982: 207–209) motivate constraining equations with familiar facts such as those in (39), with their proposal for analysis in (40):

(39) A girl is handing (*is hands, *is handed) the baby a toy.

(40) *is*: (↑ XCOMP PARTICIPLE) $=_c$ PRESENT

The VP complement of *is* has the grammatical function XCOMP in the LFG analysis, and within that, the grammatical form *handing* would provide the value 'PRESENT' for the attribute PARTICIPLE. That fulfils the requirement in (40). The important move to a constraining equation over a defining one concerns the ungrammatical variants in (39). For instance, as a finite form, *hands* is not specified at all for the attribute PARTICIPLE, and so does not provide the information that (40) needs. However, if that information in (40) were specified as defining information, it would be unified in with the information from *hands*, and – at least on that count – the sequence **is hands* would not be ungrammatical, as nothing would be inconsistent. Kaplan and Bresnan note that in a unification-based system, constraining equations have the important consequence that negative-value specifications for otherwise unnecessary features can be avoided. (For more on features see Kaplan 2019b.)

Accounts involving a constraining-type analysis are common. This is the situation that is modelled in MP analyses with an 'uninterpretable' feature – two elements between which there is some dependency have the same feature specifications, but only one such specification is the 'real one'. An MP analysis of the English auxiliary system by Aelbrecht & Harwood (2015) involves the same idea as in (40), proposing that uninterpretable but valued features match between the governed verb and the higher auxiliary which governs it.

The use of a constraining equation can be further illustrated in the case of a strict Negative Polarity Item (NPI) – an item that must appear in the context of negation, but is not the expression of negation itself. Such an NPI constrains its syntactic environment to have the NEG feature with the value + (see e.g. Sells 2000); this information must be present, but supplied by some other element, namely overt negation. From the MP perspective, Zeijlstra (2015) discusses an analysis of NPIs in which they "carry some uninterpretable negative feature [uNEG] that must be checked against a higher, semantically negative element that carries an interpretable formal negative feature [iNEG]." Again, in the relevant sense, this is a valued feature which is contentful on one element, and is on another for the purpose only of establishing an abstract syntactic relation.

Returning to the case of an attribute introduced without a value, this is an existential constraint on f-structure (see Kaplan & Bresnan 1982: 210ff. and Dalrymple 2001: 112–114). For instance, the complementizer *that* in English introduces a clause which is tensed, but it places no restriction on the value of TENSE. Hence part of the functional information associated with *that* will be the existential constraint (↑ TENSE). This constrains the f-structure of the clause to have the attribute TENSE, and any well-formed f-structure must have a value for that attribute. The value is not supplied by *that*, so that information must come from elsewhere in the clause introduced by *that*.

In summary, the notions of 'unvalued' and 'uninterpretable' features which are important in MP analyses – see immediately below – have formalized equivalents in LFG, and in LFG, neither can by itself lead to a well-formed f-structure: an f-structure cannot contain an attribute without a value, and the contribution of a constraining equation must be matched by the contribution of a (valued) defining equation. In keeping with the character of the differences between the LFG and MP approaches, a clausal f-structure in LFG is never partial nor ill-formed, unlike stages in an MP derivation. Rather, each element in the c-structure in a given example contributes to a set of constraints which the overall f-structure must satisfy. If those constraints conflict, there is no f-structure which satisfies them, and the example is thereby ungrammatical.

4.2 Features in the MP

Features are put to at least three uses in MP analyses (see Adger 2010: 200–212). The first is to represent information, the second is to establish a relationship, and the third is to make something happen. The representational aspect usually involves valued features, and might involve unvalued ones. The second use involves the notion of interpretable and uninterpretable features, which is the mechanism for establishing a relationship known as 'Agree' between a Probe and a Goal (Chomsky 2000: 101).

For instance, Adger (2010: 189) gives the following illustrative example of a feature that is unvalued, and also uninterpretable. The idea that some features are uninterpretable was originally introduced by Chomsky (1995: 277–278). In (41), the first group of features are features of the subject DP, and the second group are features on the T head of TP.

(41) {D, definite, plural} … {T, past, *u*plural}

The DP is definite and plural, and T is past and also marked as plural, but the prefix notation *u* indicates that the plural feature, though present on T, is uninterpretable on it. Adger describes (41) as follows:

> The idea is that a feature like [plural] only has an interpretation when specified on a category which can be potentially interpreted as plural (e.g. on a noun), otherwise an instance of this feature will be uninterpretable: interpretability is detectable from a feature's syntactic/semantic context. The formal property of features (the *u* prefix) which enables them to enter into dependency relations is thus linked to the interpretation of features … (Adger 2010: 189)

The [plural] feature is not interpretable on T – the interpretation of tense never makes reference to singular/plural – but the matching occurence of [plural] on the subject DP establishes the Agree relation between these two groups of features. After it has been checked by a matching interpretable feature, [plural] is then eliminated on T.

From the perspective of LFG, the equivalent of [*u*plural] in (41) would be as in (42).

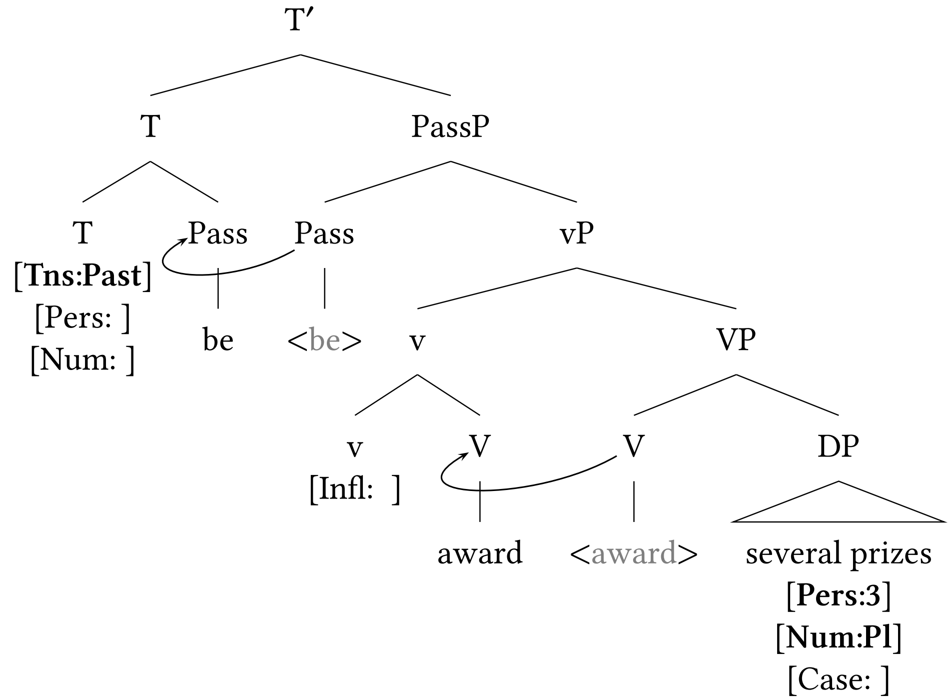
(42) $(\uparrow \textsc{subj num}) =_c \textsc{pl}$

Just as with (41), a structure described by (42) will only be well-formed if some other element (e.g. the subject) specifies the PL value for the feature, but it represents a different approach to the role of features. In (41), the feature on T is understood to convey "I am plural", which is uninterpretable; but the specification in (42) conveys "my subject's number is plural", which is actually straightforwardly interpretable.

The third use of features in the MP is to trigger an operation. Such features do not seem to overlap with the features considered above, and exist solely to make something happen. The canonical example is the 'EPP-feature' derived from GB, but used in different ways to force either XP movement or X^0 movement (head movement) in many MP analyses. This feature has been more recently cast as an 'Edge Feature' (e.g. Chomsky 2005). It is not clear formally what kind of feature this is – it must be satisfied, as an instruction for some structure to be built, and once satisfied, there are two options: either it becomes inactive, or it stays active, allowing for multiple specifiers (Chomsky 2007: 11).

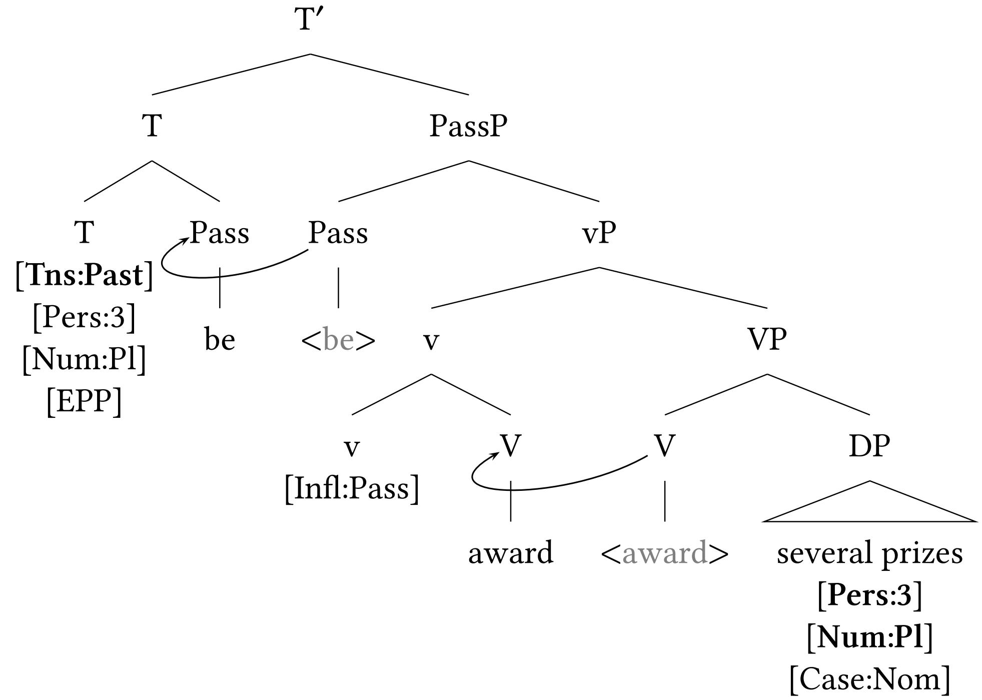
I now show in more detail how (un)valued and (un)interpretable features participate in an MP derivation. What is shown here is based on the presentation in Radford (2009: 284ff.), though using a slightly different representational format which is more internally consistent and which will also be more transparent in the context of the LFG approach to features described above. There is in fact a close relation between valued and interpretable features, as will be evident in the structures below. However, the two notions are formally distinct and can play different roles in an overall syntactic analysis (see e.g. Aelbrecht & Harwood 2015). The structure in (43) underlies the fragment *were awarded several prizes*, which is our illustrative example. The DP *several prizes* has interpretable features of person and number (it is 3rd person plural), and in the syntax it will have a value for case; but the case feature is initially unvalued, as the particular value of case will depend on the syntactic context of the DP. The v which ultimately hosts *award* has an Infl feature (sometimes referred to as VFORM in LFG), which will also be valued according to the syntactic context of the verb. Finally, the head T is specified as past tense, and it also hosts agreement features for person and number, which are unvalued at this initial stage. In the structure, the features shown in bold are those which are interpretable, and they also are the ones which are valued.

(43)



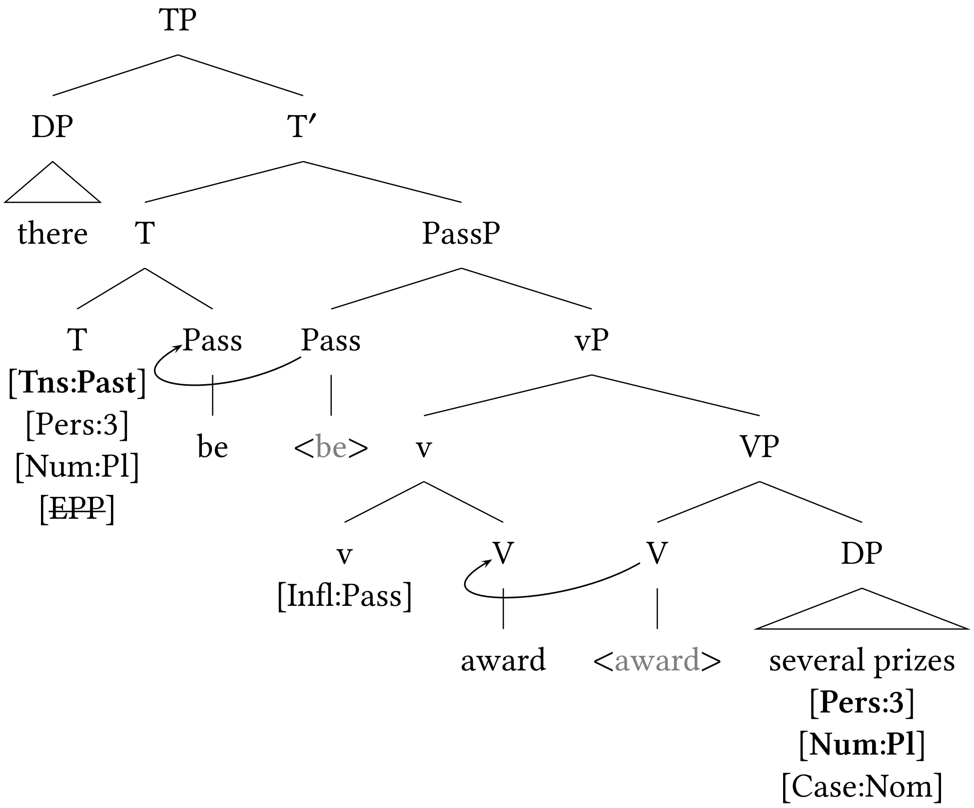
Formally, Agree establishes a relation between two nodes, a Probe and a Goal, one of which has an interpretable feature, with the other having a (matching) uninterpretable feature. In the simple example here, the uninterpretable features are the unvalued ones, and so they will become valued once Agree takes place. For instance, the Pass head *be* in (43) enters into an Agree relation with v and values the Infl feature as Pass(ive). The T head enters into an Agreement relation with the DP *several prizes*, valuing the Case on DP as Nom, and at the same time taking the values of person and number from that DP. Hence, after these Agree relations are established, all features are valued, as in (44), and these feature specifications will be relevant for morphological realization (e.g. the surface form of *be* will be *were*). Nevertheless, the non-bold (formerly unvalued) features are classed as uninterpretable, and must delete by the end of the syntactic derivation, Logical Form. Finally, (44) also shows one more feature on T, [EPP], which is discussed immediately below.

(44)



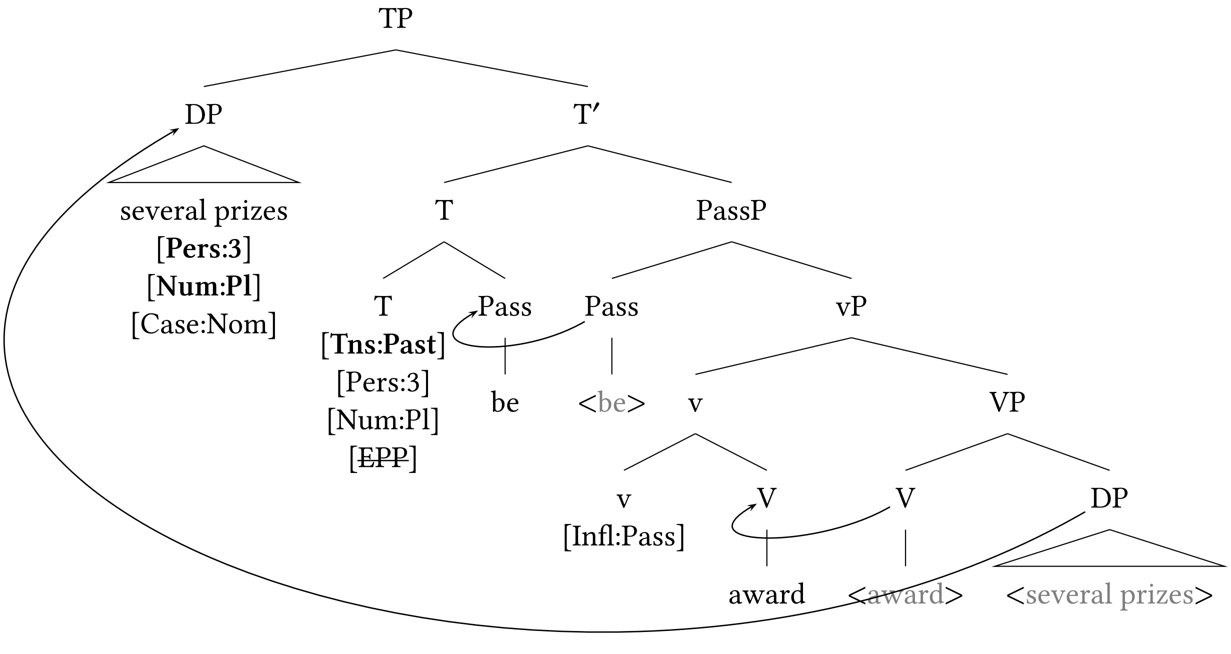
T in (44) has the [EPP] feature mentioned above, which has the effect that at the next step of the derivation a specifier must be created. This feature, then, does not represent a 'featural' property of the clause (unlike, say, 'past tense'), but represents a structural property. One option for satisfying this feature is to merge in an expletive placeholder, *there*:

(45)



Once the specifier is merged, the EPP feature is thereby satisfied, indicated in (45) by the strikethrough. Another way of satisfying this feature from the stage in (44) is to raise the object DP to the subject position, as a canonical passive:

(46)



4.3 Agreement and the direction of Agree

The second use of features in the MP noted above is that they participate in the process of Agree (Chomsky 2000), which is a prerequisite to establishing a relation in the syntax. The exemplar syntactic relation is that of agreement – say between a subject and a finite verb. As with canonical agreement (e.g. Corbett 2006), there is assumed to be a controller of agreement and a target for agreement, a directional or asymmetric relationship, formally instantiated as a Probe and a Goal in the MP. There is considerable debate in the MP literature as to the 'directionality' of Agree – is it upwards, or downwards? – as well as to whether feature valuation passes from the higher element to the lower one, or vice versa. For instance, Polinsky & Preminger (2019) make a linguistic argument about the direction of agreement (specifically, ϕ-feature agreement); they argue that agreement must be directional, looking downwards, but valuing features upwards. In contrast, Bjorkman & Zeijlstra (2019) argue for a more complex system in which a checking relation is first established, but only upwards, and then after that valuation can take place, in either direction. Some examples which bear on these issues are given below. These proposals are each 'substantive' proposals, motivated by empirical observations, as there is nothing formally about the MP system which requires a given directionality for Agree.

As noted above in Section 2.2.2, there is no sense in LFG in which agreement can be directional, as "agreement" is the informal notion we apply to a situation where more than one element provides featural information about some (other) element. The Archi examples below show that the distinction between Controller and Target, or between Probe and Goal, cannot be sustained anyway.

Polinsky & Preminger (2019) present examples such as (47) from Tsez, to support their claim that a Probe looks downwards to find a Goal – that the Probe c-commands the Goal – and the relevant feature values from the Goal are then valued upwards to the (previously incomplete) Probe. The key property of this example is that it involves long-distance agreement, in which the matrix verb does not agree with any local argument but rather agrees with the absolutive argument (object) of the embedded clause. Tsez has an ergative-absolutive case-marking system, and the verb agrees with an absolutive argument. The embedded absolutive in (47) is 'bread', class III, and both the local predicate 'eat' and the higher predicate 'know' agree with it in class, shown in boldface in the gloss:

(47) Tsez

eni-r	[už-ā	magalu	b-āc'-ru-łi]
mother-DAT	[boy-ERG	bread.**III**(ABS)	**III**-eat-PST.PTCP-NMLZ]

b-iy-xo
III-know-PRES
'The mother knows that as for the bread, the boy ate it.'

The particular argument that Polinsky and Preminger make is based on the observation that the opposite configuration appears to be unattested – we never find a structure in which a verb in a lower clause agrees with an argument in a higher clause. To rule out this logical possibility, they argue that syntactic theory should only allow downwards Agree/upwards valuation. The detail of their argument is not crucial here – what is relevant are the relative structural relations between the two elements in the agreement relationship. In (47), as the absolutive controls agreement on the higher predicate 'know', I will categorize this example as one in which the target must c-command the controller (hence, valuation is upwards).

The rest of the examples in this section are taken from Archi, another language with an ergative-absolutive system. Archi has a wide range of potential targets for agreement, but the controller is always the absolutive. (48) from Bond & Chumakina (2016: 67) shows various agreement targets (boldfaced in the gloss, each corresponding to the exponent *d-*):

(48) Archi
[d-ez χir] d-e⟨r⟩qˤa-r-ši d-i
[**II.SG**-1SG.DAT behind] **II.SG**-⟨IPFV⟩go-IPFV-CVB **II.SG**-be.PRES
'She follows me.' (male speaking)

Both the main verb and the auxiliary 'be' show agreement with the absolutive for gender and number. The gender system in Archi consists of four noun classes, and in this example, the gender agreement is for class II. The controller of agreement is not overt – it is the implicit subject of the intransitive predicate, formally in absolutive case. In addition, the first singular pronoun *d-ez* which is the object within the directional PP headed by 'behind' agrees with the absolutive of its clause, even though the pronoun is not a direct co-argument of the absolutive in this example. The pronoun is itself first person singular, but it also has an 'external agreement' slot for the clausal absolutive. Now that pronoun, inside the PP, cannot c-command anything outside that PP, and yet the intuition here is that it is the target of agreement: so for this example it must be the case that the controller (a null subject absolutive) c-commands the target. Valuation, if directional, should be downwards – exactly reversed from the Tsez example (47).

The LFG analysis of Archi agreement in Sadler (2016) codes each agreeing element for the relevant features of the notional agreement controller – the argument in absolutive case. As the GF of that argument could be subj or obj depending on the transitivity of the predicate, Sadler uses the designator piv, proposed by Falk (2006). Sadler (2016: 161) also uses the template approach (Dalrymple et al. 2004) to schematize over different agreement combinations. For the form in (49), @ii.sg associates the gender and number agreement values with the word, as in the second commentary enclosed in [ ]:

(49)

d-ez, Pronoun
(↑ pers) = 1
(↑ num) = sg [it is a first singular pronoun]
@ii.sg((gf ↑) piv) [its external agreement features are class ii singular]
…

For (48), (gf ↑) piv instantiates as (obl obj ↑) subj. The f-structure of the example is shown in (50), where the external agreement path for the first person pronoun – the inner [pred ‘pro’] – follows this instantiation and specifies values for gender and number, shown in boldface:

(50) F-structure of (48); agreement of the pronoun with the absolutive ((obl obj ↑) subj) must be: class ii, num sg

$$\left[\begin{array}{ll} \textbf{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘PRO’} \\ \text{PERS} & 3 \\ \textbf{NUM} & \textbf{SG} \\ \textbf{CLASS} & \textbf{II} \\ \text{CASE} & \text{ABS} \end{array}\right] \\ \text{TENSE} & \text{PRES} \\ \text{PRED} & \text{‘GO}\langle(\uparrow \text{SUBJ})(\uparrow \text{OBL})\rangle\text{’} \\ \textbf{OBL} & \left[\begin{array}{ll} \text{PRED} & \text{‘BEHIND}\langle(\uparrow \text{OBJ})\rangle\text{’} \\ \textbf{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{‘PRO’} \\ \text{PERS} & 1 \\ \text{NUM} & \text{SG} \\ \text{CASE} & \text{DAT} \end{array}\right] \end{array}\right] \end{array}\right]$$

Note that the first person pronoun itself does not have any “agreement slot” within its own feature structure: it has no agreement feature specification which is supposed to match or be copied somewhere else in the (f-)structure.

The informal notions of controller and target have no embodied representation, which ultimately proves to be an important fact about the LFG analysis – because there are examples in which ‘controller’ and ‘target’ are the same single syntactic element. There are different types of example in Archi where an absolutive argument “agrees with itself” – a given syntactic element has an external agreement slot, to agree with the absolutive of its clause, but that element happens to be the absolutive itself. (See also Corbett 2006: 68–69, Borsley 2016: 137.) In these examples, the distinction between controller and target – as two distinct elements in an asymmetric relationship – is invalid, but on a co-description account of the kind illustrated by (49) the examples work out straightforwardly.

(51) is one such example. A reflexive pronoun in Archi has two slots for agreement – one for the features of its antecedent, as is familiar, and another one for the features of the absolutive of the clause. In (51) (from Bond & Chumakina 2016: 70) the subject is the pronoun ‘I’, in dative case, and the object is the reflexive, in absolutive case, and it is class II, signifying a female referent. The subject pronoun, main verb and auxiliary verb each agree in class with the absolutive, as does one of the slots in the reflexive – the whole form is 1SG, agreeing with the subject antecedent, and there is also an infixed class II agreement, again agreeing with the absolutive, which is the reflexive itself.

(51) Archi
d-ez zona⟨r⟩u d-ak:u-r-ši d-i
II.SG-1SG.DAT 1SG.REFL.ABS⟨**II.SG**⟩ **II.SG**-see-IPFV-CVB **II.SG**-be.PRS
daχon-n-a-š
mirror(IV)-SG.OBL-IN-EL
‘I am seeing myself in the mirror.’

So here, (GF ↑) PIV instantiates as (OBJ ↑) OBJ, one of the logical possibilities. The f-structure is shown in (52):

(52) F-structure of (51); agreement of the reflexive with the absolutive ((OBJ ↑) OBJ) must be: CLASS II, NUM sg

$$\left[\begin{array}{ll}
\text{SUBJ} & \left[\begin{array}{ll}\text{PRED} & \text{‘PRO’}\\ \text{PERS} & 1\\ \text{NUM} & \text{SG}\\ \text{CLASS} & \text{II}\\ \text{CASE} & \text{DAT}\end{array}\right]\\
\text{TENSE} & \text{PRES}\\
\text{PRED} & \text{‘SEE}\langle(\uparrow \text{SUBJ})(\uparrow \text{OBJ})\rangle\text{’}\\
\textbf{OBJ} & \left[\begin{array}{ll}\text{PRED} & \text{‘PRO’}\\ \text{REFL} & +\\ \text{PERS} & 1\\ \textbf{NUM} & \textbf{SG}\\ \textbf{CLASS} & \textbf{II}\\ \text{CASE} & \text{ABS}\end{array}\right]\\
\text{OBL} & \left[\text{“MIRROR”}\right]
\end{array}\right]$$

Like other aspects of the grammar, the correct account of "agreement" does not involve moving something – in this case, featural information – from one place to another, but rather is a partial specification of featural information in a larger structure.

5 Conclusion

LFG takes up the challenges of accounting for human language precisely as Chomsky first articulated them, yet continuing with a view quite different from his as to what the core non-negotiable properties of the syntactic system should be. It was developed as a systematic and coherent framework for the representation of grammatical information, based on certain key design features. While these design features give these frameworks a very different character from a procedural framework such as the MP, many of the components of analysis which MP has developed are already present in declarative frameworks (see Section 4), as is the convergence of interest in exploring 'third factor' considerations (see (5)).

As Chomsky has noted, the choice between grammatical frameworks can be understood in terms of the "extra burdens" that an over-exuberant approach will entail (Chomsky 2007: 10–11). From a declarative perspective, any procedural approach creates such burdens, as the necessary mechanisms are either too powerful or are not well-founded. If those mechanisms can change or even delete syntactic information or syntactic substance, it is necessary to constrain those destructive operations with the 'No Tampering Condition' – indeed, a very natural property of a grammatical system, but one that should be intrinsic to it.

The 'copy theory' of movement (Chomsky 1995) is a way of expressing the intuition that some information is shared. However, copies involve duplication of substance, which amounts to more than the sharing of information. The discussion of structure in Section 3 provides a perspective on two kinds of further burden that necessarily arise in a copy-based approach. First, with regard to head mobility, the LFG view is that the issue is one of alternative positions, rather than successive positions which exist to provide hosts for position-occupying movement. The head is indeed only "in" one head position, but it makes the same contribution that it would have made from any of its alternative possible positions, and so might appear as if it were contributing from each position. The evidence from multiple expression of clausal information supports this view. A recent MP account of the syntax of heads by Arregi & Pietraszko (2021) associates only the informational part of a given head with several head positions, effectively recapitulating the LFG analysis of head mobility through various operations to create the right representations. Second, the facts of Mandarin verb copying show that certain parts of the syntactic analysis indeed call for a duplication of substance (when there are both in-situ arguments and adjuncts in Mandarin), while other parts involve more abstract syntactic information (the notion of a verb *having* arguments and having adjuncts). If that abstract information is conflated with the phrase structure substance, the system generates too much, and then extra operations have to be invoked, pruning or conflating substance.

The formalization of the MP by Collins & Stabler (2016) is designed in part to address the No Tampering Condition, and the apparent duplication of substance. Instead of creating copies, in this formalization, successive movements of a given element create new multidominance relations from that single element, which therefore does not change during the derivation. Their formalization is extended to head movement by Bleaman (2021). This particular formalization might make MP derivations slightly closer in nature to f-structures, in that each object in the derivation is a single informational unit which may have multiple grammatical relations and phrase-structural relations (e.g. a topicalized object is both an object and a topic, but with just one overt realization, in topic position).

A different kind of burden of potential complexity falls on the feature system of the MP, as features are used to do more than represent information (see Section 4). It becomes necessary to posit "bad" feature specifications, such as uninterpretable features, which by design are not interpretable on their hosts, and which must be eliminated during the derivation. LFG has constraints of a different character for checking that certain grammatical relationships exist, and which do not involve recourse to local pockets of uninterpretability.

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Chapter 41

LFG and Role and Reference Grammar

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LFG and Role and Reference Grammar have in common the goals of developing a formal model for the grammars of natural languages that both accommodates typological diversity and avoids syntax-centred derivationality. That said, the two frameworks differ in their choice of conceptual primitives and in the way the different components interact. In the present chapter we explore those differences in particular with respect to core sentence structure, information structure, cross-linguistic patterns and variety, and diachrony.

1 Historical Context

Both LFG and RRG emerged in the 1970's and 1980's in the context of the general reconsideration of possible models of grammar that took place at that time. These developments were driven in part by a concern to rethink the best way to capture the interaction between syntax, semantics and pragmatics, in part by a desire to reflect the typological diversity of natural languages and avoid a bias towards the sorts of structure found in 'standard average European', and in part by considerations of psychological plausibility and computational tractability. At the same time, the two frameworks differ in the relative priority to be assigned to these different lines of argument and evidence.

In the case of RRG the two principal motivating questions were the following: (a) What would a linguistic theory look like if it were based on the analysis of Lakhota, Tagalog and Dyirbal, instead of English? (b) How can the interplay

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of syntax, semantics and pragmatics in different grammatical systems best be captured and explained? (Van Valin 2009: 704). Constraining the framework are, therefore, not only the classic Chomskyan criteria of descriptive and explanatory adequacy (on which see Rizzi 2016), but also those of typological and psychological adequacy, since in the words of Austin & Bresnan (1996: 263) 'theoretical economy and explanatory elegance are unreliable guides to truth'. Typological adequacy requires that the theory should grasp commonalities between different languages without attributing to a given language any features for which that language provides no evidence. Psychological adequacy, as formulated by Dik (1991: 248), states that a theory should be compatible with the results of psycholinguistic research on the acquisition, processing, production, interpretation and memorization of linguistic expressions. This is not to say that there are no postulated universal principles either in LFG or RRG, but rather that within neither framework is there the presumption of an innate, syntactically defined U(niversal) G(rammar).

This concern for psycholinguistic plausibility was shared with LFG, as discussed for example by Bresnan & Kaplan (1982), where it was linked to issues about the length and complexity of syntactic derivations within the transformational approach. Whereas at that time generative syntax was — and indeed still is — built on an exclusively categorial set of primitives, LFG and RRG in their different ways sought to explore in addition the use of relational concepts. Influential here had been, on the one hand, Relational Grammar with its definition of structures in terms of changing grammatical functions like subject and object, albeit while still retaining a derivational approach, and, on the other hand, Fillmorean Case Grammar with its set of semantically defined roles like agent and patient. For LFG this led to a much reduced, monostratal categorial component (c-structure) linked to but not derived from a set of grammatical relations (f-structure). RRG, by contrast, goes a step further and in addition sets aside notions like subject and object as also being in danger of biassing the system towards particular types and families of languages and opting instead for a core set of semantically defined relations. Despite these differences, RRG and LFG have in common the fact that, once the analytical burden is shared between categories and relations, grammatical structures are no longer required to respect the principles of endocentricity and binary branching which have become key parts of current Minimalist, cartographic and nanosyntactic approaches. A sentence can be represented simply as S rather than needing to be CP, TP or the like and if a language does not provide ready evidence of configurational structure, none needs to be imposed (Austin & Bresnan 1996; Van Valin & LaPolla 1997b: Chapter 2).

We move now to an overview of RRG (Section 2) before returning to a more detailed comparison of the two frameworks (Section 3) and consideration of the way they deal with issues involving language change, processing and acquisition (Sections 4, 5 and 6).

2 RRG: An overview

For RRG, grammar is a system in a traditional structuralist sense. However, RRG is not only interested in the syntagmatic and paradigmatic relations that characterize syntax, but also in the combinatorial relations between units of meaning within and out of context. This framework is, thus, like LFG, a parallel architecture theory (Jackendoff 2002: Chapter 5), which relies on three independent, albeit interacting, levels of analysis: discourse, lexical semantics and syntax.[1] Much of what other syntactic frameworks would explain in terms of syntactic derivation or movement is captured in RRG in terms of the mapping of these three dimensions. This reflects the assumption that grammatical structure can only be understood and explained with reference to the expressive and communicative functions of language.

Since it seeks explanation outside of the boundaries of syntax, RRG could thus be thought to lie on the functional side of the formalist-functional divide in theories of language (Butler 2005, 2006, Mairal Usón et al. 2012), and indeed Newmeyer (1998: 14-16) cites it as an example of what he calls ‘external functionalism’, adducing the description by Van Valin (1993: 1) of RRG as a ‘structuralist-functionalist theory of grammar’. However, a preference for the explanation of linguistic phenomena in terms of meaning and external context by no means implies an absence of a formal notation. And indeed within RRG each of the levels of analysis is conceived of in terms of an articulated formalism and there are explicit constraints on the interaction of the three levels. In addition, in the last ten to fifteen years, an increasing number of scholars have attempted to apply RRG to language processing, both in the computational and the neurolinguistic domain. Such attempts have resulted in the development of new formalisms, which use the RRG framework as their basis (see Section 5 below).

The basic architecture of RRG is illustrated in Figure 1. While the two arrows in the middle show the bidirectionality of the semantics-syntax linking, the position of discourse-pragmatics with respect to this mapping indicates that discourse

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[1] A striking comparison in this connection is Sadock’s independent realisation that a language like Greenlandic calls for a parallel or ‘modular’ architecture (Sadock 1991: ix–xi), which in turn led to his own model of Autolexical Syntax.

can be relevant at every step in the linking (Bentley 2023 and Section 3.5 below). Specifically, discourse-related meaning (for example, the distinction between the information that has already been given and the new information that is provided with the utterance) is not only expressed syntactically, but also in prosody, morphology and even in lexical choices. In fact, the encoding of discourse-related meaning in syntax varies across languages in important ways and this variation has been the object of much research in RRG (see among others Van Valin 1999, Shimojo 1995, 2008, 2009, 2010, 2011, Bentley 2008).

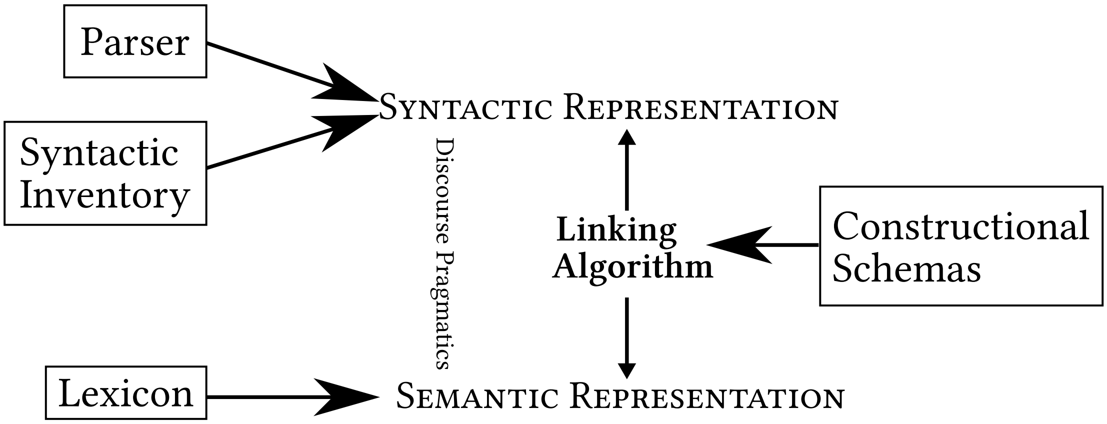

Figure 1: Organization of RRG (based on Van Valin 2005: 134)

We return to other properties of the linking at the end of Section 2.

2.1 The structure of the sentence and of reference phrases

There is a single syntactic representation for a sentence, which corresponds to the surface form of the sentence and appears in the Constituent Projection. As noted above, there is no requirement that the structure of the clause should be binary branching; the syntax of the sentence must be adequately represented in configurational and non-configurational, dependent-marking and head-marking languages alike. In clausal structure, a distinction is drawn between the semantically motivated positions, which are assumed to be universal, and other positions, which tend to be associated with particular pragmatic roles and are not universal. Together the two types of position form the Layered Structure of the Clause (see Figure 2).

There is no verb phrase in the Layered Structure of the Clause because not all languages offer evidence for it (for comparable considerations in LFG see Börjars et al. 2019: 5-6). The Nucleus hosts the predicate, while the arguments drawn from the semantic representation of the predicate, called core arguments, figure

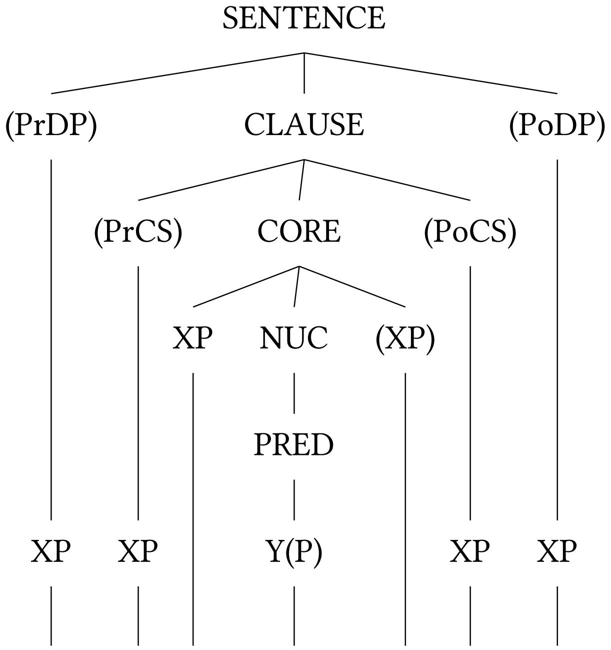

Figure 2: The Layered Structure of the Clause (from Van Valin 2023b)

within the Core and are labelled RPs (Reference Phrases).[2] No phonologically null elements are allowed in RRG syntax.[3] Neither the Nucleus nor the RP nodes are restricted to any particular lexical category, given that in some languages, such as Nootka and Tagalog, expressions that are verbs in categorial terms can have a referential function in the clause, in which case they behave as arguments, while nouns can have a predicative function (Van Valin 2008: 170).[4] In English too the predicate in the Nucleus can be an adjective, a noun phrase, or a prepositional phrase, although a verb is needed for the proper formation of the Nucleus of the clause. The Nucleus and the Core are taken to be universal positions because

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[2] Within core arguments, RRG distinguishes between direct core arguments, which are unmarked or marked by case alone, and oblique ones, which are adpositionally marked.

[3] Genuine zero anaphora, i.e., the complete failure of expression of an argument, whether as a pronoun or in inflection, is dealt with in a system of direct mapping from discourse to the semantic representation of the clause, and vice versa, with the argument being represented in both of these domains, but not in syntax (see Section 3.5). Zero morphemes are, however, admitted in RRG in morphological paradigms, the key difference between these and phonologically null syntactic elements being that the latter type of element is redundant, on the assumption that the linking can occur directly from the semantic representation to discourse.

[4] This is not to say that nouns and noun phrases have no status in RRG. On the contrary, nouns and verbs are taken to be universal lexical categories, by contrast with adjectives, which are not found in all languages.

all languages predicate and refer. Any adjuncts that modify the nucleus, or the core, or indeed any of the more external syntactic layers figure in a Periphery as M(odifier) P(hrases). Every syntactic layer (Clause, Core, Nucleus) can have its own Periphery.

Both the core-internal positions and the peripheries of the various layers of the clause can host constituents with particular discourse roles. To give but one example, to the extent that they are overt, topical subjects normally occur in the core-initial pre-nuclear position in SVO languages. However, these positions are not defined in pragmatic terms, but rather in terms of the referential and predicative functions of language. The more external positions, instead, tend to be associated with pragmatically salient functions. The Pre- and Post-Core Slot normally host foci, although there can be language-specific restrictions on the kinds of foci that they admit. In a large number of languages the Pre-Core Slot hosts pre-verbal *wh*-words and the same position has been claimed to be involved in contrastive focus fronting in some Romance languages (Bentley 2008). The Pre-Core Slot hosts topics, as well as foci, in languages with a V2 constraint on word order (Diedrichsen 2008). The Post-Core Slot is the position of secondary foci which non-canonically occur in post-verbal position in Japanese, a verb-final language (Shimojo 1995). The Pre-Detached Position (formerly called Left-Detached Position) is the position of detached topics and can iterate, thus allowing the utterance to have several topics, while the Pre- and Post-Core Slot cannot be repeated.[5] The Post-Detached Position (formerly called Right-Detached Position) hosts afterthoughts or topics.[6] The pragmatically salient positions are not universal: the languages that provide no evidence for these positions are not assumed to have them. The building blocks of the Layered Structure of the Clause are the building blocks of complex predicates and clauses, as will be explained in Section 3.4.

The structure of the RP and of adpositional phrases is built following the same principles as the structure of the clause (see Cortéz-Rodríguez 2023, Ibáñez Cerda 2023.). Thus, RPs have their own Constituent Projection, with Nucleus and Core, and their respective peripheries. RPs also have their Operator Projection, which defines the scope of the functional categories of definiteness, deixis, quantification, and number.

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[5] This raises the question of the position of initial sequences of *wh*-words in languages which allow them, for example Bulgarian, an issue which to our knowledge has only been addressed from an RRG perspective by Eschenberg (1999).

[6] The reason for the relabelling of the Left- and Right-Detached positions is that these names reflect a bias towards western languages, which are written from left to right. The problem does not arise with Pre-Detached and Post-Detached, which reflect the before and after dimensions of speech.

In RRG the functional markers of closed-class grammatical categories such as aspect, modality, tense and illocutionary force are not mapped to the Constituent Projection, but rather to the Operator Projection, and hence the framework does not incorporate an inventory of functional heads. The Operator Projection is the mirror image of the Constituent Projection because RRG assumes that the order of the morphemes that express grammatical categories is a function of their syntactic and semantic scope (Foley & Van Valin 1984, Bybee 1985). Thus, the Nucleus comes first, in the Operator Projection, as the domain of aspect, nuclear negation and directionals. Core negation and root modality have scope over the Core. Finally, status (epistemic modality), tense, evidentials, and illocutionary force have scope over the Clause.

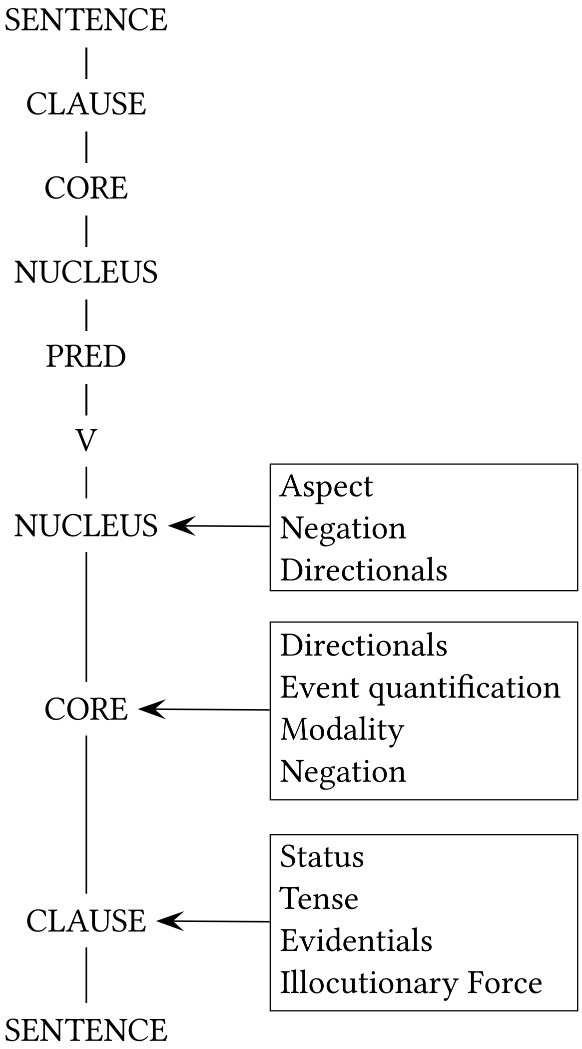

Figure 3: The operator projection in the layered structure of the clause

The Constituent Projection is not built incrementally in the linking. Rather, the syntactic structure of the clause, and of the RPs and PPs contained in it, are drawn as templates from the syntactic inventory of the given language at the relevant stage in the linking. The selection of syntactic templates in the linking is governed by the *Syntactic Template Selection Principle* (Van Valin & LaPolla 1997b: 324, Van Valin 2005: 130) and by discourse considerations (Section 3.6), to which we return below. The syntactic inventory of a language comprises all the templates that are necessary to form grammatical sentences in that language. It reflects universal linearization principles concerning the position of the extra clausal positions shown in Figure 2, as well as the word order preferences of the language: primarily, its branching directionality, in the sense of Dryer (1992). Broad typological properties, such as head and dependent marking, and configurationality, also play a role in word order. Instead, the position of the operators in the clause largely depends on their semantic scope (see Figure 3). The syntactic inventory complements the lexical inventory as well as an inventory of constructional schemas, to which we shall also return.

2.2 Logical Structures, semantic roles and macroroles

The lexicon is an important component of grammar in RRG, since the semantic representation of the clause is based on the semantic representation of the verb and any other predicating elements figuring in it, for example, any predicative adpositional phrases. The semantic representation, or Logical Structure, of a verb is based on a theory of lexical decomposition which relies on Vendler's (1967: 97-121) Aktionsart types *state*, *activity*, *achievement* and *accomplishment*, to which Van Valin & LaPolla add the distinction between plain and active accomplishment (see below) and Van Valin (2005: 32) adds the non-Vendlerian class of *semelfactives* (Smith 1997: 55-58). State and activity are the basic types upon which all the others are built. Both states and activities are [−telic] and [−punctual]. However, states describe static situations, whereas activities describe dynamic ones, that is, situations that involve change, albeit not of the type leading to a result state. We provide below the semantic representations of the states 'red' and 'know' and of the activities 'march' and 'sing'.

(1) States
   a. **be′**(x, [**red′**]) 'red'
   b. **know′**(x, y) 'know'

(2) Activities
  a. **do′**(x, [**march′**(x)]) ‘march’
  b. **do′**(x, [**sing′**(x, (y))]) ‘sing’

Predicates are presented in bold, followed by a prime, and English is the metalanguage used to represent them; **be′** figures in the Logical Structure of attributive, identificational and specificational states, alongside the constant identifying the given state. Instead, **do′** marks the Logical Structure of all activities.

Achievements and accomplishments are [+telic], which means that they describe change leading to the attainment of a result state. The former predicate type, being [+punctual], does not include a PROC(ess) component (cf. (3)), which instead characterises the latter (cf. (4)).[7] PROC and the other Logical Structure components in capital letters are operators, or markers of templatic facets of meaning, which combine with the constants representing the idiosyncratic meaning of individual lexical items. The RRG theory of lexical decomposition stands out from others in differentiating accomplishments from active accomplishments (cf. (5)). These are built on the basis of the logical structures of an activity plus an accomplishment. The process that is part of the accomplishment is simultaneous with the activity, and both are followed by the attainment of a result state (Van Valin 2018). Simultaneity is represented with the notation ∧, whereas the symbol & stands for “and then”.

(3) Achievements
  a. INGR **appear′**(x) ‘appear’
  b. INGR **be-at′**(x) ‘arrive’

(4) Accomplishments
  a. PROC INGR **dead′**(x) ‘die’
  b. PROC INGR **know′**(x, y) ‘learn’

(5) Active accomplishments
  a. **do′**(x, [**run′**(x)]) ∧ PROC **cover.path.distance′**(x, (y)) &
  INGR **be-at′**(**path.endpoint**, x) ‘run to a location’
  b. **do′**(x, [**write′**(x, y)]) ∧ PROC **create′**(y) &
  INGR **exist′**(y) ‘write (tr.)’

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[7] See Bentley (2019) and Van Valin (2023b) for proposals on the differentiation of quantized and non-quantized change in the Logical Structure of accomplishments.

Semelfactives (Smith 1997: 55–58) describe repeatable punctual events, which may be [+static] or [+dynamic] (cf. (6a) vs. (6b)), and do not lead to a result state, as testified by the absence of result state participles of these verbs in attributive function in the noun phrase.

(6) Semelfactives
  a. SEML **see′**(x, y) ‘glimpse’
  b. SEML **do′**(x, [**cough′**(x)]) ‘cough’

There are standard diagnostics to determine the Aktionsart of the predicate of a clause, based on Dowty’s (1979) seminal work. No *a priori* assumption is made as to whether verbs describing comparable eventualities should belong to the same Aktionsart type across languages, although it is acknowledged that there are striking cross-linguistic similarities of this kind, whose rationale can be captured on the basis of a system of lexical decomposition like the RRG one.

The predicate types discussed above have causative counterparts, which in principle combine any logical structure α with any logical structure β by means of the operator CAUSE. The causal event may, however, remain unspecified, as is shown in (7b), which is built upon (7a).

(7) Accomplishment vs. causative accomplishment
  a. PROC INGR **dead′**(x) ‘die’
  b. [**do′**(x, ∅)] CAUSE PROC INGR **dead′**(y) ‘kill’

Traditional thematic role labels, like *theme* or *patient*, are mere mnemonics for the position which an argument occupies in Logical Structure as determined by applying the standard tests for the Aktionsart of the predicate. It is purely on the basis of its position that a core argument derives its thematic role (Jackendoff 1976; Van Valin & LaPolla 1997b: 82-138). There are five relevant positions.

(8) Semantic positions which are relevant to the linking

Arg of DO	1st arg of **do′**(x, ...)	1st arg of **pred′**(x,y)	2nd arg of **pred′**(x,y)	arg of state **pred′**(x)

Following Van Valin & Wilkins (1996), RRG draws a distinction between agentivity as an entailment and as an inference. The first argument of verbs which entail agentivity (e.g., *murder*) is named ‘Arg of DO’, whereas the first argument of verbs which merely lend themselves to inferences of agentivity (e.g., *kill*) is represented as '1st arg of **do′**'. These argument positions are found in the Logical Structure of activities, the latter one alone, the former in combination with the latter. The other positions are found in the Logical Structure of bivalent (1st and 2nd argument of **predicate**′(x,y)) and monovalent (argument of state **predicate′**(x)) states. As can be seen in (3) to (7) these positions combine with each other and with operators of cause, semelfactivity, process and change.

Importantly, the positions in (8) are not grammatically salient *per se*, but only to the extent that they determine which generalized semantic role, or macrorole, an argument is assigned in the linking. The relation between argument positions and macroroles is captured by the Actor-Undergoer Hierarchy in (9), while the macrorole assignment principles are spelled out in (10).

(9) The Actor - Undergoer Hierarchy and its mapping onto argument positions (Van Valin 2005: 61)

ACTOR				UNDERGOER
⟶	⟶	⟶		
		⟵	⟵	⟵
Arg of DO	1st arg of **do′**(x,...)	1st arg of **pred′**(x, y)	2nd arg of **pred′**(x, y)	Arg of state **pred′**(x)

['→' = increasing markedness of realization of argument as macrorole]

(10) Default Macrorole Assignment Principles (Van Valin 2005: 63)

a. Number: the number of macroroles a verb takes is less than or equal to the number of arguments in its logical structure.
  i. If a verb has two or more arguments in its logical structure, it will take two macroroles.
  ii. If a verb has one argument in its logical structure, it will take one macrorole.

b. Nature: for verbs which take one macrorole,
  i. If a verb has an activity predicate in its logical structure, the macrorole is actor.
  ii. If a verb has no activity in its logical structure, the macrorole is undergoer.

Actor and undergoer are the two primary arguments of transitive predications. Two-place verbs belonging to different Aktionsart types, say an active accomplishment (e.g., *write a book*) and a state (e.g., *know the answer*), are not differentiated in terms of macrorole assignment: both take an actor (the highest or leftmost argument in Logical Structure) and an undergoer (the lowest or rightmost argument in Logical Structure). There is, however, a fundamental asymmetry between the two macroroles, in that the highest core argument will always be the actor, whereas the lowest one is only the default choice for undergoer. Indeed, variable selection of the undergoer from the two lower arguments of three-place predicates is allowed in some languages. This is exemplified by English *present* (as in *present a gift/prize to someone*) in (11). In addition, two-place predicates may be intransitive, in which case this is specified in the lexicon, as exemplified with English *belong (to)* in (12).

(11) a. [**do′**(x, ∅)] CAUSE [INGR **have′**(y, z)]
b. x presents z to y
c. x presents y with z

(12) **have′**(x, y) [MR1] ‘belong (to)’

In (11b) z is the undergoer, whereas in (11c) the undergoer is y. The actor is x in both cases. As for (12), [MR1] lexically specifies that this verb only takes one macrorole despite being bivalent. Finally, whether the only core argument of a one-place predicate is an actor or an undergoer is established by the principles in (10b).

An important claim of RRG is that no subcategorization requirements need to be specified for a verb, other than the argument positions in its Logical Structure and its transitivity, which is defined as the number of macroroles it takes. The prepositions that mark the oblique arguments required by some verbs (e.g., *load x with y, load y on x*) are argued to be predictable from general principles, for which we refer to Van Valin & LaPolla (1997b: 376-384).

Macrorole assignment plays a key role in the linking, allowing RRG to capture how syntactically different, but semantically comparable, structures are related. Thus, starting from the assumption that languages with nominative-accusative alignment select the actor, whereas languages with ergative-absolutive alignment select the undergoer, as the default privileged grammatical relation (Section 2.3), passive and antipassive are constructions with the marked macrorole selection as the privileged grammatical relation: undergoer in the passive and actor in the antipassive. We return below to the notion of subject, which is not considered to be a universal of grammar in RRG.

Macrorole assignment, or failure thereof, also captures the different syntax of verbs with the same number of arguments. Consider (13a) and (13b).

(13) Italian

a. Mario, la matematica, l' ha sempre amata.
Mario the maths.FSG ACC.CL.FSG has always love.PTCP.FSG

b. (A Mario), la matematica gli è sempre piaciuta.
to Mario the maths.FSG DAT.CL is always please.PTCP.FSG
'Mario, maths, he always loved/liked it.'

The contrast between nominative and dative experiencer verbs (e.g., Italian *amare* 'love' vs. *piacere* 'please, like') depends on whether both arguments are assigned a macrorole, with the result being a transitive structure, as testified by the accusative clitic and the perfect auxiliary 'have' in (13a), or the experiencer being denied macrorole status, in which case the structure has a single macrorole and is intransitive, as testified by the selection of a different auxiliary, 'be', and the dative clitic in (13b).

2.3 Grammatical relations

RRG rejects the traditional notions of subject and object as primitives or universals of syntactic theory. Following Durie's (1985, 1987) analysis of Acehnese, an Austronesian language, Van Valin & LaPolla (1997b: 255-260) claim that there are languages which group arguments in terms of their macrorole status without assigning them a syntactic function. In Acehnese, all actors are marked in the same way, as illustrated by the proclitic pronoun in (14a)-(14b), whereas undergoers are marked differently, as illustrated by the ungrammaticality of (14c) and the optional enclitic pronoun in its grammatical counterpart in (14d).[8]

(14) Acehnese (Van Valin & LaPolla 1997b: 255-256)

a. (Gopnan) geu-mat lôn.
(3SG) 3-hold 1SG
'(S)he holds me.'

b. Geu-jak (gopnyan).
3-go (3SG)
'(S)he goes.'

c. *(Lôn) lôn-rhët.
1SG 1SG-fall

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[8] The reader should note, on the one hand, that Acehnese is a head-marking language and, on the other, that the Logical Structure of the verb 'go', in this and other languages, includes an activity. Therefore, the macrorole assigned to the direct core argument is actor, following (10b-i).

d. Lôn rhët(-lôn).
1sg fall-1sg
'I fall.'

The contrast between (14a)-(14b) and (14c)-(14d) suggests that arguments are only grouped in terms of their macrorole, as is the case with active-vs.-inactive alignment, and there is no marking that defines a syntactic function. Acehnese also has no voice constructions, such as passive or antipassive, which follows from the absence of grammatical relations.

From this it also follows that if a grammatical relation is to be postulated for a given language or construction, evidence will be required of restricted neutralizations of semantic roles for grammatical purposes (see LaPolla 2023 for an in-depth discussion of this point). Such neutralizations can be, and indeed often are, found at the level of specific constructions, although the well-known Indo-European languages tend to be consistent across constructions. With reference to the Acehnese examples in (14a)-(14d), the fact that the obligatory pre-verbal clitic only cross-references the actor indicates that this type of cross-referencing involves no such neutralization, but merely a restriction to actor. Contrastingly, the controller of person and number agreement on the English verb can be characterized as a restricted neutralization, specifically [A, S, d(erived)-S], because only the actor of a transitive (cf. (15a)), the actor or undergoer of an intransitive (cf. (15b)-(15c)) or the derived intransitive S of a passive (cf. (15d)) can control this kind of agreement. The undergoer of a transitive structure cannot (contrast (15a)-(15d) with (15e)).

(15) a. Mary$_i$ (A) has$_i$ eaten all the biscuits$_j$ (U).
b. Mary$_i$ (Sa) has$_i$ eaten.
c. Mary$_i$ (Su) has$_i$ fallen.
d. All the biscuits$_j$ (d-S) were$_j$ eaten by Mary$_i$ (A).
e. *Mary$_i$ (A) have$_j$ eaten all the biscuits$_j$ (U).

The fact that the grouping [A, S, d-S] is insensitive to the distinction between Sa and Su indicates that the control of person and number agreement on the English verb neutralizes the semantic role of the controller. The fact that the undergoer of a transitive (U) is banned from this syntactic function, and indeed a special voice construction, the passive, is needed for this argument to control agreement as a d-S, indicates that the neutralization under discussion is restricted. RRG calls this kind of restricted neutralization a privileged syntactic argument (PSA).

Importantly, there are languages that provide no evidence for such restrictions. Thus, Mandarin Chinese (LaPolla 1990, 1993, 1995, 2023) has no conventionalized associations between syntactic position, agreement on the verb, case marking on the noun, etc. and particular semantic roles. The claim in RRG is, therefore, that Mandarin Chinese is a language which does not have any grammatical relations.

PSAs can have the syntactic functions of controller or pivot. The latter is the missing argument in a construction, whereas the controller is the argument that supplies its interpretation. Observe that the pivot of the English construction with *want* is defined as [A, S, d-S].

(16) a. Mary$_i$ [CONTROLLER] wants __$_i$ [PIVOT, A] to eat the biscuits.
 b. Mary$_i$ [CONTROLLER] wants __$_i$ [PIVOT, SA] to eat.
 c. Mary$_i$ [CONTROLLER] wants __$_i$ [PIVOT, SU] to die.
 d. Mary [CONTROLLER] wants __$_i$ [PIVOT, d-S] to be loved.
 e. *Mary$_i$ [CONTROLLER] wants you to love __$_i$ [PIVOT, U].

Similar considerations are valid for the missing argument in conjunction reduction. This suggests that English is consistent in how it constrains the PSA across constructions. Nonetheless, there are English constructions in which different restrictions apply. For instance, the controller of the non-finite complementation with *persuade* is the undergoer, and cannot be the actor (cf. (17)).

(17) a. Mary$_j$ persuaded Paul$_i$ [CONTROLLER] __$_{i/*j}$ [PIVOT] to stay.
 b. Paul$_i$ [CONTROLLER] was persuaded by Mary$_j$ to __$_{i/*j}$ [PIVOT] to stay.

Given that there is a restriction in (17), but no neutralization, this is a case of semantic control, comparable to the control of the pre-verbal clitic in Acehnese.

While being comparable to English, in that they have restricted neutralizations of the kind described above, other languages define the PSA differently. Thus, Kalkatungu, an Australian aboriginal language (Blake 1979), provides evidence of the restricted neutralization [U, S, d-S], which defines ergative-absolutive alignment. The participial construction exemplified below illustrates this kind of PSA.

(18) Kalkatungu (Van Valin 2005: 97-98)
 a. Ṯuaṭu pa-ji maṛapai-∅ icaji [iŋka-ʎ-iŋka-cin-∅].
 snake.ERG that-ERG woman-ABS bite go-LNK-go-PTCP-ABS
 'The snake bit the woman$_i$ [as __$_i$ was walking along].

b. [Jaṛikajan-ati-ɲin-tu] caa ŋa-t̠u l̠aji ∅
hungry-VBLZ-PTCP-ERG here 1SG-ERG kill 3SG.ABS
‘[__$_i$ Being hungry] I$_i$ killed it.’

c. Kuntu caa ḷuŋa-n̠a ∅ [ŋa-t̠u l̠a-ɲin-ka-∅]
NEG here cry-PST 3SG.ABS 1SG-ERG hit-PTCP-SUFF-ABS
‘He$_i$ didn’t cry [when I hit __$_i$].’

d. *Nga-t̠u ṇaɲa macumpa-∅ [aṛi-ɲin-∅ kat̠ir-∅]
1SG-ERG saw kangaroo-ABS eat-PTCP-ABS grass-ABS
‘I saw the kangaroo$_i$ [__$_i$ eating grass].’

The pivot or missing argument of the Kalkatungu participial construction can be an intransitive S (Sa in (18a) and Su in (18b)) or a transitive U (cf. (18c)), but it cannot be the actor of a transitive structure (A) (cf. (18d)). Therefore, there is a neutralization of semantic macroroles in this construction and this is restricted to S and U, leaving out A. In fact, if the verb in the participial construction is antipassivized, then the construction is grammatical.

(19) Kalkatungu (Van Valin 2005: 98)
Nga-t̠u ṇaɲa macumpa-∅ [aṛi-li-ɲin-∅ kat̠ir-ku]
1SG-ERG saw kangaroo-ABS eat-ANTIP-PTCP-ABS grass-DAT
‘I saw the kangaroo$_i$ [__$_i$ eating grass].’

The data in (19) indicate that d-S is also admitted in the Kalkatungu participial construction. The PSA of this structure is thus to be defined as [U, S, d-S].

It should further be noted that some languages do not have special voice constructions, in which case they may have the restricted neutralizations [A, S] or [U, S], although the latter is claimed to be very rare. In addition, in other languages, the PSA need not be a macrorole argument. We refer to Van Valin & LaPolla (1997b: 352-363) for relevant discussion.

The RRG conception of grammatical relations poses very strong constraints on the analysis of correspondences such as the ones that other frameworks conceive of as relations between active objects and passive subjects or between transitive objects and unaccusative subjects. Not only is it not possible to rely on movement or derivation, but the very construct of object is not available either. As was briefly mentioned above, the passive, as well as the antipassive, are captured in terms of the PSA selection hierarchy that is at work in the linking in a given language, or a given construction. Starting from the ranking of arguments in

(20), which reflects the argument positions in Logical Structure (cf. (8) and (9)), the default PSA is selected in accordance with the two main principles in (21).[9]

(20) Arg of DO > 1st arg of **do′** > 1st arg of **pred′**(x,y) > 2nd arg of **pred′**(x,y) > arg of **pred′**(x)

(21) PSA Selection Principles
  a. Accusative construction: the default PSA is the highest-ranking direct core argument in terms of (20).
  b. Ergative construction: the default PSA is the lowest-ranking direct core argument in terms of (20).

The principle in (21a) captures the fact that, in English and many other languages, the actor is the PSA of a transitive construction, whereas (21b) captures the selection of undergoer as default PSA in Dyirbal transitive constructions. Conversely, the marked PSA selection found in the English passive is undergoer, while the marked PSA selection found in the antipassive is actor. The principles in (21) mention direct core arguments (see footnote 2), as opposed to macroroles, because of the existence of languages in which non-macrorole arguments can be PSAs (Icelandic, Georgian, Japanese, etc.). In the present context, however, we will not dwell on this difference.

At this point we should mention constructional templates or *schemas* (Van Valin & LaPolla 1997b: 430-436; Van Valin 2005: 132-135). These are constellations of syntactic, morphological, semantic and pragmatic instructions, which, while making reference to the general principles of grammar, complement them with the language-particular information that is necessary to form and parse the constructions of a given language. In the formation of the English passive, it is the passive constructional schema that specifies that the PSA is not chosen in accordance with the default PSA selection principle (cf. (21a)), usually owing to discourse-pragmatic factors. In addition, the constructional schema establishes that the actor cannot occur within the syntactic Core, although it can be expressed in a *by*-phrase, and that the verb carries special, passive, morphology. In *wh*-questions, it is a constructional schema that instructs the speaker on the default position of the *wh*-word in the given language and whether the *wh*-word is subject to any restricted neutralizations (Van Valin 2005: 132-133). In languages

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[9] The Logical Structure of the predicate in the clause is ascertained by applying a number of standard tests, which include Dowty's (1979) ones, as mentioned above. Therefore, there are independent criteria to establish the status of the candidates for PSA-hood vis-à-vis the hierarchy in (20).

that have different PSAs in different constructions (for example Jakaltek), constructional schemas specify what the PSA is in the given construction.

To return to grammatical relations, in the absence of a notion of object, the correlation between the functions that in other frameworks are the transitive object and the unaccusative subject is captured in RRG in terms of the thematic properties of the PSA, with some unaccusative patterns being restricted to undergoers and others to the lowest ranking argument, regardless of whether this is assigned a macrorole or the status of PSA. Thus, unaccusative subjects in RRG are not underlying objects, but rather PSAs which are linked from the two rightmost positions in (20), similarly to passive PSAs.[10] It is to the linking that we now turn, as the final topic of Section 2.

2.4 The linking

As can be seen in Figure 4, the linking is bidirectional, to account for both language production and language comprehension, and includes both universal and language-specific steps. Whereas logical structures and macrorole assignment, which is based on the hierarchy in (9) and the principles in (10), are universal, languages differ substantially in how arguments link to syntax.

The linking is governed by the Completeness Constraint, which ensures that there is a match between the referring expressions in the clause and the arguments in the semantic representation of the clause.

(22) Completeness Constraint
All the arguments explicitly specified in the semantic representation of a sentence must be realized syntactically in the sentence, and all the referring expressions in the syntactic representation of a sentence must be linked to an argument position in a logical structure in the semantic representation of the sentence.

The semantic representation of the sentence is built on the basis of the Logical Structures of the predicators in the clause (including the predicating adpositions of adjunct modifiers). These Logical Structures are drawn from the lexicon, although the semantics of the predicate is also subject to compositional rules, which we omit here for the sake of brevity.[11] In the mapping from semantics to

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[10] It would not be possible to review here to the wide range of crosslinguistic variation in unaccusativity. We refer to Centineo (1986, 1995), Van Valin (1990), Bentley (2006), among others, for some of the RRG treatments of this topic.

[11] We refer here to alternations between activities and active accomplishments which depend on whether the activity in the Logical Structure of the predicate combines with the Logical Structure of an adpositional phrase describing an endpoint.

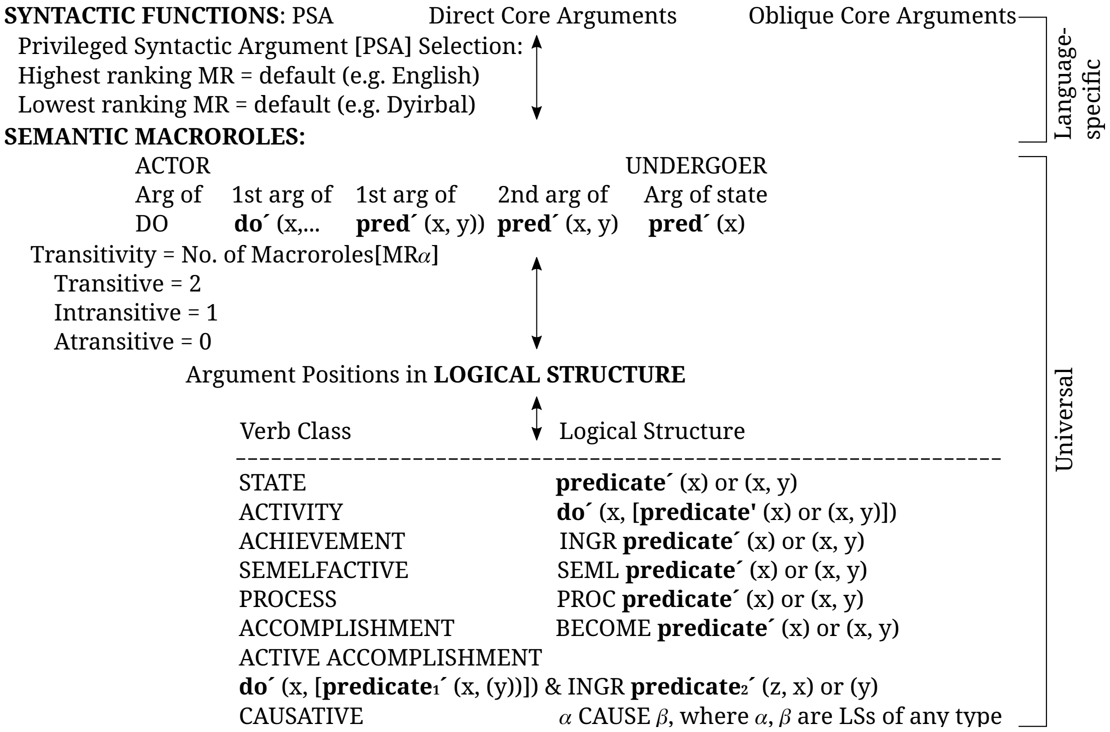

Figure 4: The linking of semantic and syntactic representation (Van Valin & LaPolla 1997b: 177)

syntax, the information in the semantic representation of the clause is key for the retrieval of the appropriate syntactic templates from the syntactic inventory. The selection of the core template is governed by the principle in (23a).

(23) a. Syntactic Template Selection Principle
The number of syntactic slots for arguments and argument-adjuncts within the core is equal to the number of distinct specified argument positions in the semantic representation of the core.[12]

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[12] An argument-adjunct is an adposition which introduces an argument of the verb, at the same time contributing its semantics to the clause. The locative adposition required by *put* is an argument-adjunct, since it is part of the valence of the verb, and hence is an argument, but it can vary independently of the verb (e.g., *put the book on/under/next to,* etc. *the desk*) in the same way an adjunct can (e.g. *dance on/next to/beside,* etc. *the desk*). The semantic representation of *x puts y in z* ([**do′**(x, [**act.on′**(x, y)])] CAUSE [INGR **be-in′** (z, y)]) reflects the argument sharing between the verb and the adposition in a way that the semantic representation of *x dances on y* does not: in **be-on′**(y, [**do′**(x, [**dance′**(x])])) the Logical Structure of the adjunct *on* modifies the Logical Structure of *dance* taking this as one of its arguments, but there is no argument sharing between the two predicates.

b. Language-specific qualifications of the Principle in (23a):
   i. All cores in the language have a minimum syntactic valence of 1.
   ii. Argument-modulation voice constructions reduce the number of core slots by 1.
   iii. The occurrence of a syntactic argument in the Pre-/Post-Core Slot reduces the number of core slots by 1 (may override 23b-i).

The Principle in (23a) follows from the Completeness Constraint and is universal, whereas the qualifications in (23b) are language-specific (though they all apply to English). An additional, universal, qualification of (23a) is needed to capture non-subordinate complex constructions, and we refer to Van Valin & LaPolla (1997b: 546) and París (2023) for this.

In the syntax to semantics linking the syntactic representation of the clause is created by a Parser on the basis of the overt syntactic structure of a sentence. The Parser appears alongside the syntactic inventory in the general architecture of RRG shown in Figure 1 (Van Valin 2005: 131). The constructional schemas also appear in the RRG architecture, since they play a key role in providing language- and construction-specific information in both directions of the linking. The step-by-step procedures that characterize the linking, in both directions, are detailed in the Linking Algorithm(s), which are rather complex, to capture language-specific variation (Van Valin 2005: 136-158).

Having introduced how RRG is conceived and how the parts of the model fit together, in the next sections we shall engage in a more detailed comparison of the different ways things are done within RRG and LFG.

3 LFG and RRG compared

As noted above, both LFG and RRG fall within the class of linguistic models defined as parallel correspondence or level-mapping. There are nonetheless significant differences between them with respects to various dimensions of linguistic analysis and description. We consider some of these differences in a little more detail in the present section.

3.1 Grammatical relations and control

A, perhaps the, key difference between the two frameworks concerns the status of grammatical relations like subject and object. These are at the heart of LFG, where they constitute the ingredients of f-structure, a level which stands as a crucial point of intersection between lexical argument structure, sentential syntax and meaning. By contrast, as we have seen, RRG regards grammatical relations as construction and language particular instantiations of possible argument relations and as such to be defined at the level of individual grammars rather than as an intrinsic part of the cross-linguistically applicable theoretical framework. Within LFG this reliance on functional structure has meant that the inventory of functions has had to be extended to include (x)COMP and (x)ADJ in order to accommodate the full range of embedded or subordinate clauses. Although the desirability of such as extended inventory has not gone unchallenged — see for example the discussion of COMP in Patejuk & Przepiórkowski (2016) — the fact remains that some f-structural account of all the parts of a sentence is required in LFG but not in RRG, where the semantically defined primitives suffice.

One place where this difference can be seen is in the treatment of control. The RRG treatment of these constructions has its roots in Foley & Van Valin's (1984: 307-308) theory of obligatory control, which is defined in semantic terms:

1. Causative and jussive verbs have undergoer control.
2. All other (M-)transitive verbs have actor control.[13]

Examples of causative verbs are *make*, *force* and *cause*, whereas *tell*, *persuade* and *order* are examples of jussive verbs, the latter group being distinct from the former in that it describes an eventuality that relies on verbal means. Examples with *persuade* were provided in (17). Here we provide an example with *tell*. The fact that the controller remains the same regardless of passivization (cf. (24b)) indicates that this construction has a semantic controller (undergoer).

(24) a. Mary told Paul$_{\text{i}}$ [CONTROLLER]__$_{\text{i}}$ to leave.
b. Paul$_{\text{i}}$ [CONTROLLER] was told by Mary$_{\text{j}}$ __$_{\text{i/*j}}$ to leave.

The control constructions with transitive verbs that are neither causative nor jussive also have a semantic controller, although here the controller is the actor:

(25) Paul$_{\text{i}}$ [CONTROLLER] promised Mary$_{\text{j}}$ __$_{\text{i/*j}}$ to leave.

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[13] M(acrorole-)transitivity is the number of macrorole arguments that a verb takes. It is syntactically more salient than S(yntactic-)transitivity, which is the number of direct core arguments a verb takes. The difference between the two is clear in the case of activity verbs with active accomplishment counterparts (*eat/eat the cake*). Whereas the active accomplishments (*eat the cake*) are M-transitive (and therefore also S-transitive), the activities can have an inherent argument that has no macrorole status (*eat pasta*), in which case they are S-, but not M-transitive.

The intuition behind the theory of control introduced above is that the lexical semantics of the verbs providing the controller determines the type of semantic control. Indeed, the theory is also valid in syntactically ergative languages (for example, Dyirbal), languages with active-inactive alignment (Acehnese) and head-marking languages (Lakhota) (Van Valin 2005: 241). In addition, if a verb can have causative and non-causative or jussive and non-jussive semantics (see, for example, *ask*) the semantics of the controller varies accordingly. If the verb providing the controller is intransitive, as for instance is the case with *try*, there is no issue of selection.

(26) Paul$_i$ [CONTROLLER] tried __$_i$ to leave.

The controlled missing argument, or pivot, on the other hand, is a PSA in all of the constructions above, in that it is characterized by the restricted neutralization [A, S, d-S].

(27) Mary told Paul$_i$ / Paul$_i$ promised Mary / Paul$_i$ tried __$_i$ to leave / __$_i$ to see a doctor / __$_i$ to be seen by a doctor / *a doctor to see__$_i$.

An important feature of control constructions is highlighted by the ungrammaticality of passivization of the first verb when this is neither causative nor jussive (cf. (28) vs. (24b)).

(28) *Paul was promised by Mary to leave.

The finding in (28) is explained by the type of semantic control that the structure requires (actor), combined with the type of syntactic linkage that the structure involves. This is a non-subordinate core juncture (Section 3.4), which independently requires that an argument of the second core be shared with — and realized within — the first core. The latter requirement is the additional, universal, qualification of the Syntactic Template Selection Principle (cf. (23)), which was mentioned in passing above (Van Valin & LaPolla 1997b: 546, Van Valin 2005: 244-245, París 2023).

(29) Universal qualification of (23a)
The occurrence of a core as the linked core in a non-subordinate core juncture reduces the number of core slots by 1.

The actor of the passive is independently claimed not to occur within its core in RRG, and, therefore, the specific argument sharing required cannot take place in (28). This results in a violation of the Completeness Constraint in the linking (cf. (22) in Section 2) and, hence, in ungrammaticality.

Raising to subject/raising to object/Exceptional Case Marking constructions are called Matrix Coding constructions in RRG. We give an example of matrix coding as PSA in (30a) and of matrix coding as non-PSA in (30b).[14]

(30) a. Mary seems to like football.
b. John believes Mary to like football.

Although these structures are characterized by the sharing of an argument between two cores, similarly to control constructions, the shared argument is not a pivot. In matrix coding to PSA, the matrix verb is bivalent, but atransitive, which means that it takes no macroroles. An example is **seem′**(x, y) [MR0], where x is an optionally realized experiencer and y is a propositional argument. In English, if *seem* is followed by a finite complement (*It seems that Mary likes football*), a non-argumental expletive pronoun (*it*) fills the initial position in the core of *seem*, satisfying the language-specific requirement of a nominative-marked RP in that position.[15]

Whether finite or non-finite, the propositional argument as such is not assigned a macrorole or a grammatical relation in RRG. Instead, the individual arguments within the propositional argument have macrorole status and play a key role in the linking in the matrix coding construction with a non-finite propositional argument (cf. (30a)). This construction coordinates two cores in the syntax: the core of *seem* and that of *like* in (30a) (see Section 3.5 and Figure 5). The predicate in the second core contributes an argument to the first core in the linking. This takes the place of the direct core argument in the first core, satisfying the universal qualification in (29), as well as the language-specific requirement of a nominative RP in the core-initial position. If an argument of the second core were not linked to the first core, the Completeness Constraint would be violated, given that, to satisfy (29), an argument specified in the Logical Structure of the verb in the second core could not have any syntactic expression.

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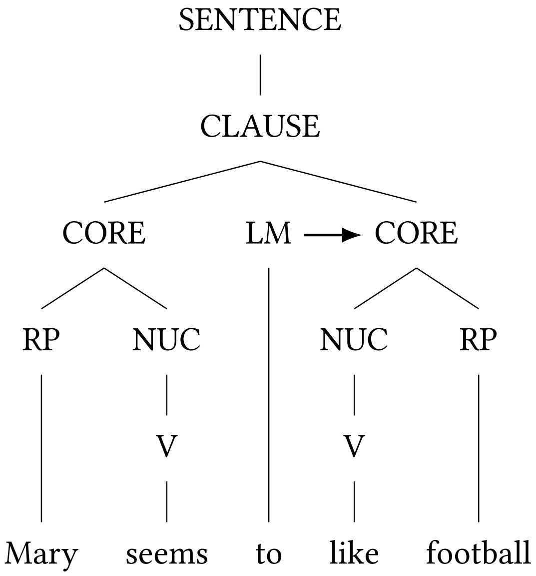
[14] Although other epistemic predicates figure in matrix coding as PSA (for example, *be likely, be certain*) this structure is not in principle limited to epistemic predicates: modality impersonal (*be necessary, must*) and factitives (*be sad, be fascinating*) are also known to figure in matrix coding crosslinguistically (Kimenyi 1980; Bentley 2003).

[15] The optionally expressed experiencer argument cannot satisfy this requirement because it is not a direct core argument and hence it cannot be marked with nominative.



seem′ (∅, [**like′** (Mary, football)])

Figure 5: Semantic and syntactic representations of (30a)[16]

As for matrix coding to non PSA, the relevant verbs (*believe*, *expect, find, consider*, etc.) are M-transitive: an example is **believe′**(x, y). The second argument can be an NP or a proposition, i.e., a full clause (*John believes that Mary likes football*) or a core (cf. (30b)). In the latter case, an argument provided in the Logical Structure of the verb in the second core is linked to the first core to satisfy (29), again avoiding a violation of the Completeness Constraint.

Therefore, in RRG, argument sharing in matrix coding is captured by an independent property of non-subordinate core junctures, i.e., (29). The difference between the two matrix coding constructions is a function of the lexical properties of the verbs occurring in the first core. Matrix coding as PSA characterizes two-place verbs which have no direct core argument to satisfy the requirement of a nominative RP in core-initial position. With these verbs, (29) is satisfied by an argument from the predicate in the second core taking the function of PSA in the first core. The other type of matrix coding characterizes M-transitive verbs which provide an argument of their own as PSA. With these verbs, (29) is satisfied by an argument of the second core taking the second argument slot in the matrix core.

In more general terms, the contrast between control and matrix coding constructions depends on the lexical properties of the verbs involved in them, with

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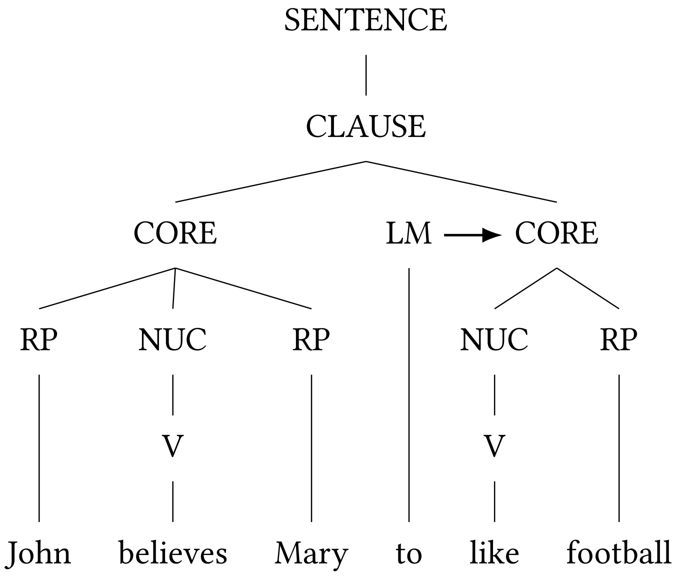
[16] LM in Figure 5 and following figures stands for Linkage Marker.



believe′ (John, [**like′** (Mary, football)])

Figure 6: Semantic and syntactic representations of (30b)

the function of the shared argument, as well as actor or undergoer control, being determined lexically.[17] Syntactically, all of these constructions are non-subordinate core junctures and they all abide by the constraints on this type of linkage.

By contrast, control in LFG makes fundamental use of the relations SUBJ and XCOMP (see Dalrymple et al. 2019: Chapter 15 and Vincent 2023 [this volume]). To take two classic instances, the entries in (31) are those proposed by Bresnan (1982a) for the functional control verbs *seem* and *try*, the difference between the two lying in the fact that for *seem* the SUBJ function is not at the same time a semantic argument whereas for *try* it is. That said, the crucial equivalence of the embedded and matrix SUBJ is formally the same in both cases.

(31) a. *seem* V (↑ PRED) = ‘SEEM⟨XCOMP⟩SUBJ’
(↑ SUBJ) = (↑ XCOMP SUBJ)
b. *try* V (↑ PRED) = ‘TRY⟨SUBJ, XCOMP⟩’
(↑ SUBJ) = (↑ XCOMP SUBJ)

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[17] The same is true of the structure that is commonly known as tough-movement. This involves matrix coding as PSA with propositional attitude adjectives, which only have a propositional argument (*it is easy to please Mary, Mary is easy to please*), and control with psych action adjectives, which have a nominative RP of their own (*Mary is eager to please*) (see Van Valin & LaPolla 1997a: Chapter 9, exercise 6).

At the same time we should emphasise that in neither framework are the particular analyses necessarily unchallenged or unchallengeable. Although it would clearly go against the principles of LFG for an analysis not to be mediated by grammatical functions, just as it would not be consistent within RRG for direct reference to be made to subject or object, the preferred account may vary from scholar to scholar. Thus, Dalrymple et al. (2019: 561-566) offer the alternative entry for *try* as in (32):

(32) *try* V (↑ PRED) = ‘TRY⟨SUBJ, COMP⟩’
(↑ COMP SUBJ PRED) = ‘PRO’

On this version, *try* is considered to be an instance of obligatory anaphoric control rather than functional control, and hence the second argument is COMP rather than XCOMP. This in turn means that the PRED value of the embedded subject is PRO; in other words a kind of null function whose value is interpreted by reference to another argument in the clause. We return to the issue of null arguments in Section 3.3 below.

3.2 Predicate types and theta roles

The presence vs. absence of grammatical relations is also evident in the different way the two models characterise the individual lexical predicates. In LFG the lexical entry for a given item includes mention of the grammatical relations with which it is associated, which in turn are related to the appropriate theta roles by means of lexical mapping. In RRG, by contrast, the lexical entries are stated directly in logico-semantic terms (see Section 2), and it is these which are then linked to the argument structure as indicated in (8) and (9) above. Moreover, RRG adopts a distinct theory of theta roles which incorporates the two macroroles Actor and Undergoer, which are defined in terms of positions in Logical Structure. These are generalizations across argument types and have no direct analogue in LFG, or indeed in any other framework which we are familiar with. Macroroles constitute the primary interface between logical structure and syntax, and their assignment is governed by universal principles, and no further argument structure is postulated. Meanwhile, the logical structure based on Dowty’s and Vendler’s approach to Aktionsart types allows for a more fine-grained classification of predicates than is to be seen in LFG, while at the same time allowing the argument structure to emerge from the logical structure rather than having to be defined in a separate structural dimension.

One consequence of the decision within RRG not to admit as theoretical primitives a separate set of grammatical functions means that the question of how to relate these to semantic roles does not arise. In short there is no RRG equivalent of lexical mapping theory.

3.3 Argument realization

So far we have discussed for the most part issues relating to the content side, whether syntactic or semantic, of arguments. There are, however, differences between the two approaches when it comes to the way those arguments and associated clausal structure are given realization. One case in point concerns the treatment of null arguments, or so-called pro-drop, as in the contrast between French *il/elle arrive* beside Italian *arriva* 'he/she/it arrives'. Here LFG and RRG agree on rejecting the categorial solution but LFG has instead recourse to the null function seen above in the analysis of control. A verb form such as Italian *arriva* will have PRO as the value of its SUBJ function with the person/number values being determined by the appropriate features which are independently required by the language's system of verbal inflection. Not surprisingly in the literature this kind of account has been labelled 'pronoun incorporation' (Börjars et al. 2019: 68-75, Toivonen 2023 [this volume]). At the same time it is also possible for the same verb form to have an overt argument as in Italian *arriva Giorgio* 'George is arriving' and hence the PRO value for the SUBJ constitutes an optional part of the verb's lexical entry triggered only when there is no overt argument. In other languages such as Chicheŵa this optionality also extends to the OBJ, but the formal mechanism is the same in both instances. For further discussion and exemplification, see Dalrymple et al. (2019: 179-85, 500-502) and Bresnan et al. (2016: Chapter 8).

In RRG, when the argument is not expressed independently of the verb, the verb inflection bearing its person/number features is linked to the Constituent Projection, similarly to the verbal affixes of head-marking languages (Van Valin & LaPolla 1997b: 331-332). In cases of extensive discourse-driven zero anaphora, found in Thai, Mandarin and Japanese, pro-drop is dealt with as a direct linking from discourse to Logical Structure, and, following Van Valin (2005: 171-174), Kamp & Reyle's (1993) Discourse Representation Theory has been adopted to formalize this linking.

A different issue concerns the treatment of long-distance dependencies as in *wh*-questions. There is considerable cross-linguistic variation here (for a typological survey see Mycock 2006) but the crucial point is that the questioned item need not occur in the position of the corresponding answer. Within derivational models this can be straightforwardly handled by a rule of *wh*-movement which shifts the relevant item to the initial position in the clause in a language like English, while a language like Chinese has no such rule and therefore question and answer occupy the same slot. For RRG the position of the *wh*-item depends on a language-specific aspect of the linking, which is specified in a constructional schema (Section 2.3), and is directly activated with the selection of an appropriate syntactic template (Section 2.4). LFG relies instead on a further function FOCUS with the functional value of the questioned item being set as equivalent to the FOCUS and therefore being realised in that slot wherever in the language that may occur. In this way it is possible to accommodate not only languages like English with a single initial slot or Chinese where the interrogative item remains *in situ* but also languages like Bulgarian which allow several different *wh*-items to occur in sequence at the beginning of the clause.

More generally then, as we have noted in various places, LFG tends where possible to avoid the proliferation of functional heads which is a characteristic of cartographic and nanosyntactic approaches. Thus, for example, although recourse is standardly had to CP to label clauses with a fronted question word or an embedded complementizer, there is no automatic assumption that all simple main clauses are CP, nor is there any attempt to split C into separate functional heads to host topics and other fronted elements. And while some LFG accounts incorporate K as the category to be associated with items such as the Hindi-Urdu ergative particle *ne* (Dalrymple et al. 2019: 102-103), this is not the general practice (see Vincent 2021 and Przepiórkowski & Patejuk 2021 for further discussion and exemplification). By contrast, such analytical strategies have no analogue within RRG, where the categorial inventory is reduced to a minimum and functional heads do not figure at all.

Finally, in this connection, an instructive case concerns the treatment of the phenomenon of co-subordination (on which see Section 3.5 below). This is a concept unique to RRG and which has no analogue either in traditional grammar or in LFG, both of which distinguish simply co-ordination, marked by items such as *and* and *or*, and subordination, signalled by various kinds of finite and non-finite complementation patterns. Foley (2010) argues against the necessity of postulating such a third mode of clause combining and offers instead an account within LFG based on a categorial distinction between the functionally headed IP and the plain S or small clause. A response by Van Valin (2021) argues against Foley's account and more generally against the postulation of categorial solutions to what are functional/semantic problems.

3.4 Syntax and configurationality

Another dimension of linguistic realization concerns constituency and configurationality. In the various versions of Minimalism and cartography all structures are by definition configurational, and thus data such as the following Warlpiri example (cited from Austin & Bresnan 1996, example (1)) are problematic.

(33) Warlpiri
kurdu-jarra-rlu =**ka-pala** maliki wajili-pi-nyi wita-jarra-rlu
child-DUAL-ERG PRES-3DU.SBJ dog-ABS chase-NPST small-DUAL-ERG
'Two small children are chasing the dog.'

According to Hale (1983), after whom this example is cited, native speakers accept any order of the words here provided that the auxiliary element (highlighted in bold) is cliticised to the first item. Moreover, the adjective 'small' and the noun 'child' may, but do not have to, go together and if they do they can count as a constituent and occupy first position before the cliticised auxiliary. A fully configurational model can only handle this kind of data by postulating one structure as underlying and deriving the other options by movements to predetermined slots, some of which will inevitably be unfilled. In addition, the arguments of the verb in Warlpiri may remain unexpressed if derivable from context. In that case the relevant position in the tree is still present but is filled by a null pro. However, in a model such as LFG, once f-structure and c-structure are separated and not required to map onto each other in a one-to-one fashion, as Austin & Bresnan (1996) show, it is a straightforward matter to distinguish the argument structure from the way those arguments are realised in terms of linear order. Strict configurationality is then a requirement of particular languages such as English or Arabic, but it is not a property of universal grammar.

Within RRG the thinking is very similar. Not only is endocentricity not a principle of RRG, but there is also no expectation that the components of individual constituents, or units of meaning within the clause, should be contiguous. The flat structure of the RRG Layered Structure of the Clause (Section 2.1), therefore, caters straightforwardly for non-configurational languages, as in its own way does LFG by not requiring all constituents to be endocentric and thus arriving at flat structures by a different but equally satisfactory route.

3.5 Predicate and clause linkage

The RRG theory of predicate and clause linkage relies on the key notions of nexus and juncture. Nexus is the relationship established between two layers of the Layered Structure of the Clause (Section 2.1): instead of the traditional coordination vs. subordination dichotomy, RRG makes a trifold distinction between coordination, co-subordination, and subordination. Each of these types of nexus can in principle occur at three levels of juncture, nucleus, core, or clause, as can be seen in Table 1, although it is not the case that all languages exhibit all the possible nexus-juncture types.

Table 1: Nexus-juncture combinations

Juncture	Nexus
Nucleus	Coordination Co-subordination Subordination
Core	Coordination Co-subordination Subordination
Clause	Coordination Co-subordination Subordination

Nuclear junctures involve a single core containing two or more nuclei, core junctures normally feature two cores within a clause, and, finally, clausal junctures are typically characterised by two clausal nodes within a sentence. We discuss below some more complex constructions whereby a core joins with a clause. Since the operators expressing grammatical categories such as aspect, modality and tense are assumed to have scope over specific layers of the clause, operator scope is an important criterion to diagnose the level of juncture of a linkage.

We will not discuss each nexus-juncture type in detail (for exhaustive treatments see Van Valin & LaPolla 1997b: 441-492, Ohori 2023). Instead, we shall first deal with co-subordination, which is not a construct of LFG, and we shall contrast it with coordination, exemplifying at the same time the key diagnostics of linkage used in RRG. Then, we shall move on to subordination, which is subdivided into the complement and the adverbial type, in accordance with assumptions made in other frameworks.

The notion of co-subordination originated with scholarship on Papuan languages, where a type of clause linkage was found which can neither be analysed as coordination nor as subordination: on the one hand, the linked clauses cannot stand alone and are dependent on a matrix clause for the expression of clausal operators; on the other hand, they fail to exhibit the marking of subordination that obligatorily occurs elsewhere. We provide here some exemplification from Chuave (Thurmann 1975).

(34) Chuave (Papuan, Van Valin & LaPolla 1997b: 448)
Yai kuba i-re kei si-re fu-m-e.
man stick get-SEQ.SP dog hit-SEQ.SP go-3SG-IND
'The man got a stick, hit the dog, and went away.'

Although (34) translates as a coordination in English, it is not a coordination in Chuave because the first two clauses cannot stand alone, which would be expected if they were coordinated main clauses, and because they lack their own illocutionary force morpheme. Every independent utterance requires an illocutionary force marker in Chuave (see *-e* in (34), which is glossed as indicative), and the fact that this marker is shared by the clauses in (34) suggests that they are not coordinated, but rather stand in a dependence relation.

RRG thus distinguishes co-subordination from coordination, assuming that the former nexus type involves operator sharing. Specifically, the non-matrix unit(s) must depend on the matrix unit for the expression of at least one operator at the relevant level of juncture. An important corollary of this assumption is that when nuclei, cores, and clauses are joined together in a co-subordinate nexus, the first node that joins them is not of the higher type, but rather constitutes the same layer as the linked layers, as shown in Figure 7, which contrasts with Figure 8, representing coordination.

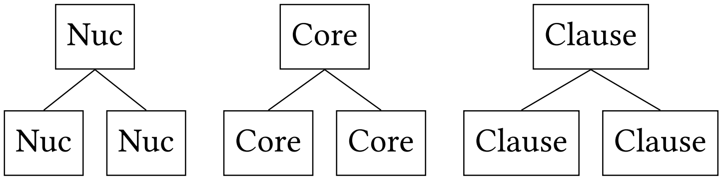


Figure 7: Nuclear, core and clausal co-subordination

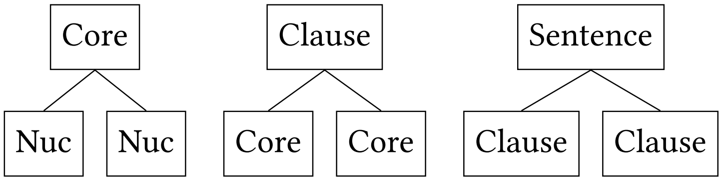


Figure 8: Nuclear, core and clausal coordination

We refer to Van Valin & LaPolla (1997b: 455) for exemplification of all the co-subordination and coordination linkages that are available in English. Here we should mention that since there are no sentence-level operators, sentences allow coordination and subordination (Van Valin 2005: 192), but not co-subordination. Sentential coordination and subordination can thus be added to the nexus-juncture types shown in Table 1, although, again, it is not predicted that all languages will allow these types of linkage.

The contrast between co-subordination and coordination emerges in non-finite complementation. Compare the English constructions in (35).

(35) a. Mary tried to open the door.
  b. Mary told Paul to open the door.

In both cases the relevant level of juncture is the Core, as suggested by the fact that in neither structure do the two predicates share the nuclear, aspectual, operators: the perfect and progressive operators only have scope over *try* and, respectively, *tell*, in (36a) and (36b).

(36) a. Mary has been trying to open the door.
  b. Mary has been telling Paul to open the door.

Sharing of all the arguments, as evidenced by passivization, would also indicate a nuclear juncture, but in both constructions *the door* is an argument of *open* alone (**The door is tried to open by Mary, *The door is told Paul to open by Mary*).

The two predicates do share one argument (*Mary* and, respectively, *Paul*), which is suggestive of a Core juncture. Yet, there is a key difference between the two constructions. The non-matrix predicate depends on *try* for the expression of deontic modality in (35a), and, therefore, (37a) can be read as (37b).

(37) a. Mary must try to open the door.
  b. Mary must open the door.

Although *must* cannot be embedded under *tell* for independent reasons (it rejects the *to* infinitive), importantly, the same operator sharing as in (37) does not apply to the structure with *tell* in (35b).

(38) Mary must tell Paul to open the door ≠ Mary must open the door.

In light of the above evidence, the linkage with English *try* is analysed in RRG as a case of core co-subordination, as opposed to the one with *tell*, which is a case of core coordination.

Similarly to the construction in (35a), the one in (39a) illustrates core co-subordination, as testified by operator sharing at the level of the core. Not only does the embedded predicate *waiting* depend on the matrix predicate *sit* for the expression of deontic modality (see (35b)), but a deontic modal operator and core negation with scope on the matrix predicate can also have scope on the embedded one (see (39c)-(39d)). In addition, the two predicates share one argument, *Mary*.

(39) a. Mary sat waiting for your call.
b. Mary sat (*must) wait(ing) for your call.
c. Mary must sit waiting for your call > Mary must wait for your call.
d. Mary didn't sit waiting for your call > Mary didn't wait for your call.

In nuclear junctures all arguments of the linked predicates are pulled together as the arguments of a single nucleus. In Italian, this is evidenced by the occurrence of accusative or locative clitics to the left of the matrix predicate, even though such clitics express arguments of the second predicate. This structure is referred to as clitic climbing in frameworks which allow movement.

(40) Italian
a. Maria lo è tornata a prendere.
Mary OBJ.CL be.3SG return.PTCP to get
'Mary went back to get it.'
b. Maria ci è cominciata ad andare.
Mary LOC.CL be.3SG start.PTCP to go
'Mary started to go there.'

Since Rizzi (1976), the structures in (40a)-(40b) have been known to be monoclausal. In RRG, they must be considered to be nuclear junctures, since the two predicates share all their arguments. The selection of the perfect auxiliary *essere* 'be' in (40) would at first seem to suggest that these are nuclear co-subordinations, whereby the non-matrix predicate depends on the matrix one for the expression of the perfect operator. This is clearly the case with (40a), since transitive *prendere* 'take' would otherwise select the perfect auxiliary *avere* 'have'.

(41) Italian
Maria lo ha preso.
Mary OBJ.CL have.3SG take.PTCP
'Mary took it.'

The case in (40b) is more puzzling, since it is *andare* 'go' that selects *essere* 'be' in the perfect, whereas *cominciare* 'begin, start' would select either auxiliary *essere* 'be' or *avere* 'have', when occurring alone, and, in fact, it would not occur with 'be' with an animate PSA.

(42) Italian

a. Lui è cambiato? – Ha cominciato.
he be.3sg change.ptcp have.3sg started
'Has he changed?' – 'He has started.'

b. Il film è cominciato.
the film be.3sg start.ptcp
'The film has started.'

In Bentley (2006: 82-83), we proposed that the structure in (40b) is a case of ad(verbial)-nuclear subordination, where *cominciare* 'start' is not a predicate because it does not contribute any arguments of its own, but merely an aspectual operator. This is represented with a Nucleus which lacks a predicate node but links to the Operator Projection to contribute aspectual information (see Figure 9). In the Constituent Projection, this Nucleus occurs in the periphery of the predicative Nucleus of the clause.

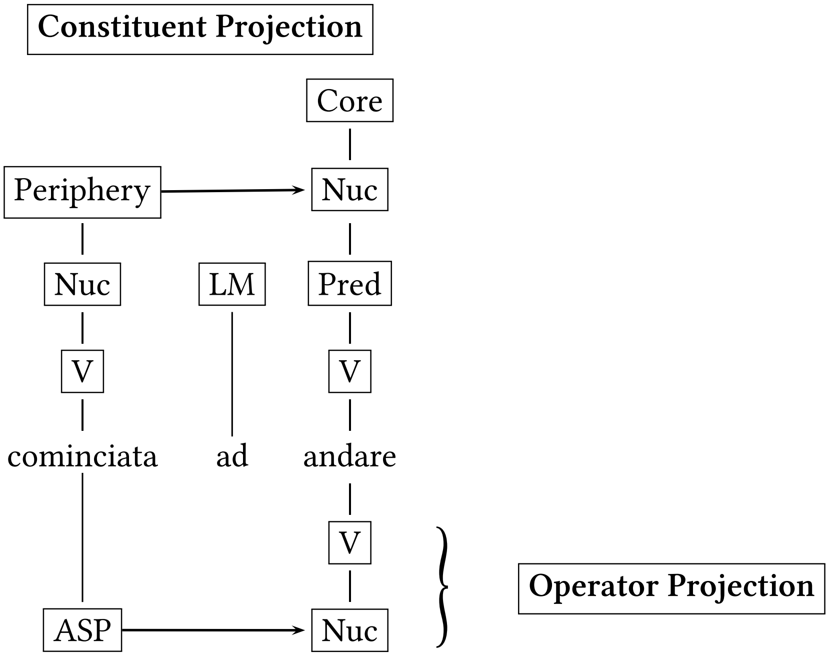


Figure 9: Ad-nuclear subordination with *cominciare* 'begin' in Italian

It is not uncommon for aspectuals, modals and indeed other classes of predicates to enter into more than one nexus-juncture type with other predicates in a given language.

RRG thus understands ad(verbial)-subordination as a structure whereby a given layer of the Layered Structure of the Clause has a peripheral modifier. While in (40b), the peripheral modification occurs at the level of the Nucleus, clausal ad-subordination — or ad-clausal subordination, as it is normally called — is illustrated in (43), which would also be analysed as a structure with an adverbial subordinate clause in other frameworks, including LFG. In this case, the subordinate clause *because you arrived* occurs in the Periphery of the main clause *Mary left*.

(43) Mary left because/even though you arrived.

Observe that, in contrast with the cases of ad(verbia)-subordination illustrated above in (40), the subordinate clause in (43) has a full-fledged predicate, which contributes its argument to the clause. It should not be assumed that by definition ad-subordination requires a modifier that lacks a predicate of its own. This can, but need not, be the case and it certainly is not the case with ad-clausal subordination.

Different semantic classes of verbs lend themselves to different nexus-juncture types (see Van Valin 2005:205-213 for a discussion of the rationale of the relevant patterns). To give but one important example: crosslinguistically, perception verbs lend themselves to forming less cohesive linkage types than causative verbs. No predictions are made in RRG on the exact nexus-juncture type that each predicate class will require in a given language. However, building upon Silverstein (1976) and Givón (1980), RRG has developed the *Interclausal Relations Hierarchy* (Van Valin & LaPolla 1997b: 481-483, Van Valin 2005: 209), which juxtaposes a scale of semantic relations with a range of nexus-juncture types, both being arranged in decreasing order of cohesion. The mapping between the two sides of the Interclausal Relations Hierarchy is many to one. However, RRG makes the strong falsifiable prediction that the tightest syntactic linkage realizing a particular semantic relation in a given language should be higher than, or as high as, the tightest syntactic linkage realizing lower semantic relations on the hierarchy in the same language. Although this prediction has been tested in work on specific languages (see, e.g., Casti 2021 on Sardinian), it ought to be further investigated in future work.

Where RRG has developed an innovative system of clausal organization and inter-clausal relations, LFG has remained more closely linked both to traditional grammar and work over the years in the generative tradition. Complex sentences involve the embedding of the c-structure of the subordinate clause within that of the matrix clause, but both are defined in terms of syntactic categories and in particular the concept of CP has been taken over wholesale from work in the Minimalist framework. It is true that the proliferation of functional heads within the clause has been avoided through recourse to the new grammatical relations (x)COMP and (x)ADJ, but, as noted above, categorial structure is still central in a way that it is not within RRG.

3.6 Pragmatics and information structure

The treatment of information structure in RRG and LFG is comparable, insofar as both frameworks consider it to be a module of grammar in its own right, which is independent from, but interacts with, the other modules. Both RRG and LFG allow information structure to be encoded in syntax (the layered structure of the clause, and, respectively, c-structure), morphology (Shimojo 1995), or prosody (see O'Connor 2006 for LFG and O'Connor 2008 for RRG). In addition, in RRG, the organization of grammar explicitly acknowledges the pervasive role of information structure at all stages of the bidirectional linking (see Figure 1). Broadly defining information structure as the organization of information in grammar, in this section we will address two principal issues, placing particular emphasis on RRG: (a) which information structure notions are adopted, and how they are defined, and (b) the place of information structure in the architecture of grammar.

Starting with the key notions, Zaenen 2023 [this volume] draws a distinction between information structure proper, or the sentence-internal organization of information, and discourse structure, which is concerned with the packaging of information in larger textual units. This contrast does not find a parallel in RRG. While in both frameworks Lambrecht's (1994) notions of presupposition and assertion play a key role in the definition of topic and focus (Van Valin 2005: 68-73 and Zaenen 2023 [this volume]), various different feature decomposition analyses have been developed in LFG to capture the nuances of salience, topicworthiness, and contrastiveness (see Zaenen 2023 [this volume] and references therein). RRG, instead, does not make use of feature decomposition, which is not to say that it does not attempt to capture the gradualness of the relevant notions, as will be explained in due course.

In RRG there is general consensus on which notions are relevant and how they should be labelled. The framework relies heavily on Lambrecht's (1994: 49) distinction between relational and non-relational constructs in information structure. The non-relational constructs are concerned with the status of the denotata of the discourse referents in the minds of the discourse participants: whether a given referent is already established or new for the hearer or both interlocutors, and, if it is new, whether it can be uniquely individuated or, alternatively, related to other referents. Although a referent is by definition brand-new, when it is first introduced into discourse, it may be possible for the interlocutors to identify it, in which case it is normally encoded as definite, in languages with overt marking of definiteness (e.g., *This morning I saw your sister / the Head of Department / the student you were taking about*). Otherwise it is unidentifiable and encoded as indefinite. Following Prince (1981) and Chafe (1987), RRG assumes that unidentifiable discourse referents can be anchored, i.e., related to established referents (e.g., *This morning I saw a student from the Physics Department)*, or, otherwise, unanchored (e.g., *This morning I saw a student*). Once a referent has been introduced, it becomes identifiable: if it is in the current focus of attention, it will be active; otherwise, it can be textually, inferentially or situationally accessible, or, alternatively, temporarily outside the focus of attention. The last type of discourse status is called inactive. Researchers in RRG have over the years investigated the grammatical correlates of the aforementioned notions in a large variety of languages (see, for example, Shimojo 1995, 2009, 2010, 2011; Pavey 2001; Belloro 2004, 2015; Matić et al. 2014; Latrouite & Riester 2018; Balogh 2021a, among others). The set of non-relational constructs which are universally adopted in the RRG treatment of information structure is illustrated in Figure 10, although we should note that other pragmatic states have been investigated by individual RRG researchers, for example saliency, or persistence in discourse (Shimojo 2009).

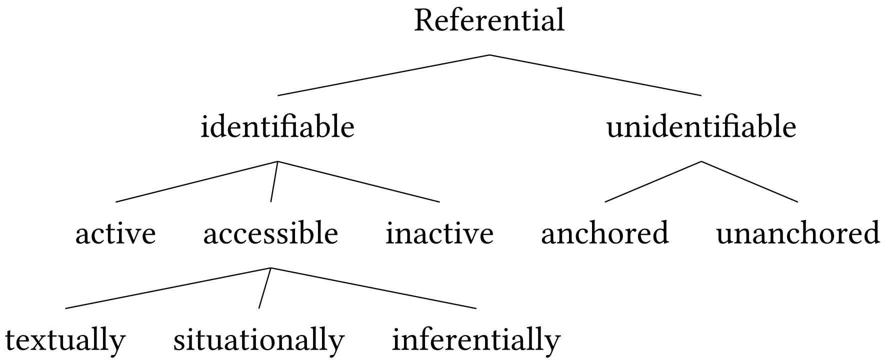


Figure 10: The cognitive states of referents in discourse (Van Valin & LaPolla 1997b: 201)

As for the relational notions, following Gundel (1988) and Lambrecht (1986, 1994, 2000), RRG defines topic as what the speaker wants to request information about, or increase the addressee's knowledge of, or get the addressee to act with respect to (Van Valin 2005: 68). The definition of topic is, therefore, inherently relational, in that it makes reference to the information unit about which new information is being requested or conveyed in the utterance. Importantly, the topic is also traditionally assumed to be part of the pragmatic presupposition, or the set of relevant propositions, and ultimately the information which is shared by speaker and hearer prior to the utterance. Drawing on Reinhart (1981), Frascarelli & Hinterhölzl (2007), Cruschina (2012), among others, in recent years, a distinction has been introduced in the framework between referential and aboutness topics, the first type being referentially old and part of the presupposition, the latter being introduced anew with the utterance, but nonetheless relational, in that it can be defined as what the utterance increases the addressee's knowledge about (see Bentley et al. 2015, Bentley (2023)).

The gradualness of the notion of topic is captured in RRG at the interface with the non-relational notions mentioned above. In particular, it is assumed that topics align with active discourse referents, as can be seen in Figure 11.

Active	Most acceptable
Accessible	
Inactive	↕
Brand-new anchored	
Brand-new unanchored	Least acceptable

Figure 11: The Topic Acceptability Scale (Van Valin & LaPolla 1997b: 204)

The morphosyntactic correlates of the alignment shown in Figure 11 are captured in Figure 12, which expresses the likelihood that the topic is marked by means of strategies that code referents in terms of their degree of accessibility.

Zero	Clitic/ bound pronoun	Pronoun [−stress]	Pronoun [+stress]	Definite NP	Indefinite NP
⟶					
Markedness of occurrence as topic					

Figure 12: Coding of referents as topic (adjusted from Van Valin & LaPolla 1997b: 205)

Focus is defined in RRG as the part of a declarative utterance that is asserted (i.e., the component of that utterance whereby the assertion differs from the presupposition) or, in an interrogative utterance, the part that is questioned (Van Valin 2005: 69). The distinction between broad and narrow focus is made in the context of Lambrecht's (1994: 221-238) theory of focus structure, which has been extremely influential in RRG scholarship.

Focus structure can be defined as the conventional association of information meanings with sentence forms or the way that presupposed and asserted information are packaged in the sentences of a given language. While all grammars have strategies to differentiate sentences which provide new information on an established topic from sentences which occur out of the blue, and would seem to be topicless, there is a great deal of crosslinguistic variation in such strategies, and such variation has received attention in connection with the broader issue of the relative language-specific flexibility of the syntactic positions of predicates and arguments, and of focal information units (Van Valin 1999, Bentley 2008, etc.). Although Lambrecht's (1994) tripartition into predicate-, argument- and sentence focus is generally adopted (argument focus being renamed as narrow focus), the assumption that sentence focus lacks a topic altogether has been challenged, in light of Erteschik-Shir's (1997) theoretical work, which finds empirical support in the study of a number of seemingly topicless constructions, such as existentials and presentationals (Bentley et al. 2015, Bentley 2018).

An important distinction made in RRG is that between the Potential Focus Domain, which is the syntactic domain in the sentence of a given language in which focus can occur, and the Actual Focus Domain, which is the syntactic component of a given sentence that is in focus. The Potential Focus Domain differs across languages, as is clearly shown by the comparison of languages that heavily rely on prosody for the encoding of focus (e.g., English, see Vallduví 1992, Van Valin 1999) with languages that rely on syntactic position (e.g., Sicilian) or on the constructional choices (e.g., French). The Actual Focus Domain differentiates the three principal types of focus structure mentioned above.

To conclude the discussion of the relational notions that have received attention in RRG, we should mention contrastiveness. This is orthogonal to the notions of topic and focus, in that the alternatives that are contrasted can be selected from the presupposition or introduced anew within the assertion. Importantly, topical and focal contrasted units exhibit the same marking in some languages, whether by syntactic or morphological means (see Shimojo 2009, 2010, 2011 for Japanese and De Cia 2019 for North-Eastern Italo-Romance). In Japanese, for example, contrastive units can be marked as topics with *-wa*. To capture the inherent informational complexity of contrastiveness, Shimojo (2011) borrows Erteschik-Shir's (1997, 2007) notion of subordinate f(ocus) structure. The essence of his claim is that *-wa* marked contrastive units in Japanese are foci, because they are selected or highlighted from a finite set, but they are embedded in and selected from a topical, contextually available, set. A Japanese clause with contrastive *-wa* marking of the argument is thus represented as follows (Shimojo 2011: 275): $[\{x_{foc}, y\}_{top}]$-wa_{top} $[\text{predicate}]_{foc}$.

As for the place of information structure in the architecture of grammar, RRG, similarly to LFG, considers information structure to be an independent module of grammar. In terms of how this view is represented in each framework, King (1997) (cited in Zaenen 2023 [this volume]) introduced an information structure projection in LFG, i-structure, and various proposals were subsequently advanced to model the flow of information from the other modules to i-structure. Similarly to LFG, RRG has a separate Speech Act Projection, which, however, does not participate in the flow of information, but rather represents the Potential and Actual Focus domain, and hence the focus structure, of an utterance in a given language.

In RRG the accessibility status of the discourse referents is conventionally represented in Logical Structure, the idea being that this status is significant in the construction of the meaning of the sentence. To give but one example, we showed in Figure 11 that an active referent lends itself more readily to the role of topic than an inactive or unidentifiable one. The topicworthiness of an active discourse referent may thus play a role in the selection of a specific lexical item as the predicate. Consider the lexical pair *fear* vs. *frighten*, or its rough Italian counterpart, *temere* vs. *spaventare*: an active stimulus will tend to be construed as the topic, which in turn will favour the choice of the *frighten* member of the pair in language production.

The activation status of the discourse referents also plays a role in the construction of meaning in language comprehension. Consider the case of an utterance which lacks an overt expression for one of the arguments of the predicate. Zero marking suggests that the position of that argument in Logical Structure can only be filled with an argument value that denotes an active discourse referent, or a referent that is textually, inferentially or situationally accessible. This referent must be retrieved from discourse.

The flow of information from the discourse context to linguistic expression is modelled in RRG by means of the tools offered by Discourse Representation Theory (Kamp & Reyle 1993), particularly in the analysis of zero anaphora phenomena, such as pro-drop (Section 3.3), in the absence of relevant morphological exponence, but also in the case of the silent predicates of Japanese and other languages. Importantly, the flow is supposed to occur directly between discourse and Logical Structure, without the intervention of syntax (or the Constituent

Projection), given that empty syntactic arguments and positions are disallowed in RRG.

As should be clear from Figure 1, information structure plays a key role in the bidirectional linking of RRG. This view has already been illustrated in the discussion of the lexical choices for predicators and the filling of silent positions in Logical Structures. PSA choice, alongside voice alternations, is also heavily affected by the informational status of the arguments, as is the morphological marking of topics and foci. To conclude, we will briefly mention the stage in the linking which requires the selection of a syntactic template for the sentence. This stage involves language-specific considerations regarding a number of pragmatically-motivated positions: the Pre- and Post-Core Slot and the Pre- and Post-Detached Position (see Section 2.1 and Balogh 2021b for further, language-specific, positions of Hungarian).

3.7 Semantic structure

Both LFG and RRG pay explicit attention to sentence semantics and, unlike Minimalism, neither theory requires the meaning of a sentence to be constructed one-to-one off syntactic heads and phrases. However, they differ in the way semantic and syntactic structure are integrated and in the type of semantic framework deployed. Within LFG, there is a separate dimension of s(emantic)-structure, which connects directly to f-structure rather than via c-structure. Although there is no strict directionality involved, it is nonetheless the case that f-structures, in turn built on the basis of the functional representations associated with lexical items, are input to the meaning construction, which is similar to the way, as described above, lexical semantics within RRG determines both the structure and overall meaning of the clause. At the same time two differences between the frameworks stand out. First, as we have seen, RRG does not use grammatical functions as an intermediary point of analysis between argument structure and sentential meaning. Second, RRG relies solely on classical predicate logic and builds the semantic representation of a sentence in the lexical phase of the semantics-syntax (or syntax-semantics) linking, retrieving the meanings of the predicates from the lexicon and combining them without recourse to specific instructions other than the rules of predicate logic. There is no linear or resource logic equivalent to the role of Glue within LFG and thus RRG corresponds more closely to what Findlay (2021: 346) describes as the ‘pre-Glue’ stage in the development of LFG.

4 LFG, RRG and diachrony

Within LFG there has been relatively little historical work to date (for recent overviews see Börjars & Vincent 2017 and Booth & Butt 2023 [this volume]) and in RRG even less (though see Ohori 1992, Eschenberg 2005, and the contributions to Kailuweit et al. 2008 and Matasović 2023). However, both approaches have much to offer in the diachronic as well as the synchronic domain, as will be explored and exemplified in this section.

Given the traditional distinction between linguistic form/*signifiant* and content/*signifié*, changes can be broadly classified into three types: changes in form, changes in content and changes in the relation between the two. As far as the first is concerned, simple change of form or sound change, neither LFG nor RRG have anything special to say. Let us start then with the last and in particular the way these changes play out in the development of the Romance causatives, and where we can detect some instructive differences in the LFG-based account in Börjars & Vincent (2017: 651-655) compared to the RRG version in Kailuweit (2008: 79-83). The basic facts are fairly straightforward. Most Romance languages have a causative construction invoving the DO verb + infinitive (see Labelle 2017, Alsina 2023 [this volume]) as in the French example (44).

(44) French

Je	ferai	manger	les	gâteaux	à	Jean
I	make.FUT.1SG	eat.INF	the.PL	cake.PL	to	John

‘I’ll make John eat the cakes’

This structure, which has parallels across the whole of Romance from the earliest attestations (Vincent 2016) is monoclausal, as evidenced among other things by the fact that if the arguments are clitics they precede the higher verb (*je les lui ferai manger* ‘I will make him eat them’) and that the structure cannot be iterated (**je ferai faire manger les gâteaux à Jean à ses enfants* – contrast the biclausal English causative *I will make John make his children eat the cakes*). In other terms, what we have here is a complex predicate construction. There are similar examples in early Romance and late Latin texts.

(45) Old French (*Chanson de Roland* 852, 12th cent.)
en Sarraguce fait suner ses taburs
in Saragossa make.PRS.3SG sound.INF his drum.PL
'in Saragossa he makes his drums sound'

(46) Latin (*Vulgate,* Numbers 11.24, late 4th cent. CE)
quos stare fecit circa tabernaculum
who.ACC.MPL stand.INF make.PST.3SG around tabernacle.ACC
'who he made stand around the tabernacle'

However, if we go back further to an earlier stage we find a biclausal accusative and infinitive construction as in:

(47) Latin (Lucilius 1224, 2nd cent. CE)
purpureamque uvam facit albam pampinum habere
purple.ACC-and grape.ACC make.PRS.3SG white.ACC vine.ACC have.INF
'and it (the sun) causes the pale vine-shoot to have purple grapes'

That this is biclausal is evidenced by the fact that there are two accusatives here, one for the actor of the embedded clause and one for the undergoer, whereas in examples like (44) the embedded actor is marked by the preposition *à*, that is to say the usual marker of the non-macrorole core argument of ditransitive verbs.

Two questions now arise:

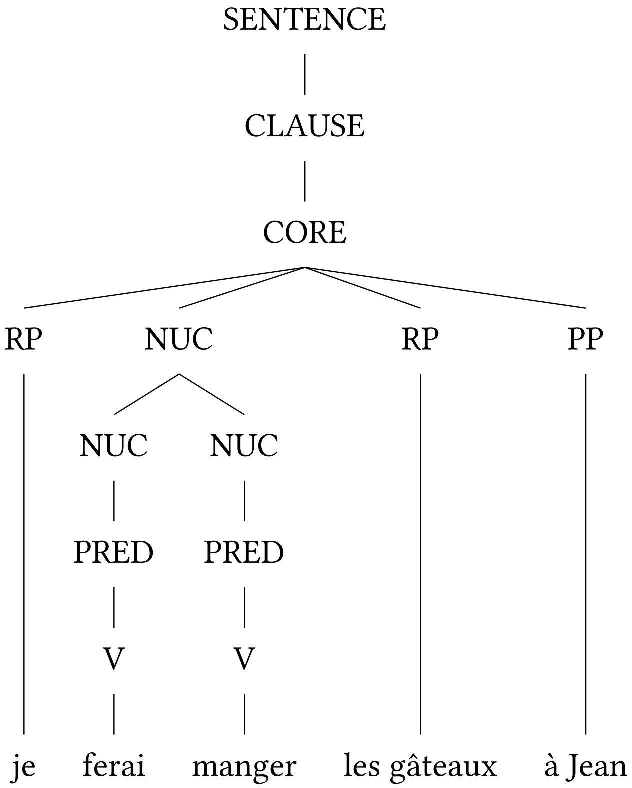
1. how do the two frameworks model such constructions?
2. what diachronic trajectories do these synchronic analyses imply?

For example (44), Van Valin (2009: Figure 28.13) proposes the following structure:[18]

---

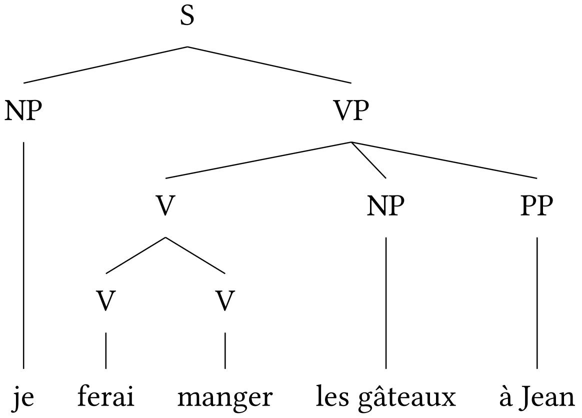
[18] Kailuweit (2008: 81) has essentially the same structure but with the verbal arguments dominated by [ARG [NP]] rather than, as here, by RP. Nothing of essence for the present issue hangs on this difference.

(48) Constituent projection of (44):



By contrast, the LFG representation in c-structure would be:

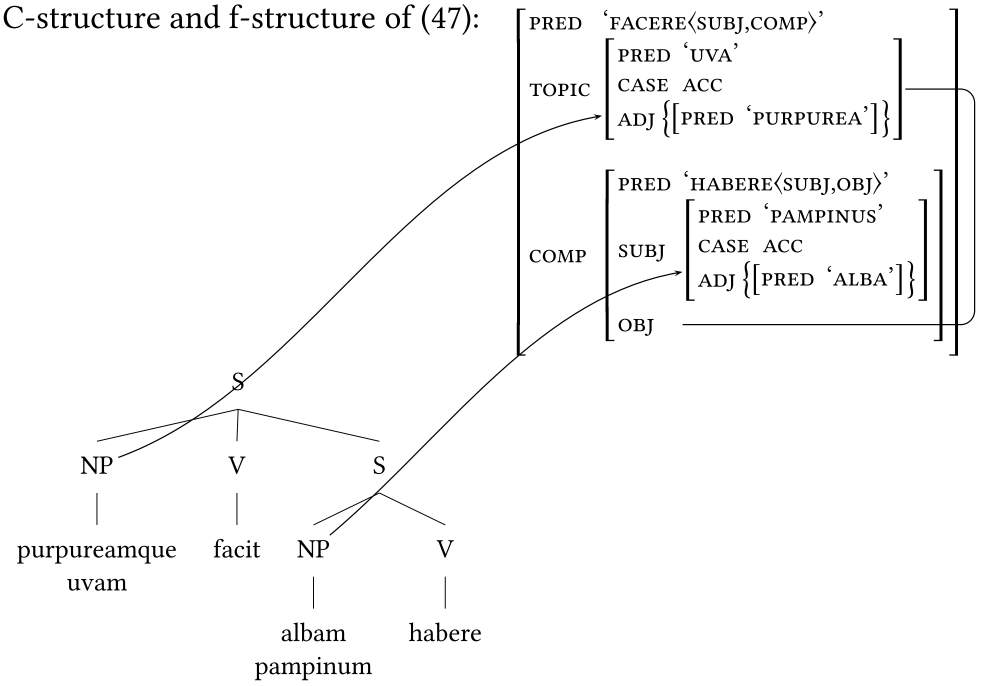
(49) C-structure of (44):



And to this would be linked an f-structure, where there is a single pred value for the verbal complex: pred ‘faire.manger⟨subj,obj,obj$_{\theta}$⟩’ with the three arguments respectively *je*.subj, *les gâteaux*.obj and *Jean*.obj$_{\theta}$. The most appropriate c-structure for Romance causatives has been a matter of some discussion within the LFG literature ever since the early work of Alsina (1997) and is discussed in Alsina 2023 [this volume] and Andrews 2023 [this volume]. The structure in (49) is the one put forward in Börjars & Vincent (2017: 652) and is modelled on the proposal for Urdu complex predicates advanced by Butt (1997). The crucial property is that the 'make' verb and its dependent infinitive constitute a complex lexical item within a monoclausal construction and in this way account for the non-iterability of Romance causatives when compared to their English counterparts.

By contrast, the LFG tree for an example such as (47) would be as follows:

(50) C-structure and f-structure of (47):



A comparison of the two LFG representations shows that the change here has been modelled at the level of f-structure; where in the Latin example there were two separate predicates *facere* 'do' and *habere* 'have', in French we have rather a single complex predicate *faire manger*. In other words, there is a shift from a biclausal to a monoclausal pattern modelled through the changing functional structures of the relevant predicates. In the RRG account by contrast there is a change from core juncture to nuclear juncture (see Section 3.4), that is to say a similar pattern of structural conflation but achieved without reference to grammatical functions.

There are, then, parallels between the accounts within the two systems of both the earlier biclausal and the later monoclausal structures, but when it comes to describing and explaining the change from the one to the other over time there is a striking difference. As Börjars & Vincent (2017: 659) note, LFG has no inherent means of accounting for the directionality of change compared to for example the

Minimalist framework. The latter includes a constraint that derivational movement, in the synchronic sense, is always upwards. Since the layers of functional structure always dominate the lexical layers, it follows that shifts can only be from lexical to functional exactly as the data from studies of grammaticalization predict. RRG by contrast, rather than relying on an abstract distinction between functional and lexical heads, incorporates the semantic-syntactic directionality directly into its overall structure via the Interclausal Relations Hierarchy (see Section 3.4 and Van Valin 2005: 209, Van Valin 2009: Fig 28.20, Matasović 2008). According to this view, there is an inherent link between semantic type and clausal structure. It is predicted therefore that a pattern containing the ingredients of causativity, if it is not already monoclausal, should move in that direction, exactly as the data we have reviewed above suggest. What neither model easily accounts for is the reversion to bicausality that is attested in some modern Romance varieties. The example in (51) is from the Piedmontese dialect of Borgomanero:

(51) Borgomanero (Tortora 2014: 155, ex. 154d)
al farissa vônga-ti lü, la strija
SBJ.CL make.COND.3SG see.INF-you.SG he DEF witch
'He would make you see the witch.'

In standard Italian or in French the clitic subject *ti* 'you' of 'see' would precede the causative in a monoclausal construction, while the fact that is attached here to the embedded infinitive leads Tortora (2014) to propose a biclausal account. Davies (1995) adduces similar evidence from modern Spanish and contrasts it with the monoclausal patterns found in the earlier stages of the language. Changes such as this suggest that it is not necessary to expect all diachronic developments to follow from asymmetries built into particular analytic frameworks, but some changes may be due to independently motivated external factors.

That said, diachrony does frequently show directionality, as is clear from the third type of change, namely those patterns that fall within the domain of grammaticalization. The emergence of grammatical markers such as tense/aspect auxiliaries, (in)definite articles and the like from former lexical items suggests that there are inherent links between different types of meaning, though the question remains open as to whether these should be attributed to forces external to language rather than to inherent properties of particular models. In this connection, Eschenberg (2005: Chapter 6), basing herself on earlier work by Rankin (2004), documents a striking series of changes in a set of particles in Umo^{n}ho^{n}

(Omaha), which serve as both articles within the NP and evidentials within the clause. Here is not the place to go into detail but Figure 13 (Eschenberg 2005: 186) demonstrates the two functions of the item *kʰe* as a marker of deixis and subsequently as indicating the evidential basis for the speaker's assertion. She concludes that the structural parallels which an account along RRG lines suggests open up the potential for grammaticalization, though in fact no directionality is predicted and indeed over time some items within this class show a shift from auxiliary to article and back to auxiliary. The general conclusion, therefore, is that whatever the analytical framework, historical and synchronic data can and do complement each other.

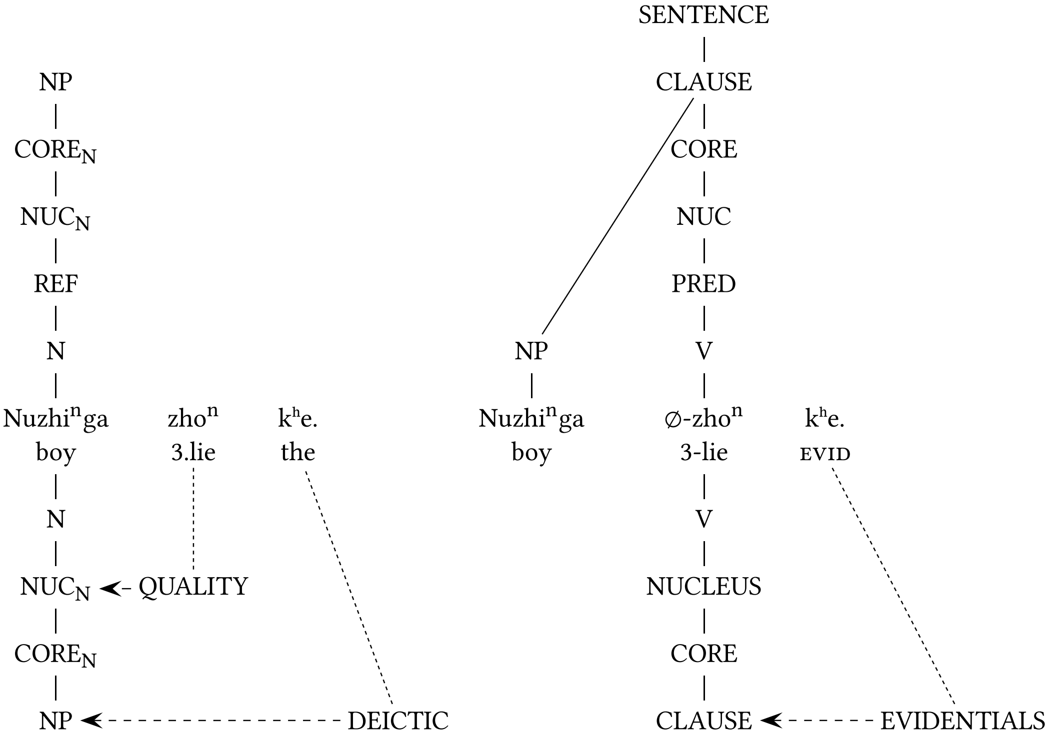


Figure 13: The marker *kʰe* in Umoⁿhoⁿ (Omaha) (Eschenberg 2005: 186)

5 Computational linguistics

Computational work has been a key component of LFG right from the outset (see the chapters in Part 5 of the present volume). By contrast, in the early stages the implementations of RRG were traditionally fewer, although there have been many relevant proposals in the last few years, and RRG now aims to offer an explanatory framework for the study of computational linguistics. While both approaches have been interested in parsing and sentence comprehension, the goal of developing more or less complete computational grammars of a range of languages has been a specific focus of LFG work, particularly but not exclusively via the ParGram project (Forst & King 2023: 3 [this volume]). The languages that figured within this project are typologically varied and in addition to the initial choice of English, French and German, the project has now been extended to include not only other Indo-European languages such as Norwegian, Polish, Urdu and Welsh but also a representative selection of languages from other families and parts of the world such as Georgian, Tigrinya, Japanese and Wolof. Comparable to the LFG ParGram project, albeit smaller in scale, are the RRG parbank project, a parallel treebank under development, which currently covers a small text corpus of German, English, Farsi, French, and Russian (Arps et al. 2021) and the RRG Biblical Hebrew treebank project (Cany Højgaard & Nielsen 2021). Moreover, Guest (2008) developed a parser which has been used to analyse a large corpus of English sentences and a somewhat smaller corpus of Dyirbal sentences (see also Nolan 2023). In addition, the cognitive scientist John Ball has, in the last decade, applied RRG in various Artificial Intelligence domains (see https://medium.com/pat-inc for details).

6 Psycho- and neurolinguistics

Language acquisition and processing are domains in which RRG and LFG line up with each other in the sense that neither requires, nor finds evidence for, an innate UG (Pinker 1989, Van Valin 2002, Weist 2023 and references therein). When it comes to acquisition both argue for the importance in the first instance of recurrent semantic patterns with syntactic structures only emerging at a later stage. Pinker (1982, 1989) in particular used LFG as a framework for the investigation and modelling of language acquisition, while Van Valin (1994, 1998, 2001, 2002) offers case studies from the perspective of RRG.

As for neurolinguistic research, RRG has been used as the grammar component of a sentence comprehension model developed in Bornkessel et al. (2004) and Bornkessel & Schlesewsky (2006). Van Valin (2023a) uses the RRG machinery to explain the ability of split-brain patients to provide grammaticality judgements with their isolated right hemisphere, developing a proposal which could potentially also capture the decoupling of grammaticality judgements and interpretation in agrammatic aphasics. For an overview of the relevant LFG-inspired work see Dalrymple et al. (2019: 726-728). Jones (2019) develops a new line of thinking for an ‘incremental’ version of LFG which addresses issues in relation to language processing and artificial intelligence.

7 Concluding remarks

In our introduction we alluded to the fact that both RRG and LFG share a commitment to formal architectures involving parallel structures and no derivations. In terms of the threefold classification of models proposed by Francis & Michaelis (2003) — (a) derivational, (b) licensing, as with the various kinds of construction grammar, and (c) level-mapping, in which each level has its own structures and theoretical primitives — LFG and RRG both fall into their third class. At the same time, in his comments on an earlier draft of this chapter, Van Valin observes that ‘RRG could be considered a kind of (generic) construction grammar, given its construction-specific theory of grammatical relations and use of constructional schemas to represent language-specific information’. That said, it must be noted that constructions are only deemed to be necessary in RRG when the general principles of the linking algorithm allow scope for variation, and thus can be applied in a construction-specific way. In similar vein, within LFG although proposals exist for integrating specific constructional types and idioms (see for example Asudeh et al. 2013), the model as a whole remains solidly based on words and phrases. The allusion to the sound-meaning link also suggests another dimension along which theories can be compared, namely the scale from syntax through semantics to pragmatics. At one extreme, there is cartography/nanosyntax with its insistence on the centrality of syntactic configurations and features while at the other there lies a purely pragmatics-driven model such as Dynamic Syntax (Kempson et al. 2016, 2017), which was set beside LFG in the workshop reported in Vincent (2009). Both LFG and RRG fall between these two extremes, but with LFG, given the importance of c-structure and the grammatical functions of f-structure, sitting nearer the syntactic end of the spectrum while RRG is more firmly based in semantic territory. However, there are signs of moves towards a larger role for semantics within LFG, as evidenced by Dalrymple et al. (2019: Chapter 8) and Asudeh 2023 [this volume] and in a different way by Findlay 2023 [this volume]. Only time will tell what the outcome of such a rapprochement might be.

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Abbreviations

Besides the abbreviations from the Leipzig Glossing Conventions, this chapter uses the following abbreviations.

CL	clitic	PROC	process
INGR	ingressive	SP	same PSA (privileged syntactic argument)
LNK	linker	SUFF	suffix
SEQ	sequential		

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Chapter 42

LFG and Simpler Syntax

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The theories of Lexical Functional Grammar (LFG) (Kaplan & Bresnan 1982) and Simpler Syntax (SiSx) (Culicover & Jackendoff 2005) both emerged out of a dissatisfaction with the conceptual and formal assumptions of Mainstream Generative Grammar (MGG) (Chomsky 1957, 1965, 1981, 1995). Due to their similar origins, LFG and SiSx have a lot in common: the reduced role of phrase-structure in the explanation of linguistic phenomena, the adoption of constraint-based formalisms and the recognition of autonomous representations for grammatical functions. But there are also crucial differences between the two approaches that relate to some of the most lively issues in linguistics: e.g. the nature of the lexicon and the role of formal grammar in explaining linguistic judgments. The goal of this chapter is to compare these two alternatives to MGG, highlighting their differences and similarities with respect to theoretical and empirical issues.

1 Introduction

The goal of this chapter is to provide a comparison between Lexical Functional Grammar (LFG) and Simpler Syntax (SiSx). Historically, both theories were born out of a dissatisfaction with the conceptual and formal assumptions of Mainstream Generative Grammar (MGG) (Chomsky 1957, 1965, 1981, 1995). Due to their similar origins, LFG and SiSx have a lot in common: the reduced role of phrase-structure in the explanation of linguistic phenomena, the adoption of constraint-based formalisms and the recognition of autonomous representations for grammatical functions, to name a few. But there are also crucial differences that relate to some of the most lively issues in linguistics: e.g. the nature of the lexicon and the role of grammar in explaining linguistic judgments.

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In Section 2, I offer a short summary of the Simpler Syntax Hypothesis (SSH). In Section 3, I lay out some goals and architectural assumptions that SiSx and LFG share, as well some important theoretical differences between the two approaches. Section 4 deals with the motivations for the constructional lexicon assumed in SiSx, which does not adhere to LFG's Lexical Integrity Principle (Bresnan & Mchombo 1995). Section 5 examines the role of constraints that are not part of the grammar, comparing SiSx with an LFG alternative. Section 6 wraps up discussing what LFG and SiSx can learn from each other.

Throughout this chapter, I will assume basic familiarity with the LFG side of the comparison and focus mainly on explaining the SiSx approach. The basic source for the latter is Culicover & Jackendoff (2005), but I will also draw freely on Jackendoff (2002, 2010), Jackendoff & Audring (2019) and Culicover (2009, 2013b, 2021).

2 The Simpler Syntax Hypothesis

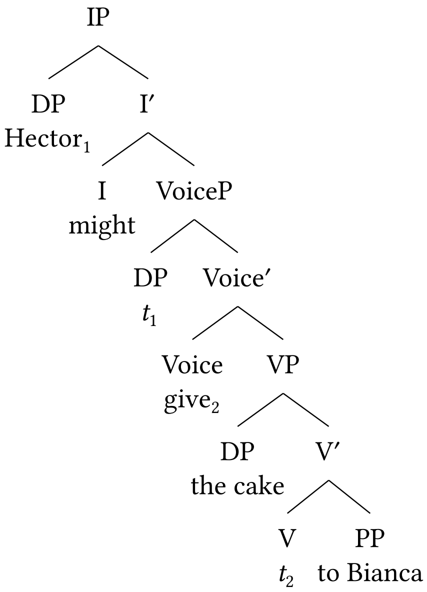
Like other syntactic theories, SiSx is an attempt to describe and explain the language user's ability to establish a correspondence between meaning and sound or gesture. What defines it is the claim that this correspondence should be as minimal as possible – i.e. that syntax should *only* be invoked when other factors (e.g. semantics, prosody, processing) are insufficient to explain the phenomena at hand. This claim is embodied in the Simpler Syntax Hypothesis (Culicover & Jackendoff 2005: 5):

(1) The Simpler Syntax Hypothesis (SSH)
The most explanatory syntactic theory is one that imputes the minimum structure necessary to mediate between phonology and meaning.

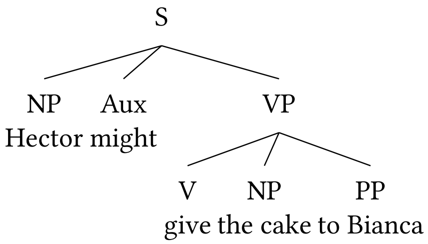
Assuming Chomsky's (1965) notions of descriptive and explanatory adequacy, what the SSH says is that, given a set of descriptively adequate grammars of a language *L*, the one the theorist should choose (i.e. the more explanatory one) is the one that assigns less structure to the expressions of *L*. The SSH favors, thus, representational economy (Chomsky 1991, Trotzke & Zwart 2014) over other notions of simplicity, such as minimizing the class of possible grammars or the number of principles in particular grammars. The latter two goals are the main driving forces of MGG since the advent of the Principles and Parameters framework (Chomsky 1973, 1981, 1995).

As an example, contrast the relatively flat constituent structure SiSx assigns to the English sentence *Hector might give the cake to Bianca* in (2b) with the MGG variant in (2a), which is based on the widely adopted VP-shell analysis (Larson 1988, Kratzer 1996, Hale & Keyser 1993, Chomsky 1995):

(2) a.



b.



MGG opts for structures like (2a) because the grammar that generates them involves *fewer* principles (and is allegedly *more restrictive*) than the one that yields (2b).[1] The idea is that (2a) follows a universal blueprint for structure-building that is virtually *invariant* across languages – one that imposes strict binary branching, endocentricity and a rigid order among heads. Moreover, the hierarchical organization of phrases in (2a) is semantically transparent, reflecting a universal THEMATIC HIERARCHY, in which AGENTS are higher than THEMES, THEMES are higher than GOALS and GOALS are higher than MODIFIERS (see Baker 1997).

The structure itself, however, is clearly much simpler in (2b): (2b) has fewer degrees of embedding (just two), no empty functional projections (e.g. VoiceP) and no phonetically null elements (traces or deleted copies). Given a suitably flexible interface, (2a) can also be placed in correspondence with a level of SEMANTIC STRUCTURE (Jackendoff 1990). The semantic properties that (2a) purports to reflect can be more naturally represented in this level, which is independently required to explain inferences that go well beyond what narrow syntax can express.[2] Thus, between representations (2a) and (2b) – the former illustrating simplicity of principles and the latter simplicity of structure – SSH recommends (2b).

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[1] The suggestion that (2a) implies a more restrictive grammatical formalism is probably not true. As Kornai & Pullum (1990) show, as soon as empty elements are introduced, X′-theory becomes equivalent to an arbitrary context-free grammar that can generate structures like (2b). Similar considerations apply to minimalist descendants of X′-theory (cf. Chomsky 1995).

[2] Even the rich structure in (2a) fails to encode the inference that *Hector* is the Source of *the cake* (in addition to the Agent of *give*), or that cakes are artifacts typically used for eating. The latter influences the interpretation of evaluative adjectives: a *good cake* is a cake that is good to *eat* (Pustejovsky 1995). The phrase-structure formalism has no natural way to represent this.

A theoretical reason for pursuing the SSH (as opposed to other measures of simplicity) is that it approximates syntactic structures to what is directly inferable from input, thereby reducing the task of the language learner (cf. Culicover 1998, 1999, Jackendoff 2011a). The child has no direct evidence for the traces and empty elements assumed in (2a). As Chomsky (1982: 19) notes, this raises poverty-of-stimulus issues, which call for the invocation of a richer Universal Grammar (UG). Insofar as SiSx posits more concrete structures, it contributes to the minimalist project of a leaner UG (cf. Chomsky 2005, Hornstein 2009).

Aside from being more *explanatory*, the option for simpler structures is also more *descriptively adequate* than accounts based on rich uniform representations like (2a). Classic constituency tests, for example, only provide motivation for the major constituent divisions shown in (2b): VPs, PPs, NPs, etc. The empirical virtues of the SSH also manifest in accounts of specific linguistic phenomena (some of which will be mentioned in Sections 4 and 5). Most arguments for SiSx analyses have the following form:

> [G]iven some phenomenon that has provided putative evidence for elaborate syntactic structure, there nevertheless exist numerous examples which demonstrably involve semantic or pragmatic factors, and in which such factors are […] impossible to code uniformly into a reasonable syntactic level […]. Generality thus suggests that, given a suitable account of the syntax–semantics interface, all cases of the phenomenon in question are accounted for in terms of the relevant properties of semantics/pragmatics; hence no complications are necessary in syntax. (Culicover & Jackendoff 2005: 5)

As this makes clear, the SSH eschews any kind of covert structure that is motivated exclusively in order to provide a uniform mapping onto semantics. This means that SiSx rejects the syntactocentric architecture of MGG – i.e. the view that syntax is solely responsible for the combinatorial richness of language (Culicover & Jackendoff 2005: 17) –, as well as the assumption of Interface Uniformity – i.e. the view that the interface between syntax and semantics is perfectly transparent (Culicover & Jackendoff 2005: 47).

As an alternative, SiSx adopts the Parallel Architecture of Jackendoff (2002), according to which linguistic structure is determined by (at least) three independent formal systems: phonology, syntax and semantics. In addition, SiSx borrows from LFG the idea of a separate syntactic layer for representing grammatical functions: the GF-tier (Culicover & Jackendoff 2005: chapter 6). Each one of these systems is defined by its own characteristic primitives and formation rules and is connected to the others by means of more or less “messy” interfaces:

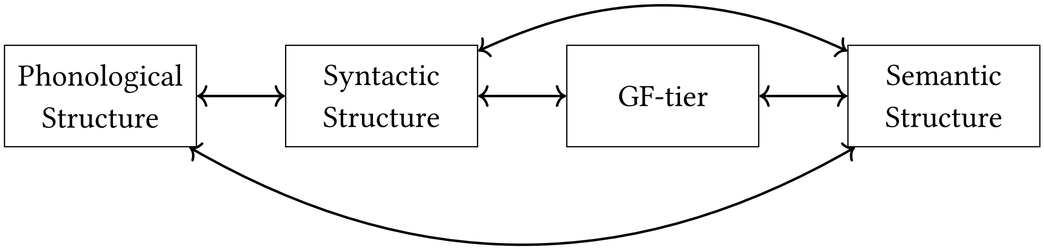

Figure 1: The Parallel Architecture of SiSx

A well-formed sentence must be well-formed in each level, in addition to having well-formed links among the interfaces.[3] A toy example is shown in (3), where natural numbers indicate interface links between the components:[4]

(3)
$$\left[\begin{array}{ll} \text{PHON} & \text{mɛəri}_1\#\text{kɪs}_2+\text{d}_3\#\text{ʤɒn}_4 \\ \text{SYN} & [_{\text{S}}\ \text{NP}_1\ [_{\text{VP}}\ \text{V}_2\ \text{-}\ \text{past}_3\ \text{NP}_4]] \\ \text{GF} & [_{\text{PRED}}\ \text{GF}_1 > \text{GF}_4]_2 \\ \text{SEM} & \mathbf{past}'_3(\mathbf{kiss}'_2(\text{AGENT}:\text{mary}_1,\ \text{PATIENT}:\text{john}_4)) \end{array}\right]$$

The structure in (3) represents the sentence *Mary kissed John.* The most opaque aspect of the formalism is likely the GF-tier. The basic units of this level are PREDS (short for syntactic predicates), which contain a sequence of ranked positions for syntactic arguments (excluding adjuncts). These positions are not explicitly labeled with grammatical function names, like SUBJECT or OBJECT. For reasons that will become clear in Section 4, these notions are relationally defined as *first GF* of PRED, *second GF* of PRED, etc. The ranking of GFs is determined according the FUNCTIONAL HIERARCHY, which has its roots in Relational Grammar (Perlmutter & Postal 1977, 1983) and Keenan and Comrie's (1977) work.

Note, furthermore, that there is nothing in SYN that signals that NP_1 in (3) corresponds to the string *Mary* – this information is phonological, and, as such, it is only represented in PHON. The terminal strings in a tree like (2b) are, thus, not strictly speaking part of the syntactic structure. A similar division between

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[3] An interface link is well-formed *iff* it instantiates some lexeme or construction in the grammar: e.g. the links indicated by subscript 1 in (3) conform to what is stipulated by the lexical entry of *Mary.* The way SiSx represents lexemes and constructions is discussed in Section 4.

[4] Throughout this chapter, I will use the AVM notation adopted in Culicover (2021) for representing linguistic objects and the constraints that such objects must satisfy. For convenience, the formalism for SEM will be a simplified version of Montague's (1974) PTQ appended with an (implicit) event semantics. The thematic predicates (AGENT, PATIENT, etc.) are abbreviations for relations between individuals and the events they partake in, as in Parsons (1990). The SEM tier in (3) is, thus, equivalent to $\exists e[\mathbf{kiss}'(e) \& \ \mathbf{Agent}'(e, \text{mary}) \& \ \mathbf{Patient}'(e, \text{john}) \& \mathbf{past}'(e)]$.

phonological, syntactic and semantic forms is anticipated in Distributed Morphology (Halle & Marantz 1994, Marantz 1997) as well as in variants of Categorial Grammar that build on Curry's (1963) PHENOGRAMMAR *vs.* TECTOGRAMMAR distinction (e.g. Oehrle 1994, Mihaliček & Pollard 2012).

In order to capture the inner workings of the subsystems of language as well as how these systems interact with each other, SiSx abandons the formal device of derivations in favor of CONSTRAINTS (or, in the terminology of Jackendoff & Audring (2019), SCHEMAS). This and many of the other points mentioned above are shared with LFG, as we will see in the next section. SiSx also draws a lot from HPSG (Pollard & Sag 1994, Müller et al. 2021, Przepiórkowski 2023 [this volume]), as will become particularly clear in Section 4.

3 Goals and assumptions

Among all non-transformational syntactic theories, SiSx and LFG are probably the most closely related ones as far as programmatic aspirations and architectural assumptions are concerned. Most of these stem from the adherence to what Jackendoff (2007b: chapter 2) identifies as two founding themes of Generative Grammar: MENTALISM and COMBINATORIALITY.

MENTALISM is the view that language is a product of the mind/brain of individual speakers. SiSx and LFG are committed to a particularly strong version of this, which Bresnan & Kaplan (1982) and Kaplan & Bresnan (1982), following Chomsky (1965: 9), dub the COMPETENCE HYPOTHESIS. This is the suggestion that the *same* body of knowledge underlies *every* type of language-related behavior (e.g. speaking, reading, learning). In this approach, the linguist's theoretical constructs are not only *psychologically real* in an abstract sense, but must be integrated to an account of how language is actually processed and acquired by real speakers.

The second founding theme of Generative Grammar shared by LFG and SiSx is COMBINATORIALITY: i.e. the view that knowledge of language is instantiated as a finite system of *rules* that define (or "generate") an unbounded array of structured expressions. The linguist's explicit formulation of these rules (i.e. the grammar) must, ideally, entail well-formedness for all sentences judged acceptable by speakers – making no principled distinction between pure manifestations of "core grammar" and "peripheral data" (Culicover 1999).

In line with these commitments, LFG and SiSx seek to characterize the human language capacity in a way that is: (i) PSYCHOLOGICALLY PLAUSIBLE, seeking a graceful integration of linguistic theory with what is known about the structure and function of mind/brain (Bresnan 1978, Jackendoff 2011b); and (ii) FORMALLY and descriptively adequate, representing generalizations of varying granularities with sufficient precision. Different aspects of these objectives are emphasized by LFG and SiSx (e.g., LFG is much more preoccupied with the formal underpinnings and SiSx with the psychological and biological foundations). The remainder of this section summarizes some of the ways the theories converge and diverge in implementing these goals.

3.1 The structure of the grammar

The commitments to mentalism and combinatoriality lead SiSx and LFG to similar conclusions regarding the overall structure of grammar. Compare Figure 1 above, which contains the architecture of SiSx, with the LFG architecture below:

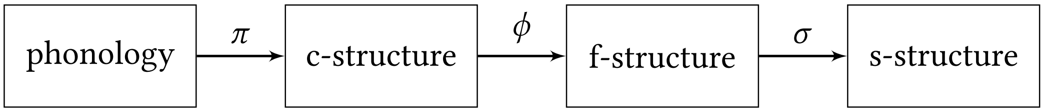

Figure 2: LFG Architecture

The most striking similarity between the two architectures above is that they abide by Representational Modularity, as defined by Jackendoff (1997):[5]

> The overall idea is that the mind/brain encodes information in some finite number of distinct representational formats or "languages of the mind." Each of these "languages" is a formal system with its own proprietary set of primitives and principles of combination, so that it defines an infinite set of expressions along familiar generative lines. For each of these formats, there is a module of mind/brain responsible for it. (Jackendoff 1997: 41)

In both theories, the primitives of phonology are things like segments (or featural decompositions thereof) and syllables. Constituent structure in syntax is built from syntactic categories (e.g. V, N, VP, and Aux) and their dominance and precedence relationships, as in a context-free grammar. The basic units of the GF-tier and f-structure are syntactic predicates and their arguments. Semantics is composed of entities, events, properties and relations (at least). These modules

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[5] There are actually different versions of LFG's general architecture going back to Kaplan (1987) (Asudeh 2006, Findlay 2016, Dalrymple & Findlay 2019, among others), but all agree on the essentials of Figure 2. The most striking omission from Figure 2 is the separate component for a-structure proposed in Butt et al. (1997) and subsequently adopted by most researchers within LFG.

are connected to one another via systematic correspondences. In this sense, the architectures in Figures 1-2 can be called correspondence architectures.

The correspondence architecture sets LFG and SiSx apart from sign-based theories like HPSG (Pollard & Sag 1994, Przepiórkowski 2023 [this volume]) and SBCG (Sag 2012). The latter use the same kind of data structure to model all aspects of linguistic objects: i.e. typed features organized in AVMs. Different types of information are not related by means of modular correspondences, but in virtue of being values assigned to different attributes of the same sign. The design of HPSG/SBCG does not make it clear that phonology, syntax and semantics are autonomous combinatorial systems. Combinatoriality only exists at the level of signs as a whole (e.g. in features like dtrs, which take lists of *signs* as values, instead of syntactic nodes).

Even though SiSx follows HPSG/SBCG in using AVMs to represent all aspects of linguistic objects, its basic ontology is much closer to LFG's: each linguistic level is conceptualized as an autonomous formal system in its own right. Just as in LFG, this requires positing correspondence principles to link the objects independently defined by each of these systems.

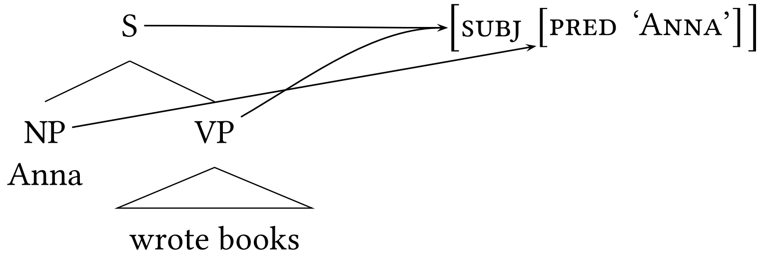
However, LFG and SiSx construe these correspondences in different ways. In LFG, structures of different types are related to each other in virtue of the projection functions π, ϕ and σ of Figure 2. This sort of mapping allows descriptions of elements in the range of a function to be defined in terms of elements in its domain. For instance, the function ϕ – whose domain and range are, respectively, c-structure nodes and f-structures – allows properties of f-structures to be "read off" from c-structure configurations.

This is crucially exploited in LFG's annotated phrase-structure rules. An example is given in (4), where "$*$" stands for the node that matches the element above it in the rule and M is the *mother-of* function (Kaplan 1995: 18):

(4)
$$\begin{array}{cccc} \text{S} & \rightarrow & \text{NP} & \text{VP} \\ & & (\phi(M(*))\textsc{subj}) = \phi(*) & \phi(M(*)) = \phi(*) \end{array}$$

This rule allows one to deduce from the c-structure of *Anna wrote books* (assuming the annotations on lexical entry of *Anna*) the correspondences in (5):

(5)



Since ϕ is a (total) function, it requires that *all* elements in its domain be mapped into elements in its range. This entails that every c-structure node – even nodes corresponding to adjuncts – must be assigned a particular f-structure.

In SiSx, on the other hand, correspondences between structures of different types are not functional, but merely relational. Therefore, there is no sense in which the properties of any level are "projected" from properties of any other, like f-structure is projected from c-structure in LFG. From the point of view of SiSx, this looks like a residue of MGG's syntactocentrism. Consider the SiSx equivalent to LFG's annotated phrase-structure rule in (4) (italics indicate that the element is a variable and not a concrete member of its respective category):

(6)
$$\begin{bmatrix} \text{SYN} & [_{S}\, \mathit{NP}_1\ \mathit{VP}_2]_3 \\ \text{GF} & [_{\text{PRED}}\, \mathit{GF}_1 > \ldots]_{2,3} \end{bmatrix}$$

Like (4), (6) expresses the information that the sister of VP corresponds to a subject (i.e. the highest ranked GF in a pred). But, unlike (4), (6) is not a phrase-structure rule: it is a correspondence rule, which is defined over independently well-formed representations on SYN and the GF-tier. No level has primacy over the others, as suggested by the symmetry of the coindexing notation. Since levels of structure are allowed more independence, the mapping between them can also be seen as only partial. This avoids the implication that all nodes in SYN must correspond to units on the GF-tier. I will come back to some positive consequences of this looser requirement below.

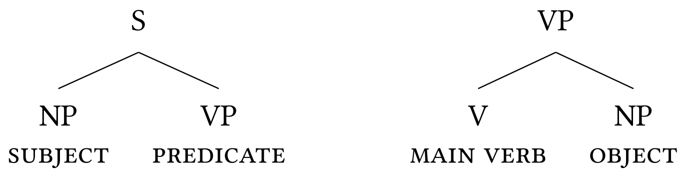
Regardless of these differences, LFG and SiSx both benefit from the general advantages of correspondence architectures, which are better suited for integration with theories of other cognitive faculties than syntactocentric models (this point is hinted at by Bresnan (1993: 45), but see Jackendoff (2007a, 2011b) for full versions of the argument). It is a given that the mind includes relations between non-linguistic representations. For instance, visual and haptic information relate to a modality-independent understanding of the spatial structure of objects (Marr 1982). This spatial structure, in turn, relates to language in a way that allows us to talk about what we perceive (Jackendoff 1987, Landau & Jackendoff 1993). Actions are also spatially guided, requiring an interface between spatial structure and schemas encoding action patterns. It does not make any sense to think of any of these representations as being *algorithmically derived* from any other – they are, rather, related in virtue of modular correspondences.

In this sense, the correspondence architectures of LFG and SiSx see the internal components of language as "connected to each other in the same way as language is connected with the rest of the mind, and in the same way as other faculties of mind are connected to each other" (Jackendoff & Audring 2019: 8). Though many details about how such connections work remain unknown, LFG and SiSx seem better suited for fruitful cross-disciplinary dialogue with cognitive science than MGG, which opts for a syntactocentric derivational design.

3.2 The role of grammatical functions

In any theory, grammatical functions (GFs) serve as abstract "relators" between a class of surface syntactic properties (e.g. linear order, case marking) and semantic roles. MGG assumes that these abstract GFs are represented in the same format as syntactic groupings – i.e. GFs are treated as epiphenomena of constituent structure configurations. An early statement of the MGG view is found in Chomsky (1965: 68–74), who claims that notions like subject and object are universally definable in terms of the structural positions in (7):

(7)



LFG and SiSx both reject this configurational design of UG for similar reasons. Consider what it implies for the English sentence in (8):

(8) Brad seems to like Janet.

In (8), *Brad* behaves like the subject of two predicates: the one headed by *seem* (where it establishes agreement) and the one headed by *like* (where it gets interpreted semantically). The configurational design requires that each of these GFs be realized in different positions, which *Brad* has to occupy simultaneously. This, however, is technically impossible in a typical phrase-structure system, since it entails multi-dominance. The alternative is to posit a sequence of phrase-markers in which these positions are occupied at separate stages, as in (9):

(9) seems [$_\text{S}$ Brad [$_\text{VP}$ to like Janet]] ⇒ [$_\text{S}$ Brad$_i$ [$_\text{VP}$ seems [$_\text{S}$ t_i to like Janet]]]

The configurational design thus calls for operations that map phrase-markers onto phrase-markers – i.e. syntactic transformations (Chomsky 1957: 44). Note, however, that these mappings are simply a way to encode the effects of multi-dominance in a system that does not naturally allow for it.

Though this might seem plausible for English (where subjects typically correspond to the configuration in (7)), it is less appealing for languages like Russian, where word order is freer and GFs are signaled mainly by case endings on nouns. A derivation for the Russian OVS sentence (10) would have to look like (11):

(10) Russian
Vaz-u razbila Olj-a (Kallestinova 2007: 30)
vase-ACC broke Olya-NOM
'Olya broke the vase'

(11)
$$\begin{aligned} &[_{\text{S}}\ \text{Olja}\ [_{\text{VP}}\ \text{razbila vazu}]] \Rightarrow [_{\text{S}'}[_{\text{VP}}\ \text{razbila vazu}]_i\ [_{\text{S}}\ \text{Olja}\ t_i]] \\ &\Rightarrow [_{\text{S}''}\ \text{vazu}_k\ [_{\text{S}'}\ [_{\text{VP}}\ \text{razbila}\ t_k]_i\ [_{\text{S}}\ \text{Olja}\ t_i]]] \end{aligned}$$

The SUBJECT and OBJECT in (11) are base-generated in the positions signaled in (7) and then scrambled to where they are actually pronounced via roll-up movements (cf. Bailyn 2003). The resulting structure is a representation of "several types of information that seem quite dissimilar in nature" (Kaplan & Zaenen 1989: 137): on the one hand, GFs like SUBJECT and OBJECT and, on the other, linear order, dominance relations and syntactic categories.

LFG and SiSx reject this on the grounds of REPRESENTATIONAL MODULARITY. Dominance, order and syntactic categories are naturally represented in a phrase-structure system but the organization of GFs has different formal properties (e.g. multi-dominance) that justify positing a separate component. This is the GF-tier in SiSx and f-structure in LFG. A SiSx analysis of (8) is sketched in (12) (from now on, tenses will be ignored and PHON will be simplified as orthography):

(12)
$$\left[\begin{array}{ll} \text{PHON} & \text{Brad}_1\ \text{seems}_2\ \text{to like}_3\ \text{Janet}_4 \\ \text{SYN} & [_{\text{S}}\ \text{NP}_1\ \text{V}_2\ [_{\text{VP}}\ \text{V}_3\ \text{NP}_4]] \\ \text{GF} & [_{\text{PRED}}\ \text{GF}_1]_2[_{\text{PRED}}\ \text{GF}_1 > \text{GF}_4]_3 \\ \text{SEM} & \textbf{seem}'_2(\textbf{like}'_3(\text{EXPERIENCER:brad}_1,\ \text{THEME:janet}_4)) \end{array}\right]$$

In the GF-tier, GF_1 (which corresponds to *Brad*) is doubly dominated by the PRED linked to *seem* and the one linked to *like*. This direct encoding of multi-dominance – which is also central to LFG's functional control analysis of raising (see Bresnan 1982a) – makes transformations like (9) unnecessary.

Likewise, the autonomy of GFs in SiSx and LFG also makes it possible to state mappings between GFs and SYN without specifying syntactic configuration or linear order. So, for dependent-marking languages like Russian, GFs can be linked directly to Ns with the appropriate case morphology, as in (13) (Culicover 2009: 154).

(13)
a. $$\left[\begin{array}{ll} \text{SYN} & [_{S}\ \ldots\ N\text{-NOM}_1\ \ldots\ ]_2 \\ \text{GF} & [_{\text{PRED}}\ GF_1 > \ldots]_2 \end{array}\right]$$
b. $$\left[\begin{array}{ll} \text{SYN} & [_{S}\ \ldots\ N\text{-ACC}_3\ \ldots\ ]_4 \\ \text{GF} & [_{\text{PRED}}\ GF > GF_3 \ldots]_4 \end{array}\right]$$

This proposal avoids abstract *ad hoc* MGG derivations like (11), opening the possibility of licensing flat structures. A SiSx analysis for (10) in this spirit could be something like (14). Note that configuration does not play a role in determining GFs in this case. (This does not mean that it cannot play a role in defining information structure properties, which are not being represented in (14).)

(14)
$$\begin{bmatrix} \text{PHON} & \text{Vaz-u}_3\ \text{razbila}_2\ \text{Olj-a}_1 \\ \text{SYN} & [_{\text{S}}\ \text{N-}\textsc{acc}_3\ \text{V}_2\ \text{N-}\textsc{nom}_1] \\ \text{GF} & [_{\textsc{pred}}\ \text{GF}_1 > \text{GF}_3]_2 \\ \text{SEM} & \textbf{break}'_2(\textsc{agent}{:}\text{olya}_1,\ \textsc{patient}{:}\text{the-vase}_3) \end{bmatrix}$$

The idea that word parts can carry information about GFs bypassing syntax is shared with LFG (Bresnan 2001). The proposal sketched in (13–14) bears a particularly close resemblance to Nordlinger's (1998) constructive case theory.

Notwithstanding their similar motivations, LFG's f-structures and the GF-tier in SiSx have very different formal properties. The most striking of these is the fact that GFs in SiSx are unlabeled; hence, notions like subject and object are not primitives of the theory. They are defined relationally in terms of a hierarchy of arguments, as in Relational Grammar (Perlmutter & Postal 1977, 1983) – the most direct inspiration for the GF-tier, according to Jackendoff (personal communication). A motivation for this will be given in Section 4.[6]

Another peculiarity of the GF-tier is that it lacks the unlimited embedding found in LFG's f-structures. Each pred in the GF-tier is represented as a self-contained unit. There is no sense in which the pred that corresponds to *like* in (12) is embedded under the one that corresponds to *seem*. The f-structure LFG assigns to the same sentence, on the other hand, virtually mirrors the hierarchical organization of the c-structure from which it is projected:

(15)
$$f_1{:}\begin{bmatrix} \textsc{pred} & \text{`}\textsc{seem}\langle\textsc{xcomp}\rangle\ \textsc{subj}\text{'} \\ \textsc{subj} & f_2{:}\begin{bmatrix}\textsc{pred} & \text{`}\textsc{brad}\text{'}\end{bmatrix} \\ \textsc{xcomp} & f_3{:}\begin{bmatrix} \textsc{pred} & \text{`}\textsc{like}\langle\textsc{subj},\ \textsc{obj}\rangle\text{'} \\ \textsc{subj} & f_2 \\ \textsc{obj} & f_4{:}\ \begin{bmatrix}\textsc{pred} & \text{`}\textsc{janet}\text{'}\end{bmatrix} \end{bmatrix} \end{bmatrix}$$

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[6] Patejuk & Przepiórkowski (2016) argue that a similar move is advantageous for LFG as well. Following Alsina (1996), they show that most GF labels redundantly represent information already available in morphosyntax and s-structure. Borrowing ideas from HPSG (Przepiórkowski 2023 [this volume]), they propose to replace GF attributes by a single ordered deps list which looks a lot like SiSx's GF-tier. This also allows a direct encoding of the functional hierarchy, which is used in LFG analyses of binding (Falk 2001) and control (Bresnan 1982a).

Moreover, since SiSx is not committed to an exhaustive mapping from SYN nodes to the GF-tier, the inventory of GFs can be much smaller than in LFG. Only elements whose morphosyntactic forms are unrevealing about their semantic roles – e.g. direct NP or CP arguments – actually need a representation on the GF-tier (Culicover 2021: chapter 6). This is not the case for adjuncts and (most) obliques, whose θ-roles are transparent in the morphology or choice of preposition. In English, for instance, PPs headed by *near* and *under* are always LOCATIONS while those headed by *during* and *after* are invariably interpreted as TIMES. Correspondence rules for these elements can, thus, be stated directly as relations between SYN and SEM, circumventing the GF-tier (as anticipated in Figure 1).

The GF-tier in SiSx is, therefore, restricted to LFG's CORE GFs (Bresnan 2001: 96): SUBJ, OBJ and OBJ2 (relations 1, 2 and 3 in Relational Grammar). These are the GFs that most strongly justify a tier for GFs in the first place, because they are the typical targets for phenomena like agreement, raising, passive, and structural case-marking– none of which can be stated in terms of direct correspondences between SEM and SYN (Culicover & Jackendoff 2005: 188–189). LFG's NON-CORE functions (e.g. ADJ, OBL_θ, COMP, XCOMP) are not necessary in SiSx.

What this shows is that, all in all, most of the richness that is present in SYN and SEM is absent from the GF-tier, which ends up being a much *simpler* level than LFG's f-structure. This derives from the fact that SiSx builds upon a more radical version of representational economy than the one LFG assumes – one that applies not only to phrase structure, but to ALL LEVELS OF GRAMMAR. If some correspondences *can* be stated as direct relations between SYN and SEM, SiSx can do this without invoking an intermediate mapping through the GF-tier.

This, however, is only possible because SiSx also abandons the assumption of INTERFACE UNIFORMITY (discussed in Section 2), which is pervasive in MGG and survives – albeit in a much lighter fashion – in LFG's version of the correspondence architecture in Figure 2. It is the idea that the mapping to semantics is established uniformly on the basis of GFs that forces LFG to populate f-structure with semantically relevant c-structure information.

SiSx's more sparing use of GFs is partly motivated by the commitment to what Jackendoff (2011a) calls the EVOLUTIONARY CONSTRAINT – namely, the idea that the architecture of grammar should be compatible with a plausible evolutionary scenario. Proponents of SiSx concur with mainstream evolutionary psychologists in assuming that the emergence of human language was gradual, involving a series of incremental steps (protolanguages), each of which offered some adaptive advantage over the previous one (Pinker & Bloom 1990, Corballis 2017, Dennett 2017, Fitch 2017, Boeckx 2017, Martins & Boeckx 2019, de Boer et al. 2020).

Given the absence of a fossil record, one of the main ways to investigate the particular stages of this incremental process is reverse-engineering: i.e. asking what components of language are advantageous without the whole system in place (Jackendoff 1999, Jackendoff & Pinker 2005, Progovac 2016). In this spirit, Jackendoff (2002: 261) speculates that the GF-tier is probably "the latest developing part of the architecture", since its properties are asymmetrically dependent upon the existence of articulated systems of constituent structure and semantics – i.e. the latter two components can exist without the GF-tier, but not vice-versa. It is hard to reconcile the LFG architecture – where f-structures are essential to the mapping between c-structure and semantics – with these considerations.

Regardless of these differences, the point remains that autonomous levels for GFs (as we see in LFG and SiSx) contribute to the overall simplification of the grammar. Insofar as these levels liberate syntax from encoding GFs configurationally, constituent structure can become more concrete. The next section shows that this is an advantage for theories that take psychological plausibility as a goal.

3.3 Surface-oriented and model-theoretic grammars

Like HPSG (Przepiórkowski 2023 [this volume]) and Construction Grammar (Matsumoto 2023 [this volume]), LFG and SiSx are SURFACE-ORIENTED. A model of grammar is SURFACE-ORIENTED if it posits syntactic structures that are directly associated with observable word strings, with a minimum of empty elements and degrees of embedding. In LFG and SiSx, this WYSIWYG flavor is a consequence of the correspondence architecture – which provides *other* levels for encoding GFs and semantic relations – along with principles that enforce representational economy on phrase-structure representations: Economy of Expression in LFG (Bresnan 2001: 91) and the SSH in SiSx.

Surface-orientation is driven by matters of psychological plausibility. Empty elements are not easily detectable from linguistic input. This raises the question of how they come to be learned (as discussed above in connection to the SSH) and inferred in real-time language processing (see Sag & Wasow 2011). The common conclusion is that they are *not learned*, but constitute part of UG. Though this move does solve the learnability problem (albeit by raising the more difficult question of how these elements evolved in humans), it hardly addresses the concern over language processing.

However, learnability and processing issues do not arise if empty elements *can* be inferred on the basis of language-internal evidence. This is arguably the case in situations where invisible structure systematically alternates with visible material, such as gaps in unbounded dependency constructions (see Kluender & Kutas 1993, Clark & Lappin 2011).[7] In these cases LFG and SiSx *do* allow them as a kind of "last resort" to maintain the generality of the mapping between form and meaning (Bresnan 2001: 193; Culicover & Jackendoff 2005: 304).

The status of empty elements in LFG and SiSx is very different from their status in MGG: they are not leftovers of transformations, but directly licensed by CONSTRAINTS. This distinction reflects the contrast between the PROOF-THEORETIC design of MGG and the MODEL-THEORETIC flavor of SiSx, LFG and many other syntactic theories (Pullum & Scholz 2001, Pullum 2013). A PROOF-THEORETIC GRAMMAR (PTG) relies on the technology of stepwise algorithmic derivations to recursively enumerate the infinite set of grammatical expressions in a language. A MODEL-THEORETIC GRAMMAR (MTG), on the other hand, formulates its basic statements as declarative constraints. The objects that satisfy the constraints (i.e. their models, in the logician's sense) are the expressions licensed by the grammar.

The manner of characterizing expressions in PTGs invites the dynamic and procedural metaphors that are routinely employed in the MGG literature. The problem with such locutions is that it is unclear what they should mean in terms of real-time processing. The practical consequence of this has been a gradual stiffening of the competence/performance distinction through the history of MGG.

The MTG formalism avoids all such problems, lending itself to a much more direct relation to processing models (Sag & Wasow 2011, Jackendoff 2007a, 2011b). Since constraints have no inherent directionality, they can be invoked in *any* order. Starting with a fragment of phonology, one can pass through its mappings to syntax and semantics and do the same the other way around. This accounts for the fact that the processor is "opportunistic" and uses diverse types of information as soon as they become available (Acuña-Fariña 2016). It also makes MTGs neutral with respect to production (which goes from semantics to phonology) and comprehension (which goes from phonology to semantics).

Moreover, constraints also yield a monotonic mapping from form to meaning – i.e. there are no destructive operations that throw out information inferable from parts of a structure. This makes MTGs suitable to deal with the grammaticality of linguistic fragments and with the incremental nature of parsing – yet another

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[7] For most of these scenarios, it can also be shown that grammars *with* empty elements are extensionally equivalent to grammars *without* them. This effectively reduces empty elements to notational devices for stating generalizations more directly and reducing the overall complexity of the grammar (see Müller (2018: chapter 19) for discussion). If one assumes a simplicity-based evaluation metric like the one in Chomsky (1951), this notational choice actually has empirical consequences for language acquisition (see Chomsky (1965: 45) for a similar point).

desirable property in light of psychological adequacy (Cahill & Way 2023 [this volume]).

SiSx and LFG can both be naturally stated as MTGs (cf. Blackburn & Gardent 1995, Pullum 2019 for some caveats). This has practical consequences for the general architecture of the grammar. As we will see below, in a full-blown MTG, it is no longer necessary to uphold a rigid distinction between the lexicon and the grammar, because BOTH can be stated in the same format: i.e. as CONSTRAINTS.

4 The structure of the lexicon

Up to now, I have talked mostly about how SiSx and LFG represent the structure of LINGUISTIC OBJECTS. This section turns to the kinds of CONSTRAINTS that are responsible for licensing these objects. A widespread assumption is that these constraints fall into two radically different classes, depending on whether they apply to WORDS and their internal parts or to larger PHRASAL UNITS. This view is famously expressed in LFG's LEXICAL INTEGRITY PRINCIPLE (LIP):

(16) THE LEXICAL INTEGRITY PRINCIPLE (Bresnan & Mchombo 1995: 181): Words are built out of different structural elements and by different principles of composition than syntactic phrases.

LFG enforces LIP by separating the LEXICON from the RULES OF (PHRASAL) GRAMMAR. The latter are responsible for the organization of novel phrases while the former is supposed to register idiosyncrasies as well as capture some partial regularities among stored items (in the form of LEXICAL RULES).[8]

SiSx argues that there is much to be gained by abandoning this distinction. The first step of the argument involves asking WHAT THE LEXICON IS. Due to the MENTALIST commitment, SiSx frames this issue in essentially psycholinguistic terms, taking the lexicon to be whatever the language user has to learn and store

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[8] In its contemporary form, this distinction dates back to Chomsky's (1970) LEXICALIST HYPOTHESIS. In that framework, however, the divide between LEXICAL RULES and RULES OF GRAMMAR overlapped with the distinction between CONSTRAINTS and ALGORITHMS. In a MTG – where ALL rules are stated as constraints – these two kinds of rules can only be distinguished by the types of variables they contain: variables on lexical constraints range over word-like elements and the ones on grammatical constraints range over phrases. LIP is, then, a requirement that constraints containing different types of variables involve fundamentally different relations (i.e. "different principles of combination"): e.g. constraints on word formation should not mention long-distance relationships between items, like the ones found in phrasal grammar. Though this is requirement is formulable in a MTG setting, it is not clear whether it can be empirically justified. See Bruening (2018) for some relevant discussion.

in long-term memory. The argument then goes on to show that a lexicon thus conceived must contain entries of such variety that a sharp distinction between lexical items and grammatical rules becomes artificial (see Jackendoff 1997, Culicover et al. 2017, Jackendoff & Audring 2019, among others). The slippery slope from words to rules of grammar prompts SiSx to view the latter as PART OF the lexicon, as in Construction Grammar (Goldberg 1995, Sag 2012). This looks natural under an MTG design, where lexicon and grammar are equally stated as CONSTRAINTS.

A typical instance of a lexical item is an individual word like *cow*. SiSx, following the Parallel Architecture in Figure 1, treats this as an interface rule, linking a small piece of phonology, a syntactic category and a meaning, as in (17):

(17)
$$\begin{bmatrix} \text{PHON} & \text{cow}_1 \\ \text{SYN} & \text{N}_1 \\ \text{SEM} & \lambda x[\mathbf{cow}'_1(x)] \end{bmatrix}$$

The same format can be used to represent items with idiosyncratic subcategorization properties that do not follow from general linking rules. The verb *depend*, for example, subcategorizes for an NP within a PP headed by *on*, as in (18):

(18)
$$\begin{bmatrix} \text{PHON} & \text{depend}_1\ \text{on}_2\ \varphi_3 \\ \text{SYN} & [_{\text{VP}}\ \text{V}_1\ [_{\text{PP}}\ \text{P}_2\ \mathit{NP}_3]] \\ \text{SEM} & \lambda y[\lambda x[\mathbf{depend}'_1(\textsc{experiencer}{:}x,\ \textsc{theme}{:}y)]](\sigma_3) \end{bmatrix}$$

Italicized elements and Greek letters represent typed variables that must be contextually instantiated in order for the item to be licensed (Culicover 2021). They are what give lexical items their combinatoric potential. Productive morphology receives a similar treatment. Since regular forms *can* be computed online – and MUST be so computed in agglutinative languages like Turkish (Hankamer 1989) – we cannot require every one of them to be stored in the lexicon (Jackendoff 1997, 2002). Therefore, regular affixes must have their own lexical entries with variables specifying the phonology, category and semantics of their putative roots – as was also assumed in American Structuralist models of immediate constituent analysis (Bloomfield 1933). (19) is an entry for the English past suffix.

(19)
$$\begin{bmatrix} \text{PHON} & \varphi_2\text{-ed}_1 \\ \text{SYN} & [_V V_2\text{-}\textsc{past}_1] \\ \text{SEM} & \mathbf{past}_1(\sigma_2) \end{bmatrix}$$

Note that, as far as SiSx is concerned, there is no deep formal distinction between the *syntactic* combinatoriality of the verb in (18) and the *morphological* combinatoriality of the affix in (19). The only difference has to do with the nature of the variable in SYN: NP_3 in (18) is phrasal and V_2 in (19) is not. So SiSx, unlike LFG (see Sadler & Spencer 2004), has no separate MORPHOLOGICAL COMPONENT.

A lexicon conceived in these terms should also contain a variety of multiword entries (Culicover et al. 2017). Among these are idioms with fully specified material on all tiers, such as *kick the bucket.* In SiSx, these expressions can be stored as whole phonological/syntactic units, linked to noncompositional semantics, as in (20). We know that this particular idiom instantiates the canonical syntactic structure of an English VP because *kick* inflects just like an ordinary verb (e.g. *John kick**ed** the bucket*, *John **will** kick the bucket*, etc.).

(20)
$$\begin{bmatrix} \text{PHON} & \text{kick}_1\ \text{the}_2\ \text{bucket}_3 \\ \text{SYN} & [_{\text{VP}}\ \text{V}_1\ [_{\text{NP}}\ \text{Det}_2\ \text{N}_3]]_4 \\ \text{SEM} & \lambda x[\mathbf{die}'_4(\textsc{patient}{:}x)] \end{bmatrix}$$

Like the verb in (18) and the affix in (19), some idioms have variables that grant them combinatorial potential of their own. These are cases like *stab NP in the back*, *put NP on ice* and *catch NP's eye*. Here is a lexical entry for this last one:

(21)
$$\begin{bmatrix} \text{PHON} & \text{catch}_1\ \varphi_2\text{'s}_3\ \text{eye}_4 \\ \text{SYN} & [_{\text{VP}}\ \text{V}_1\ [_{\text{NP}}\ NP_2\text{-}\textsc{genitive}_3\ \text{N}_4]] \\ \text{SEM} & \lambda x[\mathbf{notice}'(\textsc{experiencer}{:}\sigma_2, \textsc{theme}{:}x)] \end{bmatrix}$$

The entries in (20) and (21) pose a kind of ordering paradox for theories that assume a radical separation between grammar and lexicon, as prescribed by the LIP. The information that *kick the bucket* and *catch NP's eye* are VPs has to be stated *in* the lexicon, because their semantics is idiosyncratic. However, the phrase-structure rule that generates VPs can only apply *outside* the lexicon.

In addition to these cases, the lexicon also has to include a class of CONSTRUCTIONAL IDIOMS that use normal syntax to unusual (i.e. noncompositional) semantic ends (Jackendoff 1997, 2002). An example is the SOUND+MOTION CONSTRUCTION in (22) (Levin & Rappaport Hovav 1995, Goldberg & Jackendoff 2004):

(22) The car [$_{\text{VP}}$ rumbled past Sue].
$\mathbf{go}'(\textsc{theme}{:}\text{the-car}, \textsc{path}{:}\text{past-Sue}, \textsc{effect}{:}\mathbf{rumble}'(\text{the-car}))$

Syntactically, the VP in (22) is merely a sequence of a verb followed by a PP. Its semantics is unusual because the verb is not interpreted as a functor over the PP, but as specifying the EFFECT of a motion that is not codified by any of the words in the sentence. The effect of the motion, is, moreover, predicated of whoever is interpreted as the THEME (i.e. the entity undergoing the motion). A lexical entry with these properties is sketched in (23).

(23) SOUND+MOTION CONSTRUCTION (adapted from Culicover 2013b: 42):

$$\begin{bmatrix} \text{SYN} & [_{VP}\ V_1\ PP_2] \\ \text{SEM} & \lambda x[\mathbf{go'}(\textsc{theme}{:}x, \textsc{path}{:}\sigma_2, \textsc{effect}{:}\sigma_1(x))] \end{bmatrix}$$

What is peculiar about constructional idioms is that the SYN tier in their lexical entries consists *entirely* of variables that are completely unlinked to phonology.[9] This makes them much more rule-like than word-like.[10] However, since their interpretation does not follow from general principles, they have to be explicitly learned and stored just like words are (see Culicover 1999).

Two other examples of constructional idioms along with the relevant lexical entries proposed in the SiSx literature are given below: (24) represents the DITRANSITIVE CONSTRUCTION (Jackendoff 1990, Goldberg 1995, Asudeh et al. 2014); and (25) represents the PROXY CONSTRUCTION (Nunberg 1979, Jackendoff 1997, Varaschin 2020), wherein the meaning of NP is coerced into a proxy of its literal denotation.

(24) DITRANSITIVE CONSTRUCTION (adapted from Culicover 2021: 40):

a. Brad kicked Janet the ball.

b. $$\begin{bmatrix} \text{PHON} & \varphi_1\ \varphi_2\ \varphi_3 \\ \text{SYN} & [_{VP}\ V_1\ NP_2\ NP_3] \\ \text{SEM} & \lambda x.\mathbf{transfer'}(\textsc{source}{:}x, \textsc{goal}{:}\sigma_2, \textsc{theme}{:}\sigma_3, \textsc{means}{:}\sigma_1(x)) \end{bmatrix}$$

(25) PROXY CONSTRUCTION (adapted from Varaschin 2020: 11):

a. I put ⟨ *book-by* ⟩ Keynes on the top shelf.

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[9] The existence of "defective" lexical items lacking terms in some level is not surprising in a correspondence architecture. Jackendoff (1997: 94) notes that there are words with phonology, syntax and no meaning (e.g. expletives), others with meaning, phonology and no syntax (*hello, ouch, yes*) and even sequences with nothing but phonology (*e-i-e-i-o, inka-dinka-doo, tra-la-la*). All of these are clearly stored in long-term memory and recognized in the same way typical words are. Moreover, they fit into the phonotactic and stress patterns of English. This indicates that, though some of them have no syntax, they are still part of language. The only reason for excluding them from the lexicon is syntactocentrism – which is abandoned in SiSx and LFG.

[10] This is what drives Asudeh et al. (2013) to propose that idioms like (23) are not derived from lexical entries, but from phrase-structure rules annotated with templates. Other idioms, like the WAY CONSTRUCTION (e.g. *Sue laughed her way out of the restaurant*), would be lexically encoded by individual words (in that case, by *way*). However, it is not clear how this account extends to idioms like (20–21), which are specified by *discontinuous* portions of morphosyntax. Space prevents me from exploring further details of LFG's template-based accounts of constructions.

b. $\begin{bmatrix}\text{SYN} & \mathit{NP}_1 \\ \text{SEM} & \textbf{proxy}'(\sigma_1)\end{bmatrix}$

Language turns out to be full of constructional idioms like these (see Goldberg 1995, Jackendoff 1997, 2008, Culicover 1999). However, insofar as recognizing their existence commits us to syntactically complex lexical items without phonology, nothing stops us from seeing general syntactic and interface rules – usually thought of as part of the GRAMMAR – in the same way. The context-free rule for a transitive VP can be construed as a declarative schema for licensing a particular configuration of labeled nodes, as in (26):

(26) TRANSITIVE VP CONSTRUCTION (adapted from Jackendoff 2002: 180):
$\begin{bmatrix}\text{SYN} & [_{VP}\; V\; NP\;]\end{bmatrix}$

As far as SiSx is concerned, this is simply one of the possibilities allowed by the system: a lexical item with no idiosyncratic phonology or semantics, just syntactic category variables arranged in a particular configuration. In this respect, SiSx deviates from variants of Construction Grammar which require every syntactic configuration to be paired with a meaning (e.g. Goldberg 1995).

Default principles of compositional type-driven interpretation can also be represented as lexical items which license a maximally general correspondence between syntactic variables and meaning variables of the appropriate type. (27) represents the two possible scenarios of Heim & Kratzer's (1998) Functional Application rule (where X, Y and Z are variables over syntactic categories).[11]

(27) COMPOSITIONALITY CONSTRUCTIONS:
a. $\begin{bmatrix}\text{SYN} & [_{X}\; Y_1\; Z_2] \\ \text{SEM} & \sigma_1(\sigma_2)\end{bmatrix}$ b. $\begin{bmatrix}\text{SYN} & [_{X}\; Y_1\; Z_2\;] \\ \text{SEM} & \sigma_2(\sigma_1)\end{bmatrix}$

Likewise, the main intuition guiding linking hierarchies – such as the one in LFG's Lexical Mapping Theory (Bresnan & Kanerva 1989) – can also be formalized, within SiSx, as constructions that establish a correspondence between GF variables and SEM variables. (28) represents the rule that says that the highest thematic argument maps to the first GF.

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[11] These general constraints on form and interpretation do not need to be instantiated by ALL grammatical expressions in a language. Many of them are not satisfied in idioms, for instance. For a linguistic object to be licensed in SiSx, it suffices that each of its terms and correspondences fully instantiate SOME constraint (Culicover 2021). This entails that a linguistic object can fail to satisfy a given constraint and still be grammatical AS LONG AS there is some other constraint in the grammar which it satisfies. For instance, the idiom in (22) fails to meet the compositional constructions in (27). Since there is another (more specific) construction which it satisfies (the SOUND+MOTION CONSTRUCTION in (23)), SiSx predicts that (22) is grammatical.

(28) LINKING CONSTRUCTION (adapted from Culicover & Jackendoff 2005: 185):

$$\begin{bmatrix} \text{GF} & [_{\textsc{pred}}\ GF_1\ (> ...)]_2 \\ \text{SEM} & \sigma_2(\theta{:}\sigma_1, ...) \end{bmatrix}$$

Correspondences between GFs and SYN – which are accomplished by functional annotations in LFG – can be stated as abstract lexical items as well. The canonical correspondence for SUBJECTS and (transitive) OBJECTS in English are (29a) and (29b), respectively:

(29) ARGUMENT STRUCTURE CONSTRUCTIONS:

$$\text{a.} \begin{bmatrix} \text{SYN} & [_S\ NP_1\ \ VP_2]_3 \\ \text{GF} & [_{\textsc{pred}}\ GF_1(> ...)]_{2,3} \end{bmatrix} \qquad \text{b.} \begin{bmatrix} \text{SYN} & [_{VP}\ V_2 NP_1]_3 \\ \text{GF} & [_{\textsc{pred}} GF > GF_1]_{2,3} \end{bmatrix}$$

In this set-up, the PASSIVE can be seen as a more complex strategy for linking the GF-tier to SYN, as in (30) below. The same applies to relation-changing constructions in other languages (e.g. applicatives, anti-passives) (Culicover 2009).

(30) PASSIVE CONSTRUCTION (adapted from Culicover & Jackendoff 2005: 203):

$$\begin{bmatrix} \text{PHON} & \varphi_1\ (\text{by}_2\ \varphi_3) \\ \text{SYN} & [...\ V\text{-}\textsc{passive}_1\ ([_{PP}\ P_2\ NP_3])]_4 \\ \text{GF} & [_{\textsc{pred}} GF_3 > [_{\textsc{pred}}\ GF]_{1,4}] \end{bmatrix}$$

The construction in (30) looks very much like a non-derivational version of the Relational Grammar account of passivization (Perlmutter & Postal 1977). It expresses two fundamental intuitions: (i) that the first GF (i.e. the "logical subject") is "demoted" to an optional *by*-phrase (without disrupting the link between this GF and its θ-role, as defined by (28)); and (ii) that the second GF gets mapped to SYN like a typical SUBJECT would in virtue of (29a). This last result is accomplished by adding a second pair of brackets around the second GF.[12] A concrete example of a linguistic object which instantiates (30) is given in (31):

(31)

$$\begin{bmatrix} \text{PHON} & \text{The-cake}_1\ \text{was-eaten}_2\ \text{by}_3\ \text{Hector}_4 \\ \text{SYN} & [_S\text{NP}_1[_{\text{VP}}\text{V-}\textsc{passive}_2[_{\text{PP}}\text{P}_3\text{NP}_4]]_5] \\ \text{GF} & [_{\textsc{pred}}\ \text{GF}_4 > [_{\textsc{pred}}\ \text{GF}_1]_{2,5}] \\ \text{SEM} & \textbf{eat}'_{2,5}(\textsc{agent}{:}\text{hector}_4,\ \textsc{theme}{:}\text{the-cake}_1) \end{bmatrix}$$

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[12] This also happens to be the main technical reason why GFs in SiSx are unlabeled. If GFs were defined in terms of substantive roles (e.g. SUBJ, OBJ), as in LFG, a constructional account of relation-changing rules like PASSIVE would involve replacing one function name by another. This would violate monotonicity and Kaplan & Bresnan's (1982) DIRECT SYNTACTIC ENCODING principle. LFG avoids this problem by stating PASSIVE as a LEXICAL RULE (Bresnan 1982c). For evidence that lexical accounts of argument structure (like the one found in LFG) are superior to the SiSx constructional account sketched here, see Müller (2013, 2018). For a lexical account of PASSIVE in SiSx (which resembles the LFG one), see Culicover (2021).

SiSx's rule-like lexical entries can play two roles in the grammar: a GENERATIVE ROLE, where they are used in on-line processing to derive novel structures *via* UNIFICATION with other lexical entries; and a RELATIONAL ROLE, where they function like nodes in an inheritance hierarchy, "lending" their structure to other independently stored items (Jackendoff & Audring 2019).

The relational role of lexical entries can be defined in terms of ENTAILMENT between separate constraints stored in the lexicon. A lexical entry α entails an entry β *iff* every linguistic object which is a model of α is a model of β. When a specific lexical entry α entails a more general entry β we can say that α inherits structure from β. In this sense, the *kick the bucket* idiom in (20) inherits structure from the more general VP construction in (26), which, in turn, inherits from a more abstract HEAD-COMPLEMENT CONSTRUCTION, akin to the head-complement schema of HPSG (Pollard & Sag 1994: 33–34; Przepiórkowski 2023: 1867–1868, 1878 [this volume]).

Likewise, if particular passive or past tense verbs happen to be overtly stored due to high frequency, they will inherit from the past tense and passive schemas in (19) and (30). These relational links can be represented in an inheritance hierarchy, where the more dominated nodes entail the less dominated ones. SiSx assumes that, other things being equal, a lexical item with relational links should be easier to store and learn than one without such links (see Jackendoff 1975).

There is an obvious connection between this relational function of lexical entries and the use of templates in LFG and constructions in HPSG/SBCG (Sag et al. 2003, Dalrymple et al. 2004, Asudeh et al. 2013). These devices all do the work of lexical rules in earlier approaches going back to Chomsky (1970). But there is a difference: since many of SiSx's abstract entries can *also* be used generatively, unmarked lexical properties (e.g. regular morphology, subcategorization) can, *in principle*, be kept out of individual lexemes. There is no need to list separately the active, passive and regular past tense forms for ALL verbs. These forms can be "built" by unification with abstract items like (29b), (30) and (19) (respectively) (Culicover & Jackendoff 2005: 188). In LFG terms, it is as if schemas like (29b), (30) and (19) were, at once, templates that can be invoked in particular lexical entries and rules to license novel structures that are not in the lexicon.

The SiSx view, is, in sum, that rules of grammar ARE lexical items. There is a *continuum* from stereotypical words, which specify fully linked phonology, syntax, and semantics (cf. (17)), through idioms with a few variables (cf. (21)), constructional idioms with *nothing but* variables (cf. (23–25)) to fully general rules (cf. (26–30)), from which many constructions can inherit structure. All of these things are stated in the same format: as declarative schemas, either licensing structures at a single level (e.g. (26)) or establishing correspondences between various levels (e.g. (17)). Theories like LFG, which adopt a rigid lexicon/grammar distinction, must draw an artificial line somewhere in this *continuum*.

5 Constraints outside of the grammar

If language is indeed integrated into the larger ecology of the mind, it is expected that grammatical constraints are not all there is to explain the (un)acceptability of sentences. Since Miller & Chomsky (1963), the influence of extra-grammatical factors on linguistic judgments has been a major topic of investigation – one that is very much relevant to the pursuit of the SSH. In this section, I explore this issue in connection with the phenomena of unbounded dependencies (UDs).

The hallmark of UDs is the presence of a gap, by means of which a constituent in a non-canonical position (i.e. a filler) acquires its semantic role. In SiSx – as in HPSG (Pollard & Sag 1994: 161) – the effect of a gap can be reproduced by a lexical item that establishes a correspondence between an arbitrary phonological sequence containing the empty string (ε), a constituent containing an XP and a property which results from λ-abstraction over whatever semantics the XP would have (see Muskens 2003 for a similar proposal in Categorial Grammar):

(32) gap construction: (adapted from Culicover 2021: chap.7)

$$\begin{bmatrix} \text{PHON} & /\ldots\ \varepsilon\ \ldots/_2 \\ \text{SYN} & [\ldots\ \text{XP}\ \ldots]_2 \\ \text{SEM} & \lambda z[\sigma_2(z)] \end{bmatrix}$$

SiSx also needs a phrase-structure construction akin to (26) in order to license fillers in the left-periphery of clauses. (33) accomplishes this effect:

(33) filler construction:

$$\begin{bmatrix} \text{SYN} & [_{S'}\ \mathit{YP}\ \mathit{S}\ ] \end{bmatrix}$$

Consider how this works in the simple case of topicalization in (34) (I ignore the GF-tier and the information structure status of topics). The construction in (32) licenses an empty NP as the complement of *Janet kissed*, which, in turn, gets interpreted as a property (i.e. $\lambda z[\mathbf{kiss}'(\textsc{agent}\text{:janet}, \textsc{theme}\text{:}z)]$). (33) licenses a filler (i.e. *Brad*) in sentence-initial position. In virtue of the compositional construction in (27b), the property attained by (32) is applied to the semantics of the filler, yielding the right interpretation.

(34)

$$\begin{bmatrix} \text{PHON} & \text{Brad}_1,\ /\text{Janet}_2\ \text{kissed}_3\ \varepsilon/_4 \\ \text{SYN} & [_{S'}\ \text{NP}_1\ [_{S}\ \text{NP}_1\ [_{VP}\text{V}_3\ \text{NP}]]_4] \\ \text{SEM} & \lambda z[\mathbf{kiss}'_{3,4}(\textsc{agent}\text{:janet}_2, \textsc{theme}\text{:}z)](\text{brad}_1) \end{bmatrix}$$

A similar structure is ascribed to the *wh*-question in (35). I follow Culicover (2021) in positing a quantifier-like entry for the *wh*-word, as in (36).

(35) [What$_i$ [did [Sue say Don bought t_i]]]?

(36) $\begin{bmatrix} \text{PHON} & \text{what}_1 \\ \text{SYN} & NP_1 \\ \text{SEM} & \lambda P[\mathbf{WH}x_1(P(x))] \end{bmatrix}$

The GAP CONSTRUCTION licenses a property interpretation for the portion of (35) which excludes the *wh*-phrase (*Sue say Don bought ε*). This property, in turn, is fed as an argument to the **WH** quantifier (licensed in initial positon by (33)), which ends up binding a variable corresponding to the gap. (37) illustrates the β-reductions in the SEM tier of (35):

(37) $\lambda P[\mathbf{WH}x(P(x))](\lambda z[\mathbf{say}'(\textsc{agent}\text{:sue}, \textsc{theme}\text{:}\mathbf{buy}'(\textsc{agent}\text{:don}, \textsc{theme}\text{:}z))])$
$\rightarrow \mathbf{WH}x(\lambda z[\mathbf{say}'(\textsc{agent}\text{:sue}, \textsc{theme}\text{:}\mathbf{buy}'(\textsc{agent}\text{:don}, \textsc{theme}\text{:}z))](x))$
$\rightarrow \mathbf{WH}x(\mathbf{say}'(\textsc{agent}\text{:sue}, \textsc{theme}\text{:}\mathbf{buy}'(\textsc{agent}\text{:don}, \textsc{theme}\text{:}x)))$

The constructions (32–33) and standard principles of type-driven interpretation are all SiSx needs to model the syntactic and semantic effects of UDs.[13] The dependency between the filler and the gap is represented as variable-binding, while a null XP in SYN guarantees that the subcategorization requirements of the head that licenses the filler are locally satisfied.

However, since this mechanism assumes that gaps can be freely introduced into representations, it does not explain why sentences like (38) are bad:

(38) * Who$_i$ does that Brad admires t_i disturb Janet?

It is entirely possible to derive a perfectly well-formed structure for (38) given the principles laid out so far. Most approaches to UDs take this "overgeneration" to be a flaw and attempt to encode into the grammar restrictions that prevent gaps from occurring in ISLAND environments like (38) (Ross 1967).

Kaplan & Zaenen's (1989) LFG account of island constraints exemplifies this tendency. Their proposal represents UDs in terms of functional identity in f-structure (Kaplan 2023 [this volume]). So, for the sentence (35) above, the identification between the focalized *wh*-word and the OBJ of *buy* is accomplished by the equivalence (*f* FOCUS)=(*f* COMP OBJ). This expression is an instantiation of a

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[13] Note incidentally that the type-driven rules in (27) make the presence of subject gaps in sentences like *Who sang?* unnecessary. In those cases, the **WH** quantifier can combine directly with the bare property semantics of the VP, with no need to invoke the GAP CONSTRUCTION.

more general functional uncertainty equation which is annotated to the phrase-structure rule that introduces discourse functions (namely TOPIC or FOCUS). The particular equation Kaplan & Zaenen (1989: 153) suggest for English is (39).

(39) $(f\ \text{DF}) = (f\ \{\text{COMP}, \text{XCOMP}\}^{*}\ \text{GF}{-}\text{COMP})$

What (39) says is that the f-structure for any discourse function (DF) will be identical to a subordinate f-structure somewhere along a (possibly empty) path of COMP and XCOMP functions, as long as that path terminates in a GF function which is not a COMP. The specifications on the BODY (i.e. the middle) and on the BOTTOM of uncertainty paths like (39) are how LFG records restrictions on UDs.

For example, an identification between the filler and the gap in (38) requires passing through SUBJ, which is not specified as a possible attribute in the body of (39). This accounts for SUBJECT ISLAND violations in general. Likewise, COMPLEX NP ISLANDS like (40) are also covered, because RELMOD (the GF Kaplan & Zaenen (1989) assign to relative clauses) is not designated on the body of (39) either.

(40) * What castle$_i$ does Janet know the strange man [who owns t_i]?

From the point of view of SiSx, the functional uncertainty formalism is unobjectionable as a device to model UDs. However, it is not clear whether it should really embody substantive restrictions to account for the unacceptability of UDs in syntactic terms. Upon closer examination, there does not seem to be a purely grammatical characterization of precisely the contexts in which certain patterns of UDs are ruled out by speakers. The explanation for most (if not all) island constraints must, therefore, lie outside of the grammar, in pragmatics, discourse structure or in processing complexity. A growing body of literature points to this conclusion (Hofmeister et al. 2007, Hofmeister & Sag 2010, Hofmeister et al. 2013, Kluender 1991, 1992, 2004, Kluender & Kutas 1993, Sag et al. 2007, Chaves 2013, Chaves & Dery 2014, 2019, Culicover 2013a,b). In what follows, I briefly summarize some of the empirical evidence against grammatical theories of islands. Space limitations prevent me from getting into the details of particular performance-based alternatives.

The suspicion that something is amiss in purely grammatical accounts of island phenomena comes from the observation that concrete proposals tend to be both too weak and too strong. The constraint in (39), for example, is too weak because it fails to explain real contrasts like (41–42), originally due to Erteschik-Shir (1973: 84).

(41) a. What$_i$ did Janet claim that veganism can do t_i for you?
b. ?? What$_j$ did Janet transcribe that veganism can do t_j for you?

(42) a. What$_i$ did Frank say that Brad would like t_i for lunch?
    b. ?? What$_j$ did Frank snarl that Brad would like t_j for lunch?

The equation in (39) predicts the b-cases to be just as good as the a-cases since, in both of them, the value for the FOCUS attribute is identified with the value of OBJ through a path consisting of a single COMP – exactly as in (35). That is, the a-cases and b-cases both contain (f FOCUS)=(f COMP OBJ) in their f-descriptions.

It is, of course, possible to assign different GFs to the complement of *transcribe* and *snarl* other than COMP (something like ISLANDCOMP). In this case (41b) and (42b) would be excluded due to the body constraint in (39). But this move is simply a stipulation – one that is hard to imagine how a child could learn. The ultimate explanation might be related to the lexical semantics of the verbs (i.e. UDs are impossible with verbs that specify *manner* of speaking) or simply to frequency (*claim* and *say* are more frequent than *transcribe* and *snarl*). Whatever the ultimate truth is, no apparent syntactic difference – in f-structure or otherwise – can be identified for pairs such as (41–42).

There are also cases in which grammatical principles that purport to account for island phenomena are too strong – i.e. they exclude sentences that are actually acceptable. I observed above that (39) derives the effects of SUBJECT ISLANDS and COMPLEX NP ISLANDS. However, UDs whose gaps are contained within Subjects and Complex NPs are reasonably acceptable under suitable conditions (Kluender 2004, Sag et al. 2007, Chaves 2013), as the b-cases in (43–44) show:

(43) a. * Who$_j$ does [that you baked ginger cookies for t_j] irritate you?
    b. Who$_i$ does [baking ginger cookies for t_i] irritate you?

(44) a. * Who$_i$ did Phyllis hear the claim [that Bob is dating t_i]?
    b. Who$_j$ did Phyllis make the claim [that Bob is dating t_j]?

The equation in (39) rightly excludes (43a) and (44a). The problem is that, by the same token, it also bars (43b) and (44b). Since the a-b pairs are functionally indistinguishable – the bracketed strings map to the same GFs (SUBJ in (43) and RELMOD in (44)) – the real explanation for the contrasts must lie elsewhere.

Kluender (2004) argues that the contrast in (43) is due to a difference in the amount of discourse referential processing. In (43a), the SUBJECT is a finite clause, which introduces the reference to a temporal event. This reference is absent for the non-finite form in (43b), which makes the sentence in question less complex in processing terms (see Gibson (2000) for a similar account).

For (44), Culicover & Jackendoff (2005) suggest an explanation along the lines of Kroch (1998): (44a) presupposes the existence of *the claim* while (44b) doesn't.

The unacceptability of (44a) follows from a general principle which says that a gap cannot be referentially dependent on an operator if its reference is part of a presupposition in the discourse. This principle extends to contrasts like (45), which are also hard to account for in purely syntactic terms.

(45) a. * Who$_i$ did he buy that picture of t_i? (presupposes there is a picture)
b. Who did he buy a picture of t_i? (no presupposition)

The debate on whether all island constraints reduce to extra-grammatical factors is still very much ongoing (see Newmeyer (2016) for a useful survey). What this section meant to illustrate is that the SiSx view – which might seem too unconstrained at first glance – could turn out to be just what the data requires. If there is no grammatically coherent characterization of when UDs are unacceptable, then island constraints should not be built into the rules that license UDs (in SiSx terms, they should not be registered as conditions on the GAP CONSTRUCTION). On this view, sentences that incur island violations are not technically ungrammatical, but merely unacceptable for performance-related reasons.[14]

The overall view SiSx ends up with is this: Explanations about our intuitions regarding which structures are possible divide between grammatical constraints (as recorded in the lexicon) and extra-grammatical factors (pragmatics, processing, etc.). The former tend to correlate with sharp judgments, while the latter tend to show more variability and dependence on contextual factors (see Culicover 2013c). Sources of universals are mostly confined to extra-grammatical factors and to the pressure to reduce constructional complexity (Culicover 2013b). These correspond to the THIRD FACTOR properties of Chomsky (2005).

This leads to a very minimalist conception of UG – as it happens, one that conforms (in an unorthodox way) to what Baker (2008: 353) calls the BORER-CHOMSKY CONJECTURE: the hypothesis according to which all parameters of variation among languages are attributed to individual properties of lexical items. In this respect, SiSx is closer to MGG than to LFG. But the difference between SiSx and MGG is that, as discussed in Section 4, lexical items are highly structured

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[14] Extra-grammatical accounts of island constraints have a long history in SiSx. They go as far back as Jackendoff & Culicover (1972), In this early paper, the authors propose that "perceptual strategy constraints on acceptability" explain otherwise puzzling contrasts like (i):

(i) a. Who$_i$ did John give a book to t_i?
b. *? Who$_j$ did John give t_j a book?

Note that (i) is also not explained by Kaplan & Zaenen (1989), since the equation required to establish the dependency in (ib) – i.e. (f FOCUS) = (f OBJ) – satisfies the constraint in (39).

and include what are traditionally thought of as rules of grammar. The result is that most aspects of speakers' knowledge of language end up being potentially subject to variation.

6 What can SiSx and LFG learn from each other?

The purpose of this chapter was to survey the theoretical landscape of SiSx and compare it to LFG. This exercise revealed that both approaches seek to reconcile formal theories of grammar and psychological reality – a common goal that leads them to adopt similar architectures and analyses for particular phenomena.

However, despite these programmatic and architectural similarities, the two theories differ in important respects. Many of these differences stem from SiSx's radical commitment to representational economy, which is sustained even when this entails messier and less systematic interfaces. Another source of discrepancies is the explicit recognition, on the part of SiSx, of extra-grammatical influences on linguistic judgments, as discussed in Section 5.

Insofar as SiSx posits fewer constraints and fewer representational devices, less knowledge about abstract linguistic structure (of all kinds) is attributed to learners. This reduces the impulse to posit rich principles of UG, which, in turn, alleviates some of the burden on evolutionary accounts of the language faculty (Jackendoff 1999, 2002, Jackendoff & Pinker 2005). A similar concern with evolutionary adequacy drives current Minimalist work in MGG (Hornstein 2009, Berwick & Chomsky 2015). This does not seem to be much of a worry in LFG, which is more preoccupied with providing a formally precise and computationally tractable framework.

There is sometimes a trade-off between formal refinement and the general goal of unification with other sciences. As we saw in Section 3, the fact that the mapping from form to meaning can bypass the GF-tier in SiSx helps integrating the theory into gradualist scenarios of language evolution, given that it is implausible that stages of protolanguage had anything like abstract GFs (Jackendoff 1999, 2002, Progovac 2016). Since LFG makes the mapping to semantics critically dependent on f-structure, it is hard to imagine a story of how these simpler sound-meaning pairings could have existed in the evolutionary antecedents of language. On the other hand, LFG's rich conception of f-structure lends itself to a much more complete and computation-friendly formalization, which makes the theory more easily testable.

SiSx and LFG can, therefore, learn a lot from each other. LFG can profit from SiSx's more ambitious aspiration of connecting linguistics to human biology.

This implies seeking theories of language which are not only descriptively and explanatorily adequate, but which also offer the prospect of integration with plausible evolutionary scenarios. Simpler Syntax, in turn, can benefit from a number of the virtues found in LFG, such as: (i) the development of a formally precise and fully explicit architecture which can feed computational applications and simulations; (ii) the great variety of typologically oriented work which constantly submits the theory's formal assumptions to the test of descriptive adequacy (Part VI).

Once SiSx and LFG assimilate each other's merits, some of the differences between them might diminish and some others might become even sharper. Regardless of the outcome, the process of cross-theoretical comparison is a fruitful one, as it often leads to formal innovations and surprising discoveries about the foundations of linguistic theory.

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Chapter 43

LFG and Tree-Adjoining Grammar

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This chapter gives an introduction to Tree-Adjoining Grammar (TAG) and draws some comparisons with Lexical Functional Grammar (LFG). It is primarily aimed at those familiar with LFG who are looking to learn about TAG and see where the two formalisms differ/overlap, but the comparisons will also be of interest to those coming from a TAG background. After introducing TAG, the chapter considers questions of generative capacity, lexicalisation, and the factoring of redundancies from grammars. It then concludes by illustrating the potential for combining LFG and TAG, and discusses the theoretical implications of doing so.

1 Introduction and roadmap

The purpose of this chapter is to give an introduction to some of the properties of Tree-Adjoining Grammar (TAG: Joshi et al. 1975, Joshi & Schabes 1997, Abeillé & Rambow 2000, Joshi 2005; Kallmeyer 2010: ch. 4) and to draw some comparisons with Lexical Functional Grammar (LFG: Kaplan & Bresnan 1982, Bresnan et al. 2016, Dalrymple et al. 2019; Belyaev 2023b [this volume]). It is primarily aimed at those familiar with LFG who are looking to learn about TAG and see where the two formalisms differ/overlap, but the comparisons will also be of interest to those coming from a TAG background (although details of the LFG formalism will not be covered – the interested reader is directed to the references above and other chapters in this volume).

A TAG is a mathematical formalism for describing a set of trees, just as a context-free grammar (CFG) is a mathematical formalism for describing a set of strings. Unlike a CFG, which generates or recognises a string by repeatedly rewriting symbols until the target string is produced, a TAG does so by combining members from a starting set of ELEMENTARY TREES using two operations

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(called SUBSTITUTION and ADJUNCTION) until a tree whose yield is the target string is produced. This gives TAGs a greater generative capacity than CFGs, which is why they are of particular interest to researchers in natural language syntax: since Shieber (1985), we have known that the complexity of natural language syntax exceeds the context-free space which CFGs are capable of describing. In Section 2, I will briefly discuss this finding and the choice it has forced modern linguistic theories to make regarding their formal foundations. Section 4 delves more deeply into the generative power of TAG and compares it to that of LFG.

When TAG is used in a linguistic capacity, a number of properties are generally added to the basic formalism in order to better align it with certain theoretical assumptions and to enable more natural or transparent analyses of particular grammatical phenomena (e.g. the inclusion of feature structures on nodes to facilitate an analysis of agreement). In Section 3, I introduce some of the details of the TAG formalism along with these linguistically-motivated theoretical assumptions.

One important property generally assumed in linguistic applications of TAG is known as LEXICALISATION, the property whereby each of the basic structures of a grammar is associated with a single lexical item. Lexicalised grammars purportedly have a number of desirable traits, and I discuss lexicalisation in more detail in Section 5. This property sets TAG apart from CFG-based formalisms such as LFG, since the latter cannot in general be lexicalised – a perhaps surprising result given the lexical focus of LFG.

Section 6 briefly compares the TAG and LFG approaches to the factoring out of redundancies from grammars. TAG makes use of a so-called METAGRAMMAR, a formal system used to produce grammars, which can capture high-level generalisations and make grammar engineering easier. LFG uses TEMPLATES, which are part of the grammar proper, and allow pieces of linguistic description to be given names and reused.

Lastly, Section 7 considers the possibility of incorporating a TAG into the LFG architecture, replacing the standard CFG-based description of c-structure. This offers fertile new analytical possibilities, and has pleasing consequences for the descriptive power of LFG more generally, since it allows templates to be extended to the domain of phrase structure, opening the door to a fully constructional LFG.

2 Moving beyond context-free grammars

Context-free grammars have played (and continue to play) a major role in the development of syntactic theory at least since their formal elaboration in the

1950s (Chomsky 1956), with their conceptual roots going back even further (at least to e.g. Harris 1946, Wells 1947). However, there was also always a sneaking suspicion that natural language syntax was formally more complex than CFGs could describe. Nevertheless, by the early ’80s there had been no successful proof of this fact (Pullum & Gazdar 1982). Bresnan et al. (1982) demonstrated that the presence of cross-serial dependencies means that the dependency structure of Dutch requires more than context-free power to describe, although owing to the lack of morphological marking of such dependencies, the *string* language of Dutch remains context free. It turns out, however, that Swiss German exhibits the same cross-serial dependencies, but its nouns are case-marked, and since different verbs can assign different cases to their objects, this means that the dependencies show up in the string language as well. Thus, greater-than-context-free power is definitely needed to describe Swiss German (Shieber 1985). Since there is no reason to suspect that speakers of Swiss German are biologically distinct from speakers of other languages, or that some people would be intrinsically unable to learn Swiss German as a first language, this means that the human language faculty generally allows for languages which require greater than context-free power to describe, and so CFGs alone are inadequate as the basis of a grammatical formalism.

Given this fact, there are two different kinds of response for the syntactic theorist. We can either

1. replace the CFG with something more powerful; or
2. beef up the CFG with something extra, so that the *combination* is more powerful.

Chomskyan generative grammar had already taken the second approach from the start: the addition of transformations to a CFG base pushes the formalism well beyond context-freeness, into the space of Type-0, unrestricted grammars (Peters & Ritchie 1973). LFG similarly adds something extra to the CFG component: in this case, a separate level of representation, f(unctional)-structure; the combination of the two takes the formalism as a whole at least into the Type-1, context-sensitive space (Berwick 1982 – although see Section 4).

However, in order to account for cross-serial dependencies, we do not need a full-blown context-sensitive (or even more powerful) grammar. Instead, we only need a more modest MILDLY CONTEXT-SENSITIVE grammar (Joshi 1985). Such grammars have the useful property, shared with context-free grammars, of being parsable in polynomial time, unlike the (worst case) exponential parsing time of context-sensitive grammars (Joshi & Yokomori 1983, Vijay-Shanker & Joshi 1985), though they still go beyond the expressive power of CFGs in permitting the description of cross-serial dependencies. Responses to the challenge of the non-context-freeness of natural language which take approach number 1 above, and replace the CFG wholesale, tend to do so with a formalism which is explicitly mildly context sensitive, therefore, rather than anything more powerful. One example of this is Combinatory Categorial Grammar (CCG: Steedman 1987, 2000); another is TAG.[1]

3 An introduction to TAG

A TAG is a tree rewriting system which consists of a set of ELEMENTARY TREES and the two operations of SUBSTITUTION and ADJUNCTION for combining them. Substitution simply inserts one tree at the frontier of another (at a non-terminal node), while adjunction inserts a tree *inside* another, attaching it at a non-frontier node (more formal definitions of these processes will be given below).[2]

Most linguistic work in TAG now assumes a LEXICALISED version, LTAG (Schabes et al. 1988), in which each tree is anchored by, i.e. has as its terminal node(s), a single lexical item (which may still consist of several words, as in the case of phrasal verbs, idioms, etc.). Similarly, while trees in a TAG (*qua* mathematical formalism) can be of any size, in linguistic applications the general principle applied is that trees should correspond to the EXTENDED MAXIMAL PROJECTION (Grimshaw 2000, 2005) of a lexical item, i.e. the syntactic projection which includes all functional heads and the full argument structure of the item. Some examples of elementary trees matching these restrictions are given in Table 1. In this chapter, I will use "TAG" to refer specifically to this sub-class of lexicalised,

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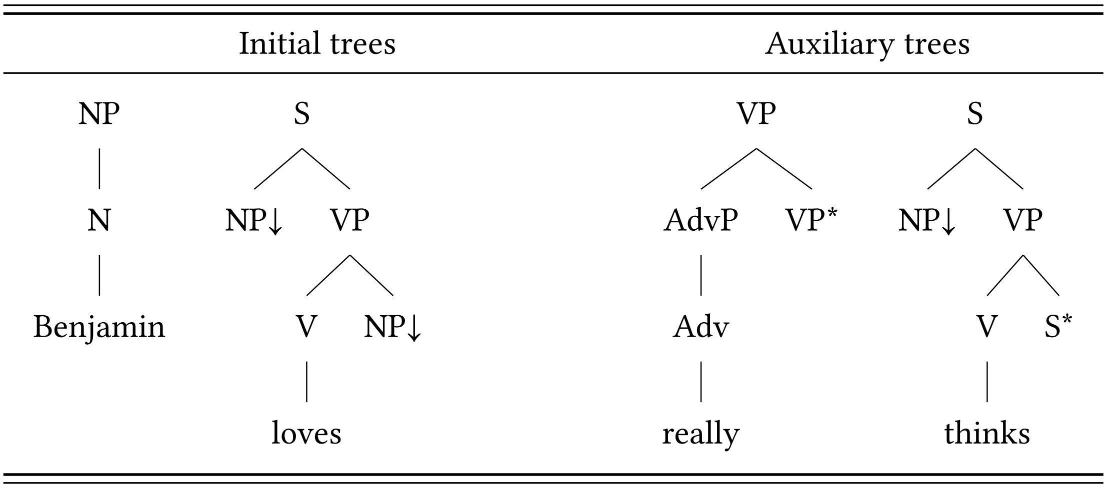
[1] In fact, things are a little more complex than this. In some definitions of mild context sensitivity (e.g. Kallmeyer 2010: 23–24), "permutation-complete" languages like MIX (the language consisting of the subset of $\{a, b, c\}^*$ with an equal number of *a*s, *b*s, and *c*s; see Bach 1981) are included (Salvati 2015, Nederhof 2016); in others (e.g. Joshi et al. 1991), they are not (Kanazawa & Salvati 2012). TAG and CCG are in the class which does not contain MIX, and so Steedman (2019: 415) suggests they should be called SLIGHTLY NON-CONTEXT-FREE to distinguish them from the larger class which does contain MIX. Nothing in this chapter hinges on this distinction, so I continue to use the more traditional "mildly context sensitive", without taking a position on whether or not this refers to the class of languages containing MIX or not.

[2] In the original formulation (Joshi et al. 1975), TAG only has one combining operation – adjunction. The addition of substitution, however, improves the descriptive capabilities of the framework, making it easier to use for linguistic purposes, while leaving its formal expressive power the same, since adjunction can be used to simulate substitution (Abeillé 1988: 7). In this chapter I will therefore continue to assume that both operations are used.

Table 1: Some elementary trees



linguistically-constrained TAG rather than merely to the mathematical formalism, except where otherwise indicated.

Elementary trees come in two types, illustrated in Table 1. An INITIAL TREE is one where all of the frontier nodes are either terminals or non-terminals marked as SUBSTITUTION SITES using the down arrow (↓).[3] Substitution sites indicate arguments of a predicate. An AUXILIARY TREE is like an initial tree except that one of the frontier nodes, called the FOOT node, shares the same label as the root, and is marked with an asterisk (*). Auxiliary trees are combined with other trees via adjunction, to be described below. When two elementary trees have been combined, we have a DERIVED TREE, which can then be further manipulated just like an elementary tree.

In the next two subsections, I introduce the two operations used to combine trees in TAG: substitution and adjunction.

3.1 Substitution

When the root of a tree has a label which matches that of a non-terminal frontier node in another tree, the first tree can be inserted at that frontier node in the second; this is called substitution, and is the process normally used to combine a predicate and its arguments. Example (1) shows this process schematically, while

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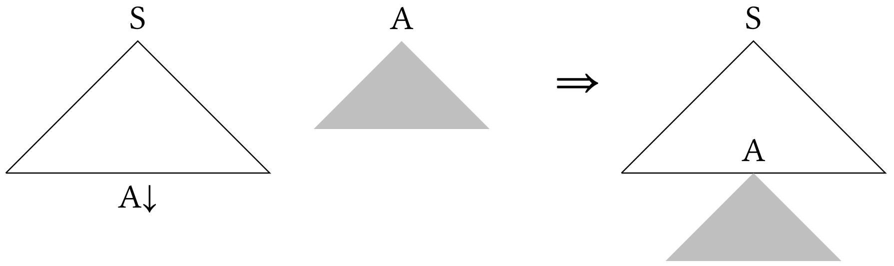
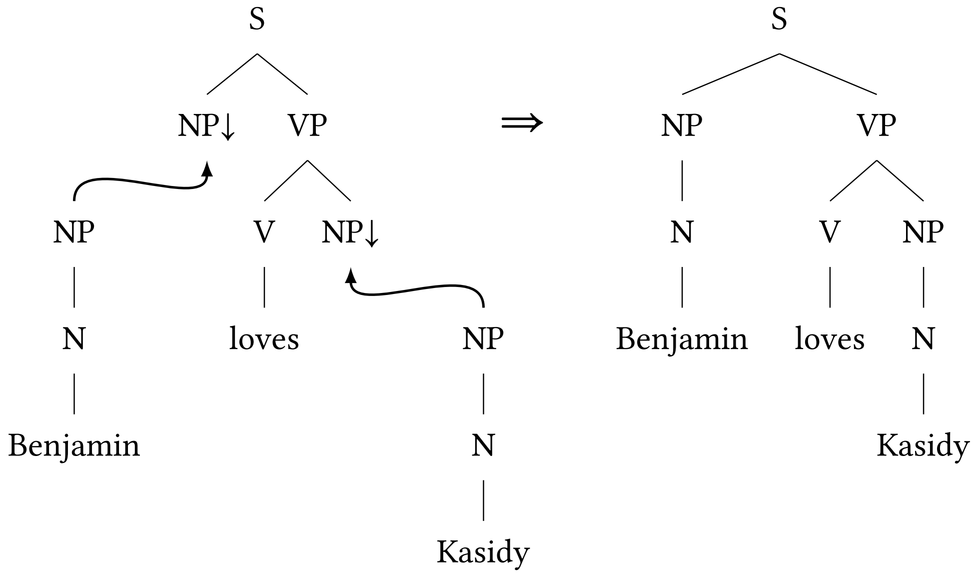
[3] In fact, every non-terminal frontier node can serve as a substitution site, so the ↓-annotation is formally redundant. Nevertheless, it is often included in expository text (if not in computational implementation) to make it clear at a glance that a tree does not represent a fully completed derivation.

(2) gives a linguistic example involving two cases of substitution: the derivation for *Benjamin loves Kasidy.*

(1) **Substitution** (after Abeillé & Rambow 2000: 5)



(2)



A tree rewriting grammar which makes use of substitution alone is called a Tree Substitution Grammar (TSG), and is at least weakly equivalent to a CFG – that is, such grammars describe the same set of string languages (weak equivalence), although there are some tree languages which can be described by a TSG for which an equivalent CFG does not exist (so strong equivalence is not guaranteed).[4] This is easy to see if we imagine converting a CFG into a TSG: all we do

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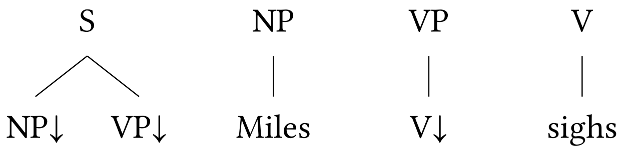
[4] Any CFG can easily be converted into a TSG by simply turning each phrase-structure rule into a tree rooted in the left-hand symbol with the right-hand symbols as daughters, as will be illustrated in the text. But to convert a TSG into a CFG, it may be necessary to relabel some nodes, since the dependency between a mother and its daughters may be tree-specific, and so not hold generally (for example, it might be the case that only trees anchored by transitive verbs have a VP dominating both a V and an NP node) – so the CFG might have to have more non-terminal symbols than the TSG (e.g. VP_{trans} and $\text{VP}_{\text{intrans}}$ instead of just VP).

is replace each phrase-structure rule with the equivalent tree which it describes (cf. McCawley's 1968 conception of phrase-structure rules as node admissibility conditions, i.e. descriptions of trees). For example, the CFG in (3) corresponds to the TSG in (4):

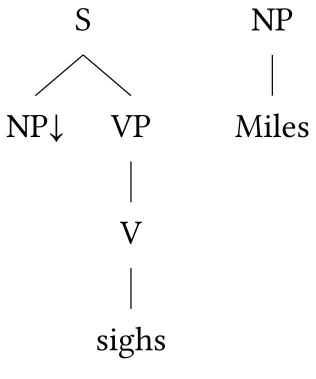
(3) S ⟶ NP VP
NP ⟶ Miles
VP ⟶ V
V ⟶ sighs

(4)



Although TSGs and CFGs are formally very close (at least weakly equivalent), there is an important theoretical difference between them: TSGs have an EXTENDED DOMAIN OF LOCALITY with respect to CFGs. Every rule in a CFG describes a tree of depth 1, but trees in a TSG can be of arbitrarily large size, which means that certain grammatical dependencies, like agreement or extraction, can be described locally in a TSG (i.e. in a single elementary tree) when they cannot be in a CFG (i.e. they cannot be described in a single rule). For example, the TSG in (5) is equivalent to that in (4), except that now the verb and its subject are in the same elementary tree, and so the agreement relationship between the two could be described locally.

(5)

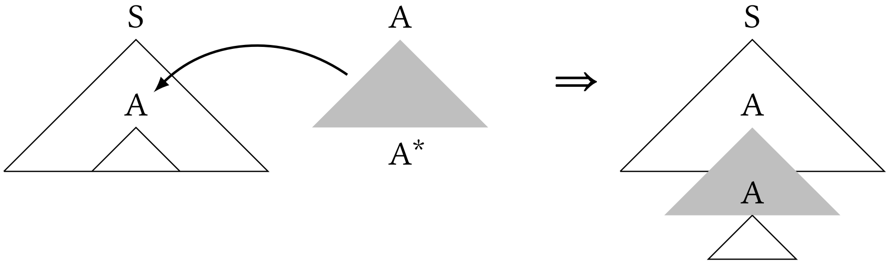


Many possibilities exist as to *how* to describe such a dependency – for example, by using complex categories in the style of GPSG (on which see Gazdar et al. 1985), or by using feature structures (on which see Section 3.3); but the point is that however one chooses to represent this relationship, it can be described locally in a TSG when it can only be described indirectly in a CFG, e.g. by percolating features up from V to VP, thus making them visible to the S → NP VP rule which introduces the subject.

3.2 Adjunction

If we add adjunction, a second type of combining operation, to a TSG, we obtain a TAG. While substitution allows a tree to be inserted at a frontier node of another tree, adjunction allows insertion at a *non*-frontier node: the adjoining tree expands the target node around itself. A tree which adjoins into another tree, called an auxiliary tree, must therefore have at least one frontier node with the same label as its root – this is called the foot node. The process of adjunction is represented schematically in (6):

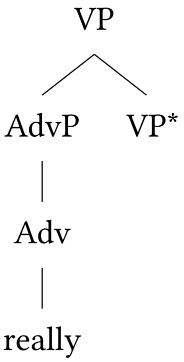
(6) **Adjunction** (after Abeillé & Rambow 2000: 9)



Because of the requirement that the root and foot of an auxiliary tree have the same label, such trees can be seen as factoring recursion out of the grammar. Rather than having a cyclic path through the rewrite rules (as in a CFG), we have a tree which directly encodes such a cycle (in (6), an A contained within an A), which can then be added into a structure via adjunction. For this reason, such auxiliary trees are used to model the recursive aspects of natural language syntax – most notably modification and sentential embedding.

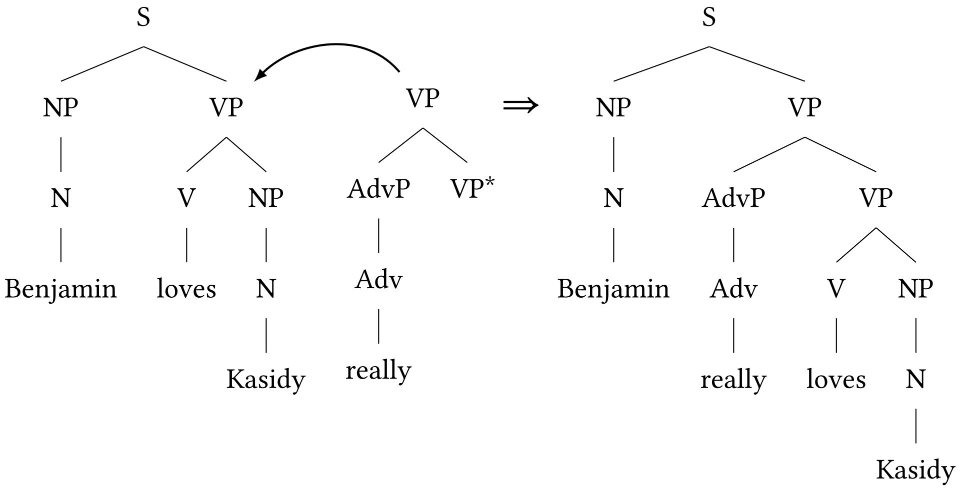
Modifiers such as adjectives and adverbs, but also e.g. relative clauses, are represented as auxiliary trees. For example, *really* is a VP-adverb which appears to the left of the VP it modifies, and so is represented by the tree in (7):

(7)



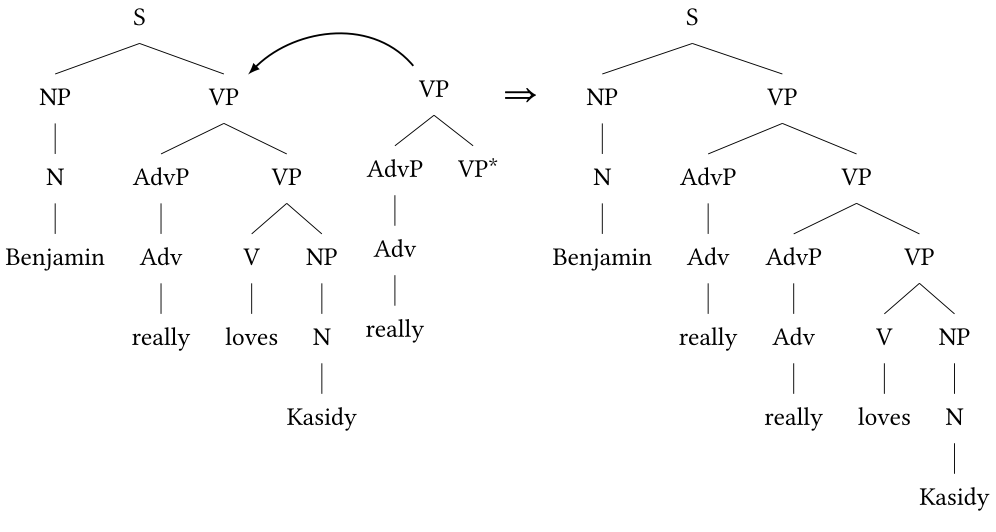
To see this in use, consider the derivation for the sentence *Benjamin really loves Kasidy*: after the substitutions shown above in (2) to generate *Benjamin loves Kassidy*, we can then adjoin the tree from (7) at the VP node in the clause, as in (8):

(8)



Of course, such a process can be repeated indefinitely many times, since there is always still a tree-internal VP node available to be adjoined to, as in (9):

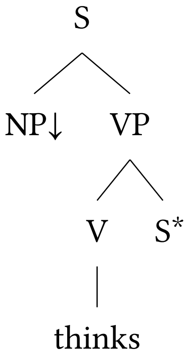
(9)



This accounts for the iterability of modifiers like *really*.

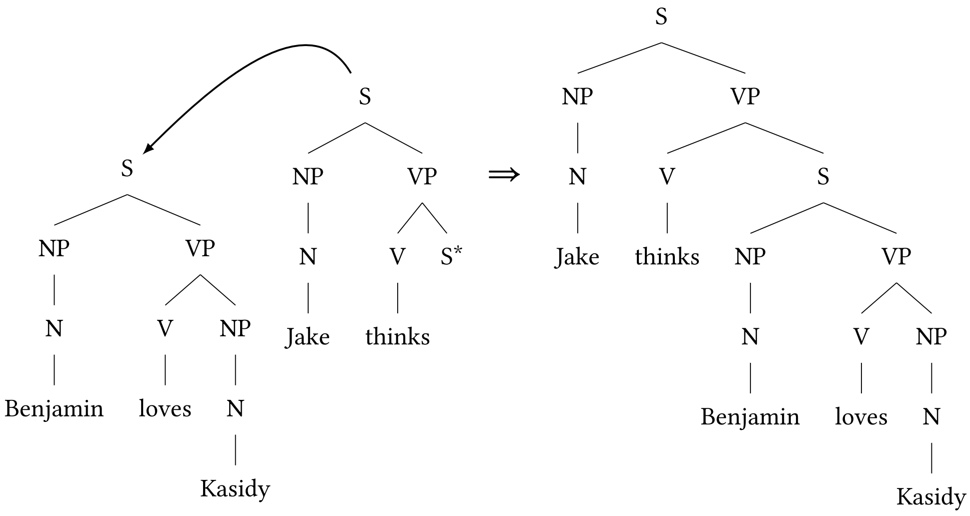
Another, perhaps more theoretically interesting, area of recursion in the grammar is in the domain of subordination, i.e. sentential embedding. Verbs which take sentential complements are represented as auxiliary trees, as in (10), for example:

(10)



Notice that this means that sentential arguments are treated rather differently from other arguments in TAG: while arguments are normally combined with their governors by means of the former being substituted into the latter, sentential arguments combine with their governors by means of the latter being adjoined into the former – this is shown in (11):

(11)

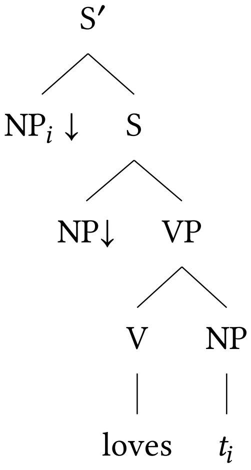


For simple declarative sentences this is a rather unnecessary complication, since the same effect could be achieved by making the foot node of the sentential-embedding verb a substitution site instead. However, the factoring of recursion into auxiliary trees interacts with another TAG principle – the local representation of syntactic dependencies. Owing to their extended domain of locality, it is possible to represnt many kinds of syntactic dependencies locally (i.e. in a single elementary structure) in TAG that would require some additional mechanism in other frameworks. This principle extends to filler-gap relations as well, such as that between a fronted focus phrase and its verbal governor, as in (12):

(12) *Kassidy* Benjamin loves (whereas Kira he merely likes).

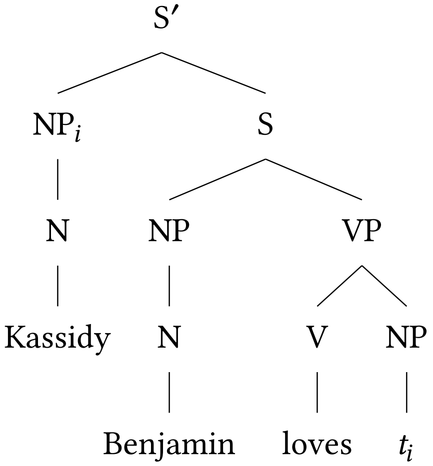
The tree in (13) represents the appropriate form of the verb *loves*, with its object extracted:[5]

(13)



Through substitution alone, this can be used to derive (14):

(14)



But of course the distance between the fronted phrase and the gap can span multiple clauses, and can be arbitrarily large, as shown in (15):

(15) *Kassidy* [Jadzia knows [Jake thinks … [Benjamin loves]]].

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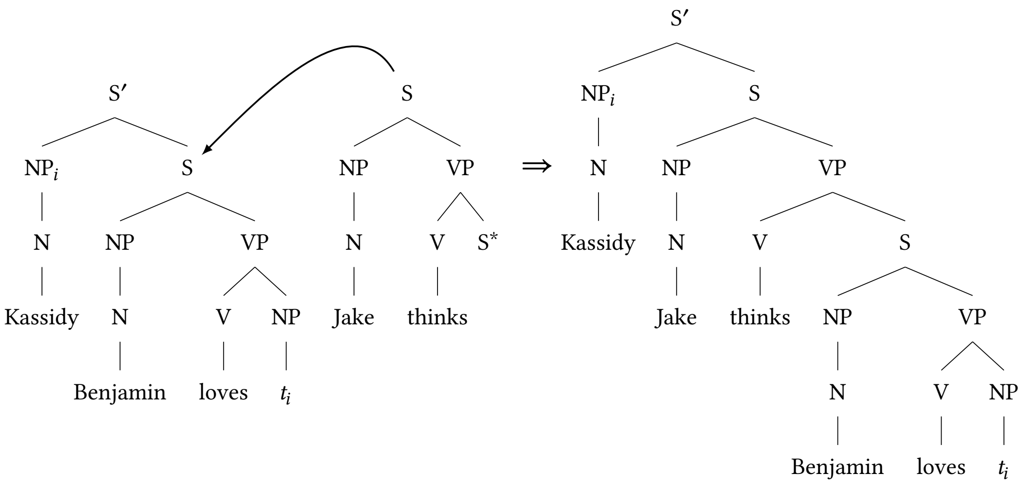
[5] The use of a trace in object position here is not an essential part of the TAG analysis, though in practice it is common. One reason for this, as argued for by Kroch (1987) and Kroch & Joshi (1985), is that empty elements allow for easier specification of some constraints on extraction in terms of the topology of trees, rather than necessitating additional mechanisms, like functional uncertainty and off-path constraints in LFG. A reviewer points out that traces are also useful in the metagrammar (see Section 6 on this concept), since they allow tree fragments to be reused more easily.

Since sentential embedding verbs are treated as auxiliary trees, this poses no problem – they are adjoined to the internal S node, and thus extend the distance between the gap and the filler:

(16)



What is more, this can clearly be repeated: other trees can be adjoined at the topmost S node, further increasing the distance between the filler and the gap. Thus, a potentially quite radically non-local dependency, between the fronted expression and its governing verb, can be expressed locally in the grammar, in a single elementary tree, because the operation of adjunction allows for the distance between nodes in a tree to grow over the course of a derivation. This same process can be applied to other kinds of filler-gap dependencies, such as *wh*-questions and relative clauses, though for ease of exposition I have chosen not to illustrate these here (since for these we must also account for things like subject-auxiliary inversion and *do*-support).[6] The TAG approach is in contrast to that of many other syntactic theories which instead derive or infer the relation between filler and gap via some additional syntactic mechanism, be that movement or, in the case of LFG, a functional uncertainty path.

3.3 Expressing constraints

Adjunction of an auxiliary tree, which has a root and foot node with the same label, captures the effects of recursion in other formalisms. However, once an auxiliary tree has been adjoined in, there will be two nodes with the same label where there was previously just one. This means that if we adjoin the same

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[6] The interested reader should consult the detailed analyses of these and other constructions in English provided by the XTAG project (XTAG Research Group 2001).

tree again (e.g. as in (9), where we adjoin *really* twice), there are two distinct possible targets (and after that adjunction there will be three, etc.). This has the potential to dramatically complicate parsing, since there will be multiple distinct possible derivations for the same tree (without there also being a genuine ambiguity of interpretation), and so we would like a means of controlling where adjunction takes place. TAG originally did this by using local constraints on adjunction (Joshi 1987: 100ff.), annotations added to the nodes of elementary trees indicating which auxiliary trees can be adjoined there. If the list of adjoiners is empty, we have a NULL ADJUNCTION (NA) constraint, which prohibits adjunction at the node. If the list is non-empty, then we have a SELETIVE ADJUNCTION (SA) constraint, which limits the trees which can adjoin. There are also OBLIGATORY ADJUNCTION (OA) constraints, which are like SA constraints except that one of the listed trees *must* be adjoined at the annotated node. In classic TAG, this is achieved simply by a diacritic indicating that the constraint is an OA one rather than an SA one. We will see below how this can be achieved in a less stipulative way by making use of feature structures.

Using these constraints, we can avoid having multiple possible parses for sentences by marking the foot node of auxiliary trees with an NA constraint (as is done in the XTAG grammar of English, for example – XTAG Research Group 2001). This means we do not add an extra potential target for adjunction each time such a tree is adjoined in, since only the root of the auxiliary tree is available for further adjunction.

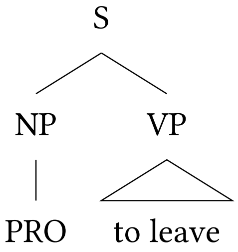
In addition to this practical motivation, adjunction constraints play a crucial theoretical role: they are a vital part of what makes TAG mildly context sensitive. Without adjunction constraints, the formalism is still more powerful than a CFG, but there are several mildly context-sensitive languages which it cannot express, such as the copy language $\{ww \mid w \in \Sigma^*\}$, or the language $\{a^n b^n c^n \mid n \geq 0\}$, also called COUNT-3 (Kallmeyer 2010: 27, 58; we return to COUNT-3 in Section 4).

Let us now consider an example illustrating the linguistic utility of selective and obligatory adjunction constraints. Vijay-Shanker (1987: 134–135) considers non-finite sentential complements such as (17):

(17) John tried [PRO to leave].

Assuming the subordinate clause has the tree in (18), our analysis needs to do two things: ensure that such clauses cannot appear on their own as full sentences – as illustrated in (19) – and ensure that they can be embedded only under verbs that select for infinitival forms – as illustrated in (20).

(18)



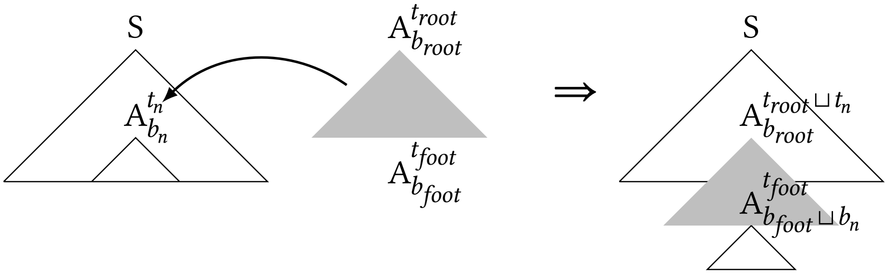
(19) *To leave.

(20)
   a. John tried to leave.
   b. *John imagined to leave.

In other words, *something* must be adjoined into the root node S (an OA constraint), and that something must only be a sentential embedding verb that selects for a non-finite complement clause (an SA constraint).

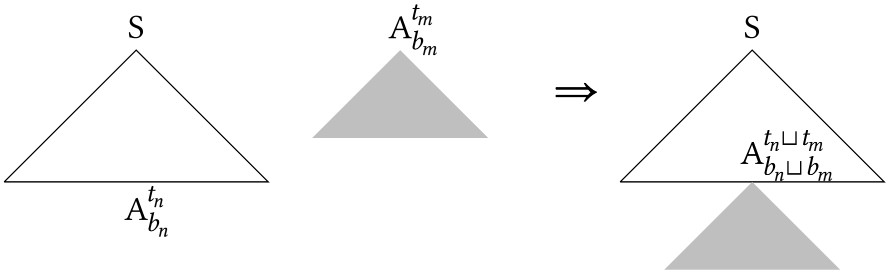
Originally, these constraints were simply seen as listings of (permitted/required) auxiliary trees, but this is not particularly linguistically illuminating, and also difficult to maintain for a grammar writer. This is remedied in later TAG work through the use of feature structures. It is common to associate nodes with feature structures in CFG-based grammars (e.g. in GPSG – Gazdar et al. 1985) in order to represent grammatical features such as case, number, tense, etc. Indeed, this is what LFG's f-structures do too (although there multiple structures from different nodes are merged into one). However, in a TAG, we cannot guarantee the integrity of each node in the tree: through adjunction, it may be split up into two nodes, corresponding to the root and foot nodes of an auxiliary tree. For this reason, in feature structure-based TAG (FTAG: Vijay-Shanker 1987: ch. 5; Vijay-Shanker & Joshi 1988), each node is associated with a *pair* of feature structures, called the TOP and BOTTOM feature structures. The top features refer to the relation of the node to its siblings and its ancestors, i.e. the view from above the node in a tree. The bottom features refer to its relation to its descendants, i.e. the view from below (Vijay-Shanker 1987: 129). Ultimately, the top and bottom features of a node must unify, to give a single description of the properties of that node. However, during the course of a derivation, adjunction may split up the node so that it is now two nodes instead; in that case, its top features will be unified with the top features of the root of the auxiliary tree involved, and its bottom features will be unified with the bottom features of the auxiliary tree's foot node. This is shown schematically in (21):

(21) **Adjunction in FTAG** (after Vijay-Shanker 1987: 130)



Substitution is simpler, since the root node of the substituted tree is simply identified with the substitution site, and so both top and bottom feature structures unify, as shown in (22):[7]

(22) **Substitution in FTAG**

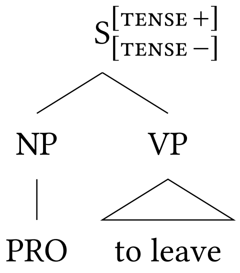


These feature structures can be used to enforce various linguistic constraints. For example, we can enforce subject agreement in initial trees for verbs by specifying number and person features on the subject NP position. More interestingly, we can use features to account for the constraints on adjunction discussed above. Because the features associated with whatever tree is adjoined at a node have to unify appropriately with its top and bottom features, we can control which trees are compatible by giving them (mis)matching features which make unification possible or not. What is more, we can give a more principled account of obligatory adjunction constraints by making the top and bottom features of a particular node incompatible with one another. This means that unless adjunction takes place and the node is split up, unification will be impossible, and the derivation will fail. Returning to our example from above, (23) shows the tree from (18) with two added feature annotations:

---

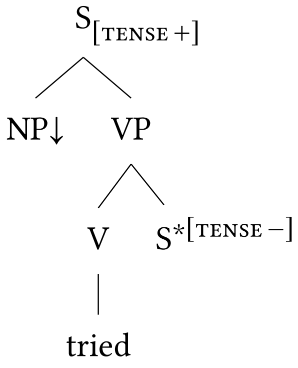
[7] The diagram in (22) follows Vijay-Shanker's (1987) original formulation, where substitution sites also contain bottom features. In much other work using FTAG, this is not the case, so b_n in (22) would be absent, and the final bottom features of A in the derived tree would simply be b_m (XTAG Research Group 2001: 13). This is of course equivalent to (22) with b_n instantiated as the empty feature structure.

(23)

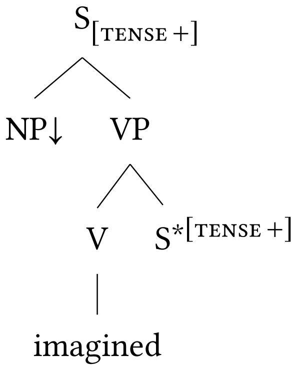


Since these features are incompatible and cannot unify, we have achieved the first of our goals, which is to ensure that this tree cannot appear on its own – i.e., to implement an OA constraint. Owing to the feature mismatch, this tree is illicit unless something adjoins to the root node. To achieve the SA constraint, we need to consider the elementary trees of verbs like *tried* and *imagined*. In (24) and (25) we present them with just the relevant features added:

(24)

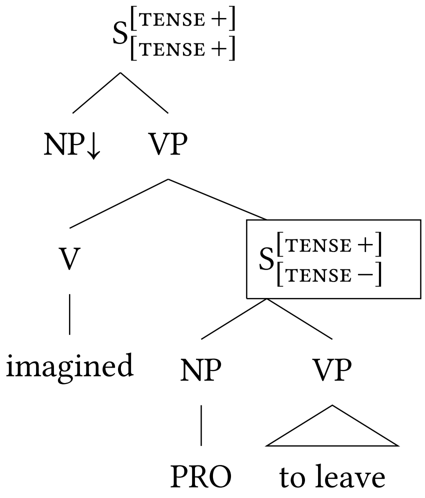


(25)



The difference between the two verbs is that *tried* selects for a non-finite, untensed, complement clause, whereas *imagined* selects for a tensed one – this is indicated by the top features on their foot nodes. If we attempt to adjoin *imagined* into the tree for the subordinate clause in (23), then we end up with mismatching features on the foot node, which means they cannot unify, and the tree remains illicit, as shown in (26):

(26)



If we adjoin the tree for *tried*, however, then there is no mismatch, and the derivation succeeds.

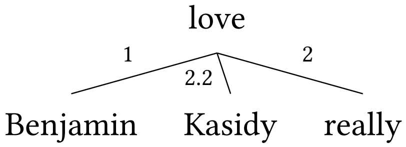
If we allow a fully-fledged unification-based feature system in FTAG, with recursive feature structures of potentially unbounded size, then FTAG becomes undecidable (Vijay-Shanker 1987: 155f.). This is a very bad result given the emphasis that TAG places on tractable, polynomial parsing. For this reason, the feature structures in FTAG are more restricted, and do not permit recursion/re-entrancy, which makes them quite unlike LFG's f-structures.

3.4 Derivation trees and dependencies

In a CFG as classically conceived, the familiar phrase-structure tree is in fact a representation of the derivation, i.e. of the process by which the output, namely the string, was produced. TAGs also have these DERIVATION TREES, representing the way in which trees were combined during a derivation – but, of course, in a TAG, the output of the derivation is already a tree, called the DERIVED TREE to set it apart. The derived tree represents word order, constituency, and category information, like LFG's c-structure. So what linguistic information does a TAG derivation tree encode? Since each elementary tree in a (lexicalised) TAG corresponds to a lexical item, the derivation tree actually represents relations between lexical items, and so has much in common with a dependency grammar representation of the sort illustrated by Meaning-Text Theory (Mel'čuk 1988), the more contemporary Universal Dependencies project (UD: Nivre et al. 2016), or, indeed, an LFG f-structure (on the relationship between dependency grammars and LFG, see also Haug 2023b [this volume]).

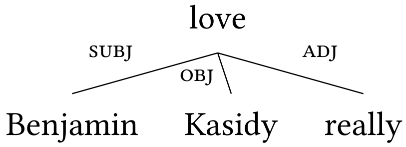
A derivation tree for *Benjamin really loves Kasidy*, the derivation for which was shown in (2) and (8), is given in (27) (cf. Joshi & Schabes 1997: 74ff.):

(27)



Here nodes are labelled with the lexeme corresponding to the elementary tree in question. Whenever a tree is substituted or adjoined into another tree, it becomes its daughter in the derivation tree. The derivation tree in (27) shows that three trees, corresponding to *Benjamin*, *Kasidy*, and *really*, were combined with the tree for *love*. Each edge is also labelled, standardly with a node address which indicates where the tree was substituted or adjoined.[8] However, we can equally well use different labels, such as assigning grammatical function names to argument positions and then treating other positions as ADJ (cf. Rambow & Joshi 1997: 175). This would give us the derivation tree in (28) instead of (27), making the parallel with dependency structures quite explicit:

(28)



Rambow & Joshi (1997) discuss the relationship between TAG and dependency grammars in more detail.

Unfortunately, the TAG treatment of sentential embedding somewhat undermines the neat parallel between derivation trees and dependency structures (Rambow et al. 1995, 2001). Recall that arguments are normally substituted into their governors, but that clausal complements have their governors adjoined into them. This reverses the normal dependency relations, and means that "(standard) LTAG derivation trees do *not* provide a direct representation of the dependencies between the words of the sentence, i.e., of the predicate-argument and modification structure" (Rambow et al. 2001: 117, emphasis in original). To see why this is so, consider the derivation tree for (11), *Jake thinks Benjamin loves Kasidy*:

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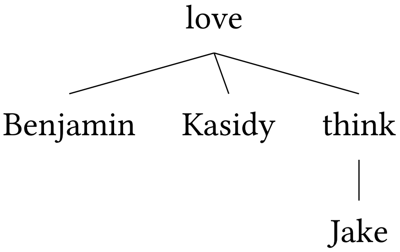
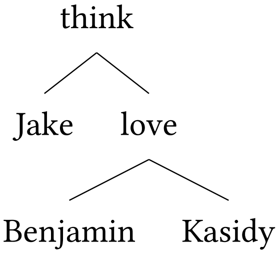
[8] These are so-called GORN ADDRESSES (Gorn 1967). The root has the address 0 (or sometimes ϵ, i.e. the empty string), the kth child of the root (reading left-to-right) has the address k, and for all other nodes, the qth child of a node with address p has the address $p.q$ (Joshi & Schabes 1997: 75).

(29)



In (30) *think* is a dependent of *love*, because the *think* tree is adjoined into the *love* tree, when of course in any real dependency grammar the relation would be reversed:

(30)



There are technical means of handling this unhappy result (see e.g. Joshi & Vijay-Shanker 2001, Kallmeyer & Kuhlmann 2012), but it nevertheless makes the parallel with dependency structures rather less direct. All the same, we might be tempted to see the division of labour between derived trees and derivation trees in TAG as analogous to that between c-structure and f-structure in LFG, where the former represents constituency, word order, and category information, and the latter encodes a sentence's dependency structure. This is certainly true to a point, but the parallel is imperfect, because f-structure also represents other information beyond the dependency structure of a sentence – syntatic features like person, number, tense, aspect, etc., which in TAG are encoded in the feature structures associated with each node instead. Still, one thing that derivation trees and f-structures have in common is that they are both seen as the appropriate level of representation to serve as input to the semantic component of the grammar.

3.5 Semantics

There have been a variety of different proposals for interfacing TAG with a semantic theory, and space precludes a full presentation here. Nonetheless, this section gives a (superficial) overview of the relevant literature, so that the interested reader can investigate further.

An early proposal for doing semantics with TAG makes use of Synchronous TAG (STAG: Shieber & Schabes 1990). In STAG, elementary trees from one grammar are paired with those from another, and links are established between individual nodes in those trees. Then, when adjunction or substitution applies in one grammar, it must also take place in the other, at the linked node, and using the equivalent, paired tree. By pairing a TAG grammar with a tree-based semantic representation, we can therefore implement a "rule-to-rule" approach to semantic derivation (to use Bach's 1976 terminology).[9] Nothing requires the paired trees to be isomorphic, so on the syntactic side it is the structure of the derivation tree, not the derived tree, which determines the meaning. Although this approach has largely fallen out of favour in TAG circles, see Nesson & Shieber (2006, 2007, 2008) for a modern revival.

Another approach which uses the derivation tree as the basis for semantic interpretation is that of Joshi & Vijay-Shanker (2001). Here elementary trees are associated with triples of semantic expressions, the first of which specifies the main variable of the predication, the second of which gives the predicate with its arguments, and the third of which specifies which argument variables are associated with which nodes in the tree. When a tree is substituted into another tree, its main variable is identified with the corresponding argument variable in the target tree's semantics (special consideration has to be made for adjunction, as discussed above: the order of dominance in the derivation tree will be different for sentential vs. non-sentential complements – see Joshi & Vijay-Shanker 2001: 152f.). Since this makes use of a unification-based semantics, the order of combination of the elementary trees is irrelevant, and the derivation tree thus offers an appropriate level of representation, since it abstracts away from order, and simply says how and where trees were combined. This unification-based approach has been developed more recently by Laura Kallmeyer and colleagues, introducing a new focus on underspefication (Gardent & Kallmeyer 2003, Kallmeyer & Joshi 2003, Kallmeyer & Romero 2004, 2008). This has also been integrated with Frame Semantics (Kallmeyer & Osswald 2013).

In LFG, the *de facto* standard approach to the syntax-semantics interface is Glue Semantics (Asudeh 2023 [this volume]). Observing that, for example, the operation of function application as used in natural language semantics is order insensitive, and that quantifier scope ambiguities show that semantic interpretation does not (always) respect the constituent structure of a sentence (see Asudeh 2012: ch. 5), Glue rejects c-structure as the appropriate level of input to semantics, and uses (a projection of) f-structure instead (where order is irrelevant and

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[9] Alternatively, by pairing two TAG grammars from different languages, we can implement a machine translation system – see Abeillé et al. (1990).

many c-structure hierarchies are collapsed). Thus, as in TAG, it is the dependency structure, not the phrasal structure, which is taken as relevant for semantic interpretation. Interestingly, however, one of the only examples of TAG theorists criticising the derivation-tree-based approach to semantic interpretation is when Glue Semantics has been combined with TAG (Frank & van Genabith 2001). Frank & van Genabith argue that the derivation tree is not suitable as the input to semantic interpretation, mostly on the basis that, as discussed above, it provides the wrong dependency structure, and they instead make use of the derived tree in their Glue-based framework.

3.6 The big picture

Linguistic theories based on TAG have two key properties (Joshi & Schabes 1997: 95f.):

1. Extended domain of locality: Since TAG elementary trees encompass the whole extended projection of a lexical item, dependencies which in a simple CFG-based grammar would be spread across multiple rules, e.g. agreement, can be expressed “locally” in a TAG (i.e. in the same elementary structure). This is what enables a TAG to lexicalise a CFG (see Section 5).

2. Factoring recursion from the domain of dependencies: Relatedly, the elementary trees are the structures over which the vast majority of dependencies are stated, and that includes filler-gap relations. Such dependencies are therefore local in nature, but can become long distance via the adjunction operation. Recursion is thereby factored out of the domain over which these dependencies are initially stated.

This approach is summed up by Bangalore & Joshi (2010: 2) in the slogan “complicate locally, simplify globally”. That is, local, elementary representations are where almost all linguistic constraints are stated, meaning that they can become quite complex, but the payoff is that the composition of elementary trees can be achieved by just two, very general, operations: substitution and adjunction. This also means that cross-linguistic variation is entirely a matter of what elementary trees a grammar contains, a position very much in keeping what Baker (2008: 353) calls the Borer-Chomsky Conjecture, after Borer’s (1984) proposal and Chomsky’s (1995) later adoption of it, whereby parametric variation is restricted to the lexicon.

How does this compare with LFG? The second property certainly divides the frameworks: LFG grammars include recursive c-structure rules, and filler-gap dependencies are expressed syntactically, not lexically. This means, moreover, that the lexicon is not the only source of complexity in LFG grammars; many constructions are analysed as instantiating complex annotated phrase structure rules (see e.g. the analysis of long-distance dependencies in Dalrymple et al. 2019: ch. 17). There is more overlap between the two frameworks when it comes to the first property. Via the parallel projection architecture (see Belyaev 2023b: sec. 5 [this volume]), LFG does obtain an extended domain of locality: for example, agreement can be encoded locally in the agreement controller's lexical entry via the use of paths through f-structure (see Haug 2023a [this volume]). However, since c-structure is generated by a CFG, any non-local dependencies between c-structure nodes (i.e. those spanning more than one "generation" in the tree) can only be expressed indirectly via other levels of representation. That is, we have no extended domain of locality at c-structure *per se*, only parasitically via other levels. To the extent that phrasal constructions larger than a tree of depth 1 are objects we want to be able to represent in the grammar, this is a shortcoming. We return to this point in Section 7.2.

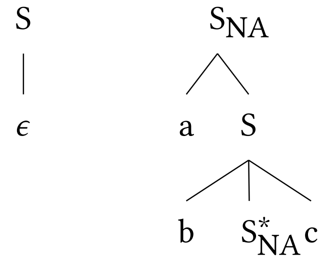
Construction Grammar (CxG: Fillmore et al. 1988, Goldberg 1995, 2006, Kay & Fillmore 1999, Boas & Sag 2012, Hoffmann & Trousdale 2013, *i.a.*) of course considers such objects as basic to linguistic theorising, and for this reason it has been argued that TAG is a natural means of formalising CxG (Lichte & Kallmeyer 2017). For example, among the properties of constructions listed by Fillmore et al. (1988: 501), one is that they "need not be limited to a mother and her daughters, but may span wider ranges of the sentential tree" – precisely the enlarged definition of locality which a TAG provides, and which LFG denies (at least directly). TAG has a natural means of representing both "formal" and "substantive" idioms, to use Fillmore et al.'s (1988) classification: formal idioms can be included in the set of trees associated with each lexical item of the appropriate class (Lichte & Kallmeyer 2017: 208f.), and substantive idioms can be represented as elementary trees in their own right (Abeillé 1995). While LFG can quite well represent formal idioms at the more schematic end of the scale (see e.g. Asudeh et al. 2013), it struggles with substantive idioms, precisely because it lacks an extended domain of locality at c-structure (Findlay 2023: sec. 4).

4 Generative capacity

TAG was designed specifically as a formalism with only mildly context-sensitive power (in the technical sense of Joshi 1985). This means there are languages out of the reach of context-free grammars that TAGs can describe, but also that there are languages properly considered context sensitive which TAG cannot. Such a constrained expansion into the context-sensitive space enables parsing algorithms for TAG to preserve the computationally appealing property of a polynomial run time.

As a simple demonstration of the increased generative capacity of a TAG when compared to a CFG, consider the artificial formal language $\{a^n b^n c^n \mid n \geq 0\}$, also known as count-3 – that is, the language which contains all strings consisting of some number of *a*s followed by the same number of *b*s, then the same number of *c*s. Partee et al. (1990: 497) demonstrate through application of the pumping lemma for context-free languages that count-3 is not context free. By contrast, there is a quite straightforward TAG grammar for count-3, shown in (31):[10]

(31)



So, we can see that TAGs are more powerful than CFGs. They are not, however, very much more powerful. There are many kinds of language which they cannot describe, including those which it has been shown can be described by similarly modest extensions to context-free grammars. One example of this is the language MIX (Bach 1981), mentioned in footnote 1, which consists of all permutations of each string in the set $\{a^n b^n c^n \mid n \geq 0\}$, i.e. any number of *a*s, *b*s, and *c*s, in any order, provided there is the same number of each. Salvati (2015 – originally circulated as a technical report in 2011) showed that MIX is in the class of multiple context-free languages, where a multiple context-free grammar (MCFG) is itself a mildly context-sensitive grammar formalism, for which the parsing problem is also decidable in polynomial time. However, MIX is *not* a tree-adjoining language, as conjectured by Joshi et al. (1991) and proved by Kanazawa & Salvati (2012): so there are languages which are only slightly within the context-sensitive space and which are still not describable by a TAG. More generally, although count-3 and count-4 (i.e. $\{a^n b^n c^n d^n \mid n \geq 0\}$) are tree-adjoining languages, count-5 is not (Joshi 1985: 223f.).

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[10] Recall that a node annotated with "NA" bears a null adjunction constraint – see Section 3.3. As mentioned above, without adjunction constraints, TAG becomes less expressive, and cannot describe count-3: see Kallmeyer (2010: 222) for a proof.

The carefully constrained computational complexity of TAG is in marked contrast to the situation in LFG (although see below for attempts to constrain the power of the LFG formalism). Whereas the class of tree-adjoining languages is equivalent to that of the mildly context-sensitive languages (or, perhaps, the slightly non-context-free languages: see fn. 1), the languages described by LFGs are equivalent to the class of recursively enumerable languages (Nakanishi et al. 1992). This has the expected deleterious effect on computational complexity: the parsing problem for LFGs is NP-complete (Berwick 1982), and so, in the worst case scenario, computationally intractable (assuming $\mathsf{P} \neq \mathsf{NP}$).

There have been attempts to remedy this situation, however. While the LFG formalism as a whole may be computationally very complex, some of the properties responsible for this are not relevant for the description of natural languages – this opens the possibility that the formalism could be constrained to allow tractable parsing (i.e. in polynomial time) while still preserving its usefulness as a tool for describing natural languages. Seki et al. (1993) propose one such restriction, which limits the kinds of functional annotations permitted on c-structure nodes, and the number of nodes which can correspond to a single f-structure. This successfully buys tractability for the resulting formalism, but at a heavy theoretical cost: many staple aspects of LFG analyses are no longer available, including the very common $\uparrow = \downarrow$ head-sharing annotation, or functional control equations like $(\uparrow \textsc{xcomp subj}) = (\uparrow \textsc{subj})$. More recently, Wedekind & Kaplan (2020) have addressed this limitation, describing a more expressive but still tractable version of the LFG formalism, which is provably equivalent to a Linear Context-Free Rewriting System (LCFRS), and therefore in the mildly context-sensitive space. (See also Kaplan & Wedekind 2023 [this volume] and references therein for discussion of the formal and computational properties of LFG.) This approach only covers the original LFG formalism of Kaplan & Bresnan (1982), however, and it remains to be seen whether certain extensions to this basic formalism, such as functional uncertainty (Kaplan et al. 1987, Kaplan & Zaenen 1989), can be accommodated as straightforwardly in this new approach.

One point worth noting is that even in the absence of a tractable version of LFG, this contrast between TAG and LFG should not automatically be viewed as a failing on the part of the latter. In fact, it reflects a rather deep meta-theoretical question: do we want the formalism *itself* to say something interesting about the class of natural languages? The view embodied by TAG is that we should be interested in "finding a grammar formalism that, by itself, gives already a close characterization of the class of natural languages" (Kallmeyer 2010: 7).[11] By

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[11] This view is also shared by Combinatory Categorial Grammar (CCG: Steedman 2000) and Multiple Context Free Grammars (MCFGs: Seki et al. 1991), among others.

contrast, the view embodied by LFG is that "it is the theory that imposes the constraints, not the language in which the theory is expressed" (Pollard 1997: 9).[12] In theoretical terms, at least, it does not seem obvious that one approach is *better* than the other – they are merely different perspectives on the problem.[13]

5 Lexicalisation

I mentioned at the start of Section 3 that linguistic applications of TAG assume that the grammar is "lexicalised". Abeillé & Rambow (2000: 7) give the following definition of this term (emphasis in original):

> We will call a grammar *lexicalised* if every elementary structure is associated with exactly one lexical item (which can consist of several words), and if every lexical item of the language is associated with a finite set of elementary structures in the grammar.

In contrast to (L)TAG, LFG grammars are not in general lexicalised, which is perhaps somewhat surprising given what the "L" in "LFG" stands for. Although there is a focus in LFG on the lexicon as a richly structured respository of grammatical information, there is no requirement that this information *cannot* be expressed through non-lexical means. This section begins by sketching the potential for lexicalising CFG-based formalisms, like LFG, and then explores what the potential advantages of lexicalised grammars are.

In general, CFGs are not lexicalised. For example, the toy grammar in (3), repeated below, is not lexicalised, since the first and third rules are not associated with any lexical item – they consist purely of non-terminals.

(3) S ⟶ NP VP
NP ⟶ Miles
VP ⟶ V
V ⟶ sighs

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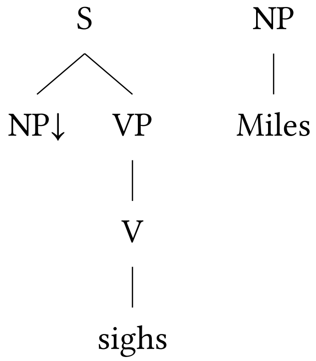
[12] This view is also shared by Head-Driven Phrase Structure Grammar (HPSG: Pollard & Sag 1994) and Minimalism (Chomsky 1995), among others.

[13] Of course, from a more practical point of view, it matters very much whether a formalism is tractable if it is to be used in some natural language processing task. However, there is already a very successful computational implementation of LFG in the form of the Xerox Linguistic Environment (XLE: Kaplan & Newman 1997; Crouch et al. 2011), which employs various "packed computation" (Lev 2007) heuristics to ensure efficient parsing (Maxwell & Kaplan 1989, 1993, 1996). So whatever limitations may exist in principle, they do not necessarily apply in practice.

Since LFG is based on a CFG, via c-structure, LFG grammars standardly make use of many non-lexicalised rules like these, which means that LFG grammars are generally not lexicalised.

It is possible to convert a non-lexicalised grammar into a lexicalised one, but this can require a change to the formalism used. We can speak of one grammar (weakly or strongly) lexicalising another if the former is (weakly or strongly) equivalent to the latter, except that the former is lexicalised whereas the latter is not.[14] For example, the Tree Substitution Grammar shown above in (5), and repeated below, strongly lexicalises the grammar in (3), since each elementary object in (5) is associated with a lexical item, and the grammar describes the same string and tree language as (3).

(5)



Sometimes it is possible to use a CFG to strongly lexicalise another CFG, but it turns out that this cannot be guaranteed in principle. For, although there is a way of converting any CFG into so-called Greibach normal form (Greibach 1965), where the right-hand side of each rule begins with a terminal symbol – thereby lexicalising the grammar – such grammars do not in general generate the same set of trees as the grammars they normalise, since they will include different (and many more) rules. That is, converting a CFG into Greibach normal form only weakly lexicalises it. The extended domain of locality of a TSG/TAG allows us to avoid this problem, however, and makes tree grammars like this "naturally" lexicalised (Schabes et al. 1988: 579). In fact, to strongly lexicalise an arbitrary CFG, we require a TAG, not simply a TSG (see Kallmeyer 2010: 22f. for a proof). And although a TSG may be sufficient to lexicalise many linguistically relevant CFGs, it places syntactically undesirable restrictions on the resulting grammar,

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[14] Two (classes of) grammars are weakly equivalent if they describe the same (sets of) string languages (though the corresponding (sets of) tree languages may differ). They are strongly equivalent if they also describe the same (sets of) tree languages.

and so a TAG is preferable here too (Schabes et al. 1988: 579; Schabes 1990: ch. 1). But why should we care whether a grammar is lexicalised or not?

One early advantage touted for lexicalised grammars was based on parsing. In a lexicalised grammar, a given sentence can contain at most as many elementary structures as there are words in the sentence. Since each lexical item is associated with a finite number of elementary structures, this also means that the number of analyses for the sentence is finite, thus guaranteeing that the recognition problem is decidable (Schabes et al. 1988: 581f.). As Kallmeyer (2010: 21; emphasis in original) puts it, "[l]exicalized grammars are *finitely ambiguous*, i.e., no sequence of finite length can be analyzed in an infinite number of ways". However, in practice, the dangers of non-terminating parses are virtually non-existent in sensibly-written natural-language grammars, and so this advantage is not so great as it may seem.[15]

A related claim is that lexicalised grammars assist parsing because "parsing need consider only those trees of the grammar that are associated with the lexical symbols in the input string" (Eisner & Satta 2000: 79f.), rather than searching the whole grammar, and so the specific words used in a sentence "help to restrict the search space during parsing" (Kallmeyer 2010: 20). Once again, however, this argument carries less practical weight than it might seem, since parsing times for TAG grammars are actually rather slow: the best parsing algorithms for TAGs have a time complexity of $\mathcal{O}(n^6)$, as opposed to $\mathcal{O}(n^3)$ in the case of CFGs, for example (Kallmeyer 2010: ch. 5).[16]

There are, however, more theoretical reasons to be interested in lexicalised grammars. Firstly, it is by virtue of lexicalisation that the derivation tree of a sentence corresponds to its dependency structure (Kuhlmann 2010: 4ff.), as discussed in Section 3.4. Because each elementary object in a lexicalised grammar corresponds to a lexical item, by tracking the combination of those objects we are in fact tracking the combination of lexical items. Especially given the recent interest in dependency grammars prompted by the Universal Dependencies project (Nivre et al. 2016), it is clearly advantageous if our formalism has a transparent connection to dependency structures (see also Haug 2023b [this volume] on the relationship between LFG and dependency grammars).

Secondly, a lexicalised grammar fits very well with a lexicalist view of syntactic theory. Since the 1970s (at least since the publication of Chomsky 1970), there

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[15] My thanks to Adam Przepiórkowski and Timm Lichte for discussion of this point.

[16] Although this is true of TAGs in general, if our only concern is lexicalising an existing CFG-based grammar, then we could likely devise a parser specialised for TAG grammars that lexicalise CFGs which would have a complexity below $\mathcal{O}(n^6)$. My thanks to a reviewer for this observation.

has been a trend in linguistic theory towards giving lexical analyses of many phenomena which were previously treated as purely syntactic. Indeed, driven by this trend, a plethora of linguistic frameworks have emerged which very deliberately place the lexicon front and centre, treating it as a "richly structured" object, and assuming "an articulated theory of complex lexical structure" (Dalrymple 2001: 3) – this includes LFG, as well as (to a greater or lesser extent) Generalized Phrase Structure Grammar (GPSG: Gazdar et al. 1985), Head-Driven Phrase Structure Grammar (HPSG: Pollard & Sag 1994, Müller & Wechsler 2014), Combinatory Categorial Grammar (CCG: Steedman 2000), Minimalism (Chomsky 1995), and others. Such a focus on the richness of the lexicon is in stark contrast to the historically more prominent view of it as a mere "collection of the lawless", to use Di Sciullo & Williams's (1987: 4) term, where it is simply a repository of exceptions, "incredibly boring by its very nature", about which "there neither can nor should be a theory" (*ibid.*: 3f.). Given that a lexicalist syntactic theory assumes a richly detailed lexicon, in its most parsimonious form this is *all* it would require, the syntactic component being encoded in the lexical entries themselves. In fact, this is just what lexicalisation provides: in TAG, for example, aside from the basic operations of adjunction and substitution, any other grammatical constraints are described in the elementary trees of lexical items; that is, in the lexicon. In a lexicalised grammar, the lexicon essentially *is* the grammar.[17] This means that every language shares the same computational component, and the only differences between languages are in the lexicon (cf. the Borer-Chomsky Conjecture, mentioned above). This is unlike LFG, for example, where languages differ both in their lexica and in the set of c-structure rules they employ.

6 Factoring out redundancies

Natural language grammars involve a large amount of redundancy: for example, the TAG elementary trees for *loves* and *thinks* shown in Table 1 are identical except for their lexical anchors and for the fact that *loves* takes an NP complement where *thinks* takes an S complement. Similarly, all proper nouns will have elementary trees like *Benjamin*, and all VP adverbs will have elementary trees like *really*, except they may follow rather than precede the VP they modify (i.e. the

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[17] Note that it is possible to collapse the lexicon/grammar distinction without also collapsing the word/phrase (or, equivalently, morphology/syntax) distinction: the processes which build word forms, i.e. the leaf nodes of elementary trees in TAG, need not be the same as those which build derived trees in the syntax. Thus, the formal language theory objections to Construction Grammar presented by Asudeh et al. (2013: 4f.) are only objections to the most radical version of the theory, and need not be taken as objections to constructional approaches generally.

order of the foot node VP* and the AdvP node may be reversed). There is less redundancy when it comes to trees in an LFG grammar, because elementary trees are broken down into smaller-scale phrase-structure rules, but there is plenty of repetition in functional descriptions, where, for example, all 3sg verbs in English will bear the same annotations describing the person and number of their subjects.

Such redundancy or repetition is unavoidable, but it brings with it two undesirable properties: firstly, from a theoretical perspective, it means that certain generalisations may not be expressed; e.g. there are things that *thinks* and *loves* have in common, such as requiring a 3sg subject, and so it is not a mere coincidence that there is overlap in their TAG elementary trees or in their LFG functional descriptions. But nowhere in either grammar is this generalisation expressed *qua* generalisation. Secondly, from a grammar engineering perspective, this kind of redundancy makes updating and extending grammars very difficult: if we change how we analyse a particular phenomenon, we have to make sure we change every instance of it in the grammar (e.g. change every transitive elementary tree); and if we introduce a new feature to deal with some new phenomenon, we have to make sure it is handled correctly in all the existing structures, by manually adapting them one by one. This is clearly likely to lead to inconsistencies and inaccuracies due to human error.

It is therefore desirable to find a means of factoring out redundancies from a grammar, and expressing the generalisations they capture in a single place. Both LFG and TAG have a means of achieving this. In TAG, it is common practice to make use of a METAGRAMMAR, essentially a grammar responsible for generating grammars, where such redundancies can be described just once. Candito (1996, 1999) was one of the first to develop such a metagrammar;[18] her version describes elementary trees along three dimensions: 1) subcategorisation (i.e. how many arguments a verb selects for), including the canonical syntactic functions of the subcategorised arguments; 2) valency alternations/redistribution of syntactic functions; i.e. the actual syntactic function of the arguments; 3) the surface syntactic manifestation of these functions. Each of these dimensions is described by an inheritance hierarchy, and the classes of the metagrammar, corresponding to specific linguistic constructions, such as the English *by*-passive, inherit from

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[18] Candito's approach was the first to make use of non-destructive inheritance hierarchies, a move which has served as the basis for more modern metagrammar implementations (such as XMG, to be introduced below), but it was not the first to tackle the question of factoring redundancies from TAG grammars. Earlier approaches (Becker 1994 and Srinivas et al. 1994), however, make use of (destructive) lexical rules, which has made them less appealing to researchers who prefer a monotonic approach (I thank a reviewer for bringing this to my attention).

one of the terminal classes in the first dimension, one of the terminal classes in the second dimension, and as many of the terminal classes in the third dimension as there are arguments to realise. Constructions can therefore be described by listing the terminal classes they inherit from each of the three dimensions, a label which Kinyon (2000) calls a HYPERTAG (following from the notion of SUPERTAG introduced by Bangalore 1997 – see also Bangalore & Joshi 2010).

The most recent implementation of the concept of metagrammar is the EXTENSIBLE METAGRAMMAR (XMG) of Crabbé et al. (2013). This does away with Candito's three explicit dimensions, and instead employs a highly expressive description language that enables linguistic structures to be given a single, complex description, including multiple levels of representation (e.g. syntax and semantics). It is also designed so that it can be extended to cover new phenomena or linguistic formalisms, and so fewer theoretical assumptions are baked into the formalism. XMG makes use of an inheritance hierarchy, but a single hierarchy instead of Candito's three: rather than taking the approach of describing default syntactic function assignments (dimension 1) and then overriding them with specific valency frames (dimension 2), which might vary, e.g. in the case of diathesis alternations, XMG makes heavy use of disjunctions between alternating descriptions, which enables such alternations to be described fully declaratively, and in just one place. For example, we can express the familiar active-passive diathesis of English as in (32), where each term in italics refers to a class in the metagrammar's inheritance hierarchy that gives a partial description of a (sub-)tree (Crabbé et al. 2013: 616).

(32) $$\begin{aligned} \mathit{TransitiveDiathesis} \rightarrow \quad & (\mathit{Subject} \wedge \mathit{ActiveVerbForm} \wedge \mathit{Object}) \\ & \vee (\mathit{Subject} \wedge \mathit{PassiveVerbForm} \wedge \mathit{ByObject}) \\ & \vee (\mathit{Subject} \wedge \mathit{PassiveVerbForm}) \end{aligned}$$

Each of the disjuncts in (32) combines these descriptions to give a partial description of a full elementary tree schema (an elementary tree minus its lexical anchor). For now I leave aside the details of how these classes actually describe trees; a simplified version of the logical description language employed will be introduced in the next section. The crucial observation here, and the move which sets XMG apart from earlier approaches to metagrammatical analysis, is that the description in (32) does not privilege one elementary tree/realisation of arguments as basic, but simply describes all possible realisations simultaneously.

The terminal classes of the metagrammar are families of trees which are then associated with lemmas, and represent all the different ways of realising that lemma's arguments (e.g. active vs. passive, *wh*-extraction, clefting, etc.). The *TransitiveFamily* associated with a lemma like LOVE might just consist of (32), while the *DitransitiveFamily* of a verb like GIVE might inherit from the *TransitiveFamily* but add an additional object argument:

(33) *TransitiveFamily* → *TransitiveDiathesis*
DitransitiveFamily → *TransitiveDiathesis* ∧ *IndirectObject*

This modular and structured approach to the metagrammar means that, for instance, if the analysis of a particular phenomenon changes, we just need to modify the relevant class(es): when the grammar is compiled anew, all of the implicated elementary trees will be altered accordingly. The choice of classes can also have theoretical implications, and may shed light on important linguistic generalisations.[19]

Although the metagrammatical approach has been used to generate LFG grammars as well as TAGs (Clément & Kinyon 2003a,b), this is not common practice in LFG work. Rather, since redundancies in an LFG grammar are far more abundant in the functional descriptions associated with lexical entries than in phrase structure, the standard solution employed here is to make use of TEMPLATES, a type of macro which can be used to abbreviate pieces of functional description that are re-used across lexical entries (Dalrymple et al. 2004, Crouch et al. 2011; see also Belyaev 2023a: sec. 5.1 [this volume]). These templates can take arguments, and can also call other templates, creating a hierarchical organisation – though it should be noted that this is an *inclusion* hierarchy rather than an inheritance hierarchy, since template calls can be negated (Asudeh et al. 2013: 18f.). The semantics of template invocation (represented by prefixing the template name with a '@' symbol) is substitution: the template name is replaced by its contents. This means that a grammar without templates is extensionally equivalent to one with them, but in the latter it will be possible to express generalisations that cannot be expressed in the former.

By way of illustration, (34–35) present some templates which capture some of the same information present in the XMG classes shown above. The TRANSITIVEDIATHESIS template takes a predicate name as its argument, and consists of a disjunction of three other templates; it will be called by the lexical entry of any transitive verb which participates in the active/passive alternation in English. Each of the three templates it invokes provides a PRED value for the verb in

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[19] Although metagrammars of this sort can certainly be useful theoretical tools, this is not to say that they are intended as models of how the human language faculty functions. As a reviewer points out, it is perhaps implausible that, in the process of language acqusition, the language learner has to recompile their entire grammar every time they make a change or add a new observation. In this regard, LFG's templates (to be introduced below), which are nothing more than abbreviations, might seem more promising as a model of the learner's competence.

question, associating it with the correct set of grammatical functions, and also provides mapping equations which link the GFs to argument positions at semantic structure, or express the fact that the argument is not syntactically realised, in the case of the short passive (this approach to mapping is described in Asudeh & Giorgolo 2012 and Findlay 2016; see also Findlay et al. 2023: sec. 6.2 [this volume]).

(34) $\textsc{TransitiveDiathesis}(P) \equiv$
$@\textsc{ActiveTransitive}(P) \vee @\textsc{ByPassive}(P) \vee @\textsc{ShortPassive}(P)$

(35) a. $\textsc{ActiveTransitive}(P) \equiv (\uparrow \textsc{pred}) = \text{‘}P\langle\textsc{subj}, \textsc{obj}\rangle\text{’}$
$(\uparrow_\sigma \textsc{arg1}) = (\uparrow \textsc{subj})_\sigma$
$(\uparrow_\sigma \textsc{arg2}) = (\uparrow \textsc{obj})_\sigma$

b. $\textsc{ByPassive}(P) \equiv (\uparrow \textsc{pred}) = \text{‘}P\langle\textsc{subj}, \textsc{obl}_{\textsc{by}}\rangle\text{’}$
$(\uparrow_\sigma \textsc{arg1}) = (\uparrow \textsc{obl}_{\textsc{by}})_\sigma$
$(\uparrow_\sigma \textsc{arg2}) = (\uparrow \textsc{subj})_\sigma$

c. $\textsc{ShortPassive}(P) \equiv (\uparrow \textsc{pred}) = \text{‘}P\langle\textsc{subj}\rangle\text{’}$
$(\uparrow_\sigma \textsc{arg1})_{\sigma^{-1}} = \emptyset$
$(\uparrow_\sigma \textsc{arg2}) = (\uparrow \textsc{subj})_\sigma$

One noteworthy difference between the use of a metagrammar and the use of templates is that the latter but not the former are part of a grammar itself. A metagrammar, as the name suggests, sits outside the grammar proper: it outputs grammars, where the elementary objects do not (necessarily) contain information about which metagrammar classes they instantiate. Templates, on the other hand, are part of the description language of the grammar, although of course they are merely names for pieces of functional description, and so have no special formal status themselves.

7 Combining LFG and TAG

Now that we have seen some of the key concepts of TAG, along with their motivations and apparent benefits, we might wonder whether LFG could also benefit from some of these boons if we were to combine the two approaches – most naturally, by using a TAG instead of a CFG to describe LFG’s c-structure. Joshi (2005: 496) described this idea as being “of great interest”, and it was previously explored by Kameyama (1986) and Burheim (1996) – but unfortunately only in unpublished work, which has proved impossible to track down. More recently, the idea has been revived by Findlay (2017a,b, 2019). In this section, I outline two different approaches to achieving the goal of combining LFG and TAG, and discuss some of the consequences of adopting such a merger.[20]

7.1 Two approaches

The most straightforward way of combining TAG and LFG is simply to take a TAG grammar and add appropriate LFG annotations to the elementary trees. Of course, once we have access to the whole tree, we gain a greater degree of flexibility in how we express functional annotations. Most notably, we can refer to any node in the tree directly, rather than being limited to the current node or its mother – a consequence of TAG's extended domain of locality. For example, instead of relying on a sequence of $\uparrow = \downarrow$ annotations to pass information from a lexical item to the top of its extended projection, we can refer to the top directly. For the sake of simplicity, let us use node labels as shorthand for the nodes themselves.[21] Then the ($\uparrow$ PRED) = 'love' annotation on the verb *loves*, for example, could be rewritten as (S_ϕ PRED) = 'love', using S_ϕ to refer to the f-structure of the clause directly, rather than indirectly via V_ϕ (the instantiation of $\uparrow$), which is equated with both VP_ϕ and S_ϕ. Indeed, since we can use absolute rather than relative labels for the nodes in the tree, there is no need to mark annotations actually on the tree at all; instead, we can treat lexical entries as pairs consisting of the tree on the one hand and the annotations on the other, which refer to nodes in the tree. This arguably simplifies the process of determining an f-structure from an annotated c-structure, since many identities which would normally have to be computed are instead already given in the descriptions. Table 2 shows the elementary trees from Table 1 augmented in this fashion.

The trees then combine as usual for a TAG, using the operations of substitution and adjunction, albeit understood in a particular fashion. Substitution involves identifying two nodes, so that, e.g. if the tree for *Benjamin* were substituted into the subject position of the tree for *loves*, NP and NP1 would be identified (and therefore so would their f-structures, requiring the nodes to bear compatible annotations – and thereby accounting for the agreement facts, for example). Ad-

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[20] One concern about replacing the CFG component of LFG with a more powerful TAG might be that it makes the formalism as a whole more computationally complex. However, since TAGs are strictly less powerful than LFGs (see Section 4), such a concern is ultimately baseless.

[21] Of course, in reality nodes and their labels are distinct: several nodes can bear the same label, for example (e.g. there can be more than one NP in a tree). When this happens, I follow the TAG convention of suffixing node labels with numbers (e.g. NP1 and NP2), but it should be borne in mind that this is just a representational choice, and that in reality such nodes have identical labels.

junction involves three steps: first we excise a sub-tree rooted at the adjunction site; next, we *replace* it with the adjoining auxiliary tree; finally, we unify the foot node of the auxiliary tree with the root node of the excised sub-tree it replaced.[22] This way, we identify the target of adjunction with the foot of the auxiliary tree, and correctly distribute the annotations between the two "parts" of the expanded node without the need for top and bottom feature structures.[23,24]

This first approach is much more in the spirit of TAG than of LFG, since the c-structure component is derivational, making use of the combining opera-

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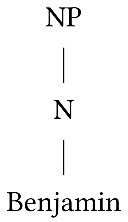
[22] Note that it is particularly important in this setting that adjunction is only defined where the adjoining tree's root and foot nodes are of the same category. In some TAG settings this would not need to be stated explicitly, depending on how adjunction is defined, but here the root of the auxiliary does not unify with anything, and so there is nothing which formally requires the root and foot nodes of such a tree to have the same category (I thank a reviewer for this observation). Allowing trees with mismatched root and foot nodes to participate in adjunction would have undesirable consequences: for example, we do not want the tree for *loves* in Table 2 to act as an NP modifier (e.g. **the Benjamin loves boy*).

[23] A reviewer asks how obligatory adjunction can be implemented in this setting, since in FTAG it exploits the possibility of mismatching top and bottom features (see Section 3.3). Ultimately, the answer is that the greater expressive power of the LFG projection architecture means that the effects of obligatory adjunction constraints will be captured in different ways in different situations. Constraining equations will frequently be relevant: for example, returning to the example of *to leave* from (18), to implement the SA constraint we might specify that *tried* requires its comp to contain the feature [finite −], whereas *imagined* requires it to contain [finite +]; if *to leave* specifies that its f-structure contains [finite −], then it will be compatible with the former but incompatible with the latter. If we wish to avoid *to leave* appearing on its own (i.e. we rule out fragments), we might implement a general ban on root f-structures containing [finite −], or we might rely on the resource sensitivity of Glue Semantics, since an infinitive alone will not permit a linear logic proof terminating in the goal type of propositions.

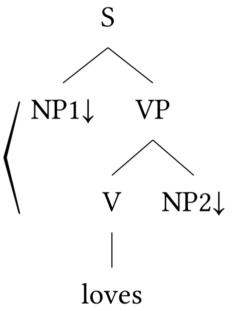
[24] Findlay (2017a: 222, fn. 12) claims that we are forced to adopt the second proposal to be discussed below, using descriptions of trees, because adjunction means that the ↑ and ↓ chains in annotations will be disrupted. This would be true if we were forced to refer to f-structures only indirectly, via mother-daughter links, but fails to appreciate the additional freedom afforded by being able to refer to nodes absolutely, as discussed above. There is, however, a small wrinkle when it comes to verbal trees for extraction constructions (e.g. *wh*-questions): if nothing is adjoined to them, we want to unify the f-structures of the root S′ and the S node it immediately dominates; but if a sentential embedding verb is adjoined there, we cannot identify the two f-structures, or else we will end up with a cyclic f-structure which is its own comp. All this shows us though is that we have to take care when writing the functional annotations. Here, for example, we can solve the problem by actually reintroducing an element of relativity: we identify the root node's f-structure with the f-structure of its S daughter (e.g. by defining a predicate CatDaughter(n, C) which identifies the unique daughter of node n which bears label C, and is undefined if there is none or more than one), regardless of which node that actually ends up being. I omit the formal details of how this can be achieved, since ultimately we will settle on the second approach to integrating TAG and LFG described below, but it is important to note that this first approach is not unworkable.

Table 2: Some elementary trees with associated LFG annotations

Initial trees

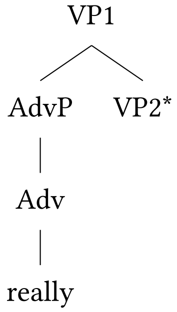


$$\begin{gathered}\mathrm{NP}_\phi = \mathrm{N}_\phi \\ (\mathrm{NP}_\phi\ \textsc{pred}) = \text{‘Benjamin’} \\ (\mathrm{NP}_\phi\ \textsc{num}) = \textsc{sg} \\ (\mathrm{NP}_\phi\ \textsc{pers}) = 3\end{gathered}$$

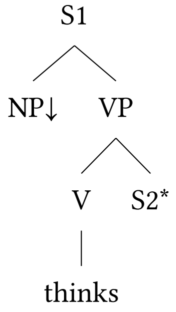


$$\begin{gathered}\mathrm{S}_\phi = \mathrm{VP}_\phi = \mathrm{V}_\phi \\ (\mathrm{S}_\phi\ \textsc{pred}) = \text{‘love’} \\ (\mathrm{S}_\phi\ \textsc{tense}) = \textsc{pres} \\ (\mathrm{S}_\phi\ \textsc{subj}) = \mathrm{NP1}_\phi \\ (\mathrm{S}_\phi\ \textsc{obj}) = \mathrm{NP2}_\phi \\ (\mathrm{NP1}_\phi\ \textsc{num}) = \textsc{sg} \\ (\mathrm{NP1}_\phi\ \textsc{pers}) = 3\end{gathered}$$

Auxiliary trees



$$\begin{gathered}\mathrm{VP1}_\phi = \mathrm{VP2}_\phi \\ \mathrm{AdvP}_\phi = \mathrm{Adv}_\phi \\ (\mathrm{AdvP}_\phi\ \textsc{pred}) = \text{‘really’} \\ \mathrm{AdvP}_\phi \in (\mathrm{VP1}_\phi\ \textsc{adj})\end{gathered}$$



$$\begin{gathered}\mathrm{S1}_\phi = \mathrm{VP}_\phi = \mathrm{V}_\phi \\ (\mathrm{S1}_\phi\ \textsc{pred}) = \text{‘think’} \\ (\mathrm{S1}_\phi\ \textsc{tense}) = \textsc{pres} \\ (\mathrm{S1}_\phi\ \textsc{subj}) = \mathrm{NP}_\phi \\ (\mathrm{S1}_\phi\ \textsc{comp}) = \mathrm{S2}_\phi \\ (\mathrm{NP}_\phi\ \textsc{num}) = \textsc{sg} \\ (\mathrm{NP}_\phi\ \textsc{pers}) = 3\end{gathered}$$

tions of substitution and adjunction. Let us therefore call it LFG-TAG. But as Kaplan (1995: 11) points out, this PROCEDURAL, or CONSTRUCTIVE, approach to grammatical analysis is in contrast to the DESCRIPTIVE (a.k.a. DECLARATIVE or MODEL-BASED) approach which is the “hallmark of LFG” (*ibid.*). Findlay (2019: ch. 5) therefore explores another way of combining the two frameworks which is more in keeping with the LFG spirit. In brief, we associate lexical entries with *descriptions* of trees, rather than with the trees directly, as is standard practice in metagrammars, for instance.[25] In the simplest cases there is a one-to-one correspondence between a description and the (minimal) tree it describes, and so we could straightforwardly translate LFG-TAG into a more LFG-like format. However, descriptions can also make use of negation, disjunction, or other operations that go beyond simple conjunction of propositions, and in this case the relation between descriptions and trees is no longer isomorphic (Kaplan 1995: 14).

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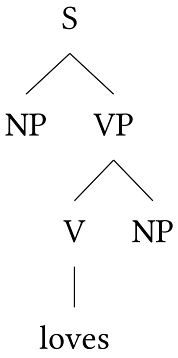
[25] The use of tree descriptions has been discussed extensively in the context of TAG – see, for instance, Vijay-Shanker (1992), Rogers & Vijay-Shanker (1994), Rambow et al. (1995, 2001), Kallmeyer (2001).

In order to add descriptions of trees to LFG lexical entries, we need a suitable language to write the descriptions in. There are a variety of different possibilities, but here we will assume a fairly simple language based on that used in XMG (Crabbé et al. 2013: 599), which will consist of the following:[26]

(36)
1. a set N of node variables
2. a set P of unary labelling predicates, including all terminal and non-terminal labels
3. the following binary predicates:
    - $\rightarrow$, immediate dominance (the *mother-of* relation)
    - $\rightarrow^*$, dominance (the transitive, reflexive closure of $\rightarrow$)
    - $\prec$, linear precedence[27]

The tree in (37) can then be described by the set of constraints in (38):[28]

(37)



(38)

$$\begin{array}{lll}
\mathrm{S}(n_1) & n_1 \rightarrow n_2 & n_2 \prec n_3 \\
\mathrm{NP}(n_2) & n_1 \rightarrow n_3 & n_4 \prec n_5 \\
\mathrm{VP}(n_3) & n_3 \rightarrow n_4 & \\
\mathrm{V}(n_4) & n_3 \rightarrow n_5 & \\
\mathrm{NP}(n_5) & n_4 \rightarrow n_6 & \\
\mathrm{loves}(n_6) & &
\end{array}$$

However, as it stands, the constraints in (38) are too rigid. Specifically, they will not allow adjunction at the VP node, since then at least one statement in the

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[26] We will also assume that sufficient axioms are in place to ensure the usual well-formedness conditions on trees, e.g. that they are singularly rooted, that branches cannot cross, etc. Rogers (1998: 15f.) gives one such set of axioms.

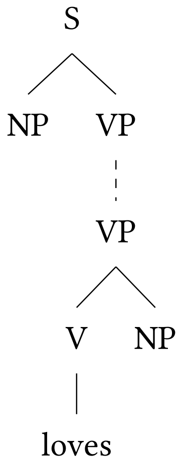
[27] Here this is to be understood as the transitive closure of immediate linear precedence, i.e. what Crabbé et al. (2013: 599) represent as $\prec^+$. In other words, a node linearly precedes everything to its right, but does not linearly precede itself.

[28] In descriptions, we will assume that all node variables are ultimately existentially bound.

description will no longer be true: if we identify the target n_3 with the root of the adjoining tree, then $n_3 \rightarrow n_4$ will no longer hold (the foot node of the auxiliary tree will dominate n_4 instead), and if we identify it with the foot node of the adjoining tree, then $n_1 \rightarrow n_3$ will not be true instead. The basic problem is that "[t]he composition operation of adjoining creates a new structure that does not maintain all of the properties that held in the original (fully specified) structures of which it is composed" (Vijay-Shanker 1992: 486). What this means is that we cannot operate with fully specified descriptions, but must make use of partial descriptions instead.

For each node where adjunction can apply, we instead describe a pair of quasi-nodes which stand in the dominance relation (Vijay-Shanker 1992: 486ff.). That is, instead of (38), we have (40), which is represented schematically in (39) (where a dashed line represents dominance rather than immediate dominance):

(39)



(40)			
	S(n_1)	$n_1 \rightarrow n_2$	$n_2 \prec n_3$
	NP(n_2)	$n_1 \rightarrow n_3$	$n_5 \prec n_6$
	VP(n_3)	$n_3 \rightarrow^* n_4$	
	VP(n_4)	$n_4 \rightarrow n_5$	
	V(n_5)	$n_4 \rightarrow n_6$	
	NP(n_6)	$n_5 \rightarrow n_7$	
	loves(n_7)		

As elsewhere in LFG, we take the solution to a set of constraints to be the *minimal* structure (or structures) which satisfies all the constraints. Since the dominance relation is reflexive, the minimal tree which satisfies (40) remains (37), i.e. one where we equate n_3 and n_4. But, crucially, if something is adjoined here, the nodes can come apart, with the result that n_3 is identified with the root of the auxiliary tree and n_4 with its foot node.

Now that we have a description of this tree, we can combine it with functional descriptions to form a full LFG lexical entry:[29]

(41)
$$\begin{array}{llll}
\mathrm{S}(n_1) & n_1 \rightarrow n_2 & n_2 \prec n_3 & n_{1\phi} = n_{3\phi} \\
\mathrm{NP}(n_2) & n_1 \rightarrow n_3 & n_5 \prec n_6 & n_{4\phi} = n_{5\phi} \\
\mathrm{VP}(n_3) & n_3 \rightarrow^{*} n_4 & & (n_{5\phi}\ \textsc{pred}) = \text{‘love’} \\
\mathrm{VP}(n_4) & n_4 \rightarrow n_5 & & (n_{5\phi}\ \textsc{tense}) = \textsc{pres} \\
\mathrm{V}(n_5) & n_4 \rightarrow n_6 & & (n_{1\phi}\ \textsc{subj}) = n_{2\phi} \\
\mathrm{NP}(n_6) & n_5 \rightarrow n_7 & & (n_{4\phi}\ \textsc{obj}) = n_{6\phi} \\
\text{loves}(n_7) & & & (n_{2\phi}\ \textsc{num}) = \textsc{sg} \\
 & & & (n_{2\phi}\ \textsc{pers}) = 3
\end{array}$$

To parse a sentence, we just collect up all of the constraints associated with each lexical item and find the minimal structures – both c-structure and f-structure – which satisfy them.

Of course, (41) is not particularly readable, so we might prefer to collect some parts of the description in various templates. For example, the tree for any transitive verb will share most of the description in (41), so we can factor out this part of the description, parametrising the only variable, namely the lexical anchor:

(42) $\textsc{TransitiveTree}(s, np_1, vp_1, vp_2, v, np_2, a, \textit{ANCHOR}) \equiv$
$$\begin{array}{llll}
\mathrm{S}(s) & s \rightarrow np_1 & np_1 \prec vp_1 & s_{\phi} = vp_{1\phi} \\
\mathrm{NP}(np_1) & s \rightarrow vp_1 & v \prec np_2 & vp_{2\phi} = v_{\phi} \\
\mathrm{VP}(vp_1) & vp_1 \rightarrow^{*} vp_2 & & (s_{\phi}\ \textsc{subj}) = np_{1\phi} \\
\mathrm{VP}(vp_2) & vp_2 \rightarrow v & & (vp_{2\phi}\ \textsc{obj}) = np_{2\phi} \\
\mathrm{V}(v) & vp_2 \rightarrow np_2 & & \\
\mathrm{NP}(np_2) & v \rightarrow a & & \\
\textit{ANCHOR}(a) & & &
\end{array}$$

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[29] Here I have kept to a more conservative annotation scheme than above, whereby e.g. lexical contributions are associated with the f-structure of n_5, i.e. the V node, rather than with that of the root S. This is because adjunction may in principle alter the structure of the tree so that it is no longer the case that the f-structure of the S node is the same as the f-structure of the V node. In fact, with verbal trees like this, that will not be the case, because the only auxiliary trees which target VPs in a TAG grammar will be auxiliary verbs or adverbial modifiers, neither of which will break the link between V and S in terms of f-structure-identity. But it will, for example, be relevant for verbal trees containing extraction sites, which can be targetted by sentential embedding verbs, thereby separating the root's f-structure from the head verb's.

We have to "expose" all nodes as parameters of the template, so that they can be referred to by other constraints in the same lexical entry, thereby taking advantage of the extended domain of locality afforded by having the description of the whole tree in one place. However, since all of the parameters in (42) except the lexical anchor will simply be node variables, I propose a shorthand: when calling the template, all but the last parameter will be omitted (though, to repeat, when defining it all the parameters must be specified); if we wish to refer to any of the other parameters, we can do so by using the template name and suffixing it with the appropriate parameter.[30] For example, TransitiveTree.s refers to the first parameter, a node variable which corresponds to the root node s in (42). With these conventions in place, we can write a more readable lexical entry for *loves* as in (43), using a local name, %up, to refer to the verb's f-structure – see Belyaev 2023a: sec. 3.2.5 [this volume] for the details on local names):[31]

(43) @TransitiveTree(loves)
%up = TransitiveTree.v_{ϕ}
(%up pred) = 'love'
(%up tense) = pres
(%up subj num) = sg
(%up subj pers) = 3

One theoretical advantage of this approach is that we can build up trees from smaller parts by making use of nested template calls. This allows us to capture connections between phrasal configurations in a way which CFG rules do not. For example, there is no relationship between the two rules in (44), even though the latter is obviously partially described by the former:[32]

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[30] This is based on the conventions of XMG for exported variables (Crabbé et al. 2013: 602–604).

[31] Here I have reverted to describing the agreement constraints on the subject via the verb's f-structure rather than via the NP's, to make this lexical entry closer to the LFG standard. But of course the option is still open to us to describe it via the tree directly, by associating TransitiveTree.$np_{1\phi}$ with a name, e.g. %subj-np, and then declaring that (%subj-np num) = sg. Although these options are extensionally equivalent here, there can be theoretical/descriptive reasons to prefer one over the other. Cross-linguistically, for example, we might want to treat subject agreement as the same kind of phenomenon both in languages where phrase-structure position is a clear guide to grammatical function (like English) and in languages where it is not (like Warlpiri); so it would make sense to retain the standard LFG approach of describing agreement via f-structure. But in other cases it might make more sense to refer to a particular phrase-structure position, and the integration of an extended tree description into the lexical entry means we now have that choice.

[32] Of course, we can use the convention of surrounding optional nodes in parentheses, and then we can express the relationship between the two rules within a single phrase-structure rule as follows:

(44) a. $$\begin{array}{llll} \text{VP} & \longrightarrow & \text{V} & \text{NP} \\ & & \uparrow=\downarrow & (\uparrow \textsc{obj}) = \downarrow \end{array}$$

b. $$\begin{array}{lllll} \text{VP} & \longrightarrow & \text{V} & \text{NP} & \text{NP} \\ & & \uparrow=\downarrow & (\uparrow \textsc{obj}) = \downarrow & (\uparrow \textsc{obj}_{\theta}) = \downarrow \end{array}$$

On the other hand, if we have a template DitransitiveTree which calls the TransitiveTree template (as well as another template which adds a secondary object), then this containment relationship is made explicit, as shown in (45).

(45) DitransitiveTree(*anchor*) ≡ @TransitiveTree(*anchor*)
@SecondaryObject

Of course the TransitiveTree template can also be decomposed into a call of an IntransitiveTree template plus a PrimaryObject one, and so on. By continuing along these lines, we can capture all the various generalities across trees in a template inclusion hierarchy, recreating the class hierarchies of a TAG metagrammar inside an LFG grammar itself.

7.2 Implications

Having now seen how LFG and TAG can be combined, let us consider the consequences of such a merger. There are several potential gains which such a move could bring, along with several unanswered questions which require further research.

Firstly, the second approach described above offers a pleasing harmonisation of LFG lexical entries. Standard LFG lexical entries contain descriptions of all levels of the projection architecture, but since such lexical entries are really just context-free phrase-structure rules, the description of c-structure is limited to information about the word itself and its mother. In contrast, descriptions of all other levels of structure can refer to arbitrarily distant elements (via functional uncertainty). The inclusion of tree descriptions removes this irregularity from the grammar, since now non-local elements of c-structure can also be included.

(i) $$\begin{array}{lllll} \text{VP} & \longrightarrow & \text{V} & \text{NP} & \left(\begin{array}{c} \text{NP} \\ (\uparrow \textsc{obj}_{\theta}) = \downarrow \end{array}\right) \\ & & \uparrow=\downarrow & (\uparrow \textsc{obj}) = \downarrow & \end{array}$$

However, once we move beyond simple examples like this, such an approach becomes unwieldy, with multiply nested parentheses and very complex disjunctions. Unlike the templatic approach, which provides a readable front-end to the formal complexity, and allows us to represent the relationship(s) between sub-trees in an inclusion hierarchy, this approach forces us to create fewer but more complex rules, which does nothing to aid human-readability.

Secondly, we now have the opportunity to lexicalise an LFG grammar (indeed, Findlay 2019: ch. 5 calls the description-based approach described above "Lexicalised LFG"). As outlined above, the extended domain of locality of a TAG means that all dependencies, including long-distance ones, can be encoded locally in a lexical entry. Lexicalisation seems a natural goal for a lexicalist theory like LFG, and it is perhaps lamentable that it was not possible before.

Thirdly, we can now straightforwardly account for idioms (Findlay 2019: ch. 6). These are problematic for the current leading account of constructions in LFG (Asudeh et al. 2013), since they do not simply add additional constructional meaning to existing lexical meaning, but rather *replace* the lexical meaning with another, different meaning (that is, *shooting the breeze* involves neither shooting nor a uniquely contextually salient breeze). This forces lexicalist theories like LFG to adopt an approach which treats idioms as conspiracies of independent lexical items that select for one another (see Findlay 2023: sec. 4.3). Such approaches face a host of problems, not least of which is that they singularly fail to capture our intuitions about idioms – *viz.* that they are "things" (as Williams 2007 puts it), and not mere epiphenomena of the grammar (see Findlay 2019: 58ff. for discussion of various other problems). But now that we can have lexical entries containing multiple, separable word forms, something which is not possible in vanilla LFG, there is no obstacle to encoding multiword expressions in a single place, thus enabling a much more satisfying analysis. Findlay (2019: ch. 3) provides detailed discussion of the need for this kind of constructional approach to idioms, as well as arguments against other types of analysis.

Fourthly, in addition to idioms, we have a straightforward account of constructional phenomena more broadly. Similar arguments can be made here about the need for constructions to have some ontological status in the theory – to be "things".[33] Admittedly, Asudeh et al. (2013) demonstrate that we do not need to admit constructions as first-class entities in our theory in order to explain *some* kinds of constructional effects, but they only consider constructions which can be described by a single lexical entry or a single context-free phrase-structure rule, and so the constructions in question can be described in a single place. Other constructions require reference to wider spans of phrase structure, or require

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[33] There is suggestive psycho- and neurolinguistic evidence that the way we process language makes heavy use of prefabricated chunks ("prefabs") (Pawley & Syder 1983, Wray 2002) and of constructions more generally (Bencini & Goldberg 2000, Kaschak & Glenberg 2000, Goldwater & Markman 2009, Pulvermüller 2010, Allen et al. 2012, Johnson & Goldberg 2012). Obviously grammatical theory need not have anything to say about how language is processed in the mind, but it might still be seen as an advantage if it at least makes available the kinds of objects the mind seems to work with – e.g. constructions.

the presence of multiple specific words, potentially in quite distant parts of the phrase, and here the approach will once again have to rely on multiple interacting lexical entries and phrase-structure rules which conspire to give the correct constructional effects. Even if this gives the right results, one might, again, object that it does so for the wrong reasons, since it fails to account for the unitary nature of constructions as grammatical objects. By contrast, in the description-based approach to merging TAG and LFG, although constructions are still not added as new objects in the ontology of the theory, they nevertheless have a kind of first-class status, since they can either be entire (complex) lexical entries or be a part of a lexical entry in the form of a tree template which can be called by all the different words which can fill the empty slots in the construction. See Findlay (2023) for a broader discussion of the connection between LFG and Construction Grammar, and for arguments that vanilla LFG is inadequate to give a satisfactory analysis of certain multiword (substantive) constructions.

Alongside these advantages of combining LFG and TAG, there remain some unexplored implications which are ripe for future work. Firstly, one of the parade examples of LFG's utility is in describing languages with highly flexible word orders, such as Warlpiri (see e.g. Bresnan et al. 2016: ch. 1). With TAG's focus on configurational properties, we need to ensure that incorporating a TAG into LFG does not undo its ability to describe these non-configurational languages. Given the flatter tree structures generally assumed for such languages (Simpson 1991, Austin & Bresnan 1996), a first pass solution in the present framework would be to simply make use of looser tree descriptions, which, for example, lack linear precedence relations between a verb and its arguments, so that the the entry for a verb does not describe a unique minimal tree, but rather several minimal trees which represent the different orderings of arguments. Of course, these different orderings are not just random, and actually correspond to different information structures, so simply allowing free choice between them is inadequate. Instead, we should once again make use of disjunction, this time between the descriptions corresponding to the different orderings of verb and arguments, where each of the different word orders is also accompanied by the correct information-structural annotations.

Such languages also often permit discontinuous constituents, and these will require their own solution. For example, some adjuncts might be represented not as auxiliary trees that induce a more articulated structure, but rather as simpler trees whose root merely unifies with another node, such as the clausal root S, adding the adjunct as a sister to the existing daughters. Obviously this sketch needs to be developed into a fully fleshed-out proposal before we can be confident that no analytical clout has been lost.

Another open question arises from the fact that using a TAG as the basis of the c-structure component means that we can employ adjunction to account for long-distance dependencies. This then removes a foundational motivation for functional uncertainty (Kaplan & Zaenen 1989), one of the major sources of formal complexity in LFG. Unfortunately, this does not mean we can simply remove functional uncertainty from the formalism, since it has been employed by researchers in various other domains beyond filler-gap dependencies – most notably in LFG's binding theory (e.g. Dalrymple 1993, Dalrymple et al. 2018). Determining whether these analyses can be reformulated so that functional uncertainty could be done away with altogether remains a task for future work, perhaps drawing on existing TAG analyses of binding (e.g. Ryant & Scheffler 2006, Champollion 2008, Storoshenko et al. 2008, Storoshenko & Han 2013).

Lastly, including a description of a tree which incorporates the full extended projection of a predicate in its lexical entry means that we can take a rather different view of argument structure. A predicate's arguments and the possibilities for their realisation can be encoded directly in its lexical entry, rather than relying on a separate level of representation like a-structure (on which see Findlay et al. 2023 [this volume]). And alternative argument realisations, e.g. diathesis alternations, can be expressed through disjunctive templates, as discussed above in parallel with XMG, rather than through a separate mechanism of mapping between a-structure and f-structure. Work on developing templatic approaches to argument structure include Asudeh & Giorgolo (2012), Findlay (2016, 2020), and Przepiórkowski (2017), but these do not take c-structure into account: with the new TAG perspective, the phrase-structural effects of argument structure/mapping phenomena can also be directly expressed.

8 Conclusion

Tree-Adjoining Grammar offers a rather different perspective on some grammatical phenomena from that of CFG-based formalisms.[34] For instance, it allows us to describe constraints on filler-gap relationships via the structure of the elementary trees in the grammar rather than via an independent principle like Subjacency. It also provides a natural account of the fact that many "lexical" items in fact incorporate several distinct word forms (e.g. phrasal verbs, compounds, idioms), and of constructional meaning, by virtue of its expanded concept of locality. And, computationally speaking, it possesses just the right degree

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[34] TAG has also played an important role outside of theoretical linguistics – specifically in both computational linguistics (see e.g. Kallmeyer et al. 2008, Kasai et al. 2017, Koller 2017) and psycholinguistics (see e.g. Ferreira 2000, Ferreira et al. 2004).

of context-sensitivity to account for natural languages while remaining parsable in polynomial time. Nonetheless, its representation of dependency structures is imperfect, and its focus on the primacy of phrase structure leaves it somewhat impoverished when compared to the richly expressive parallel projection architecture of LFG, which facilitates a much fuller view of the grammar as a whole. Combining the two approaches might therefore offer a tempting opportunity to acquire the best of both worlds. In Section 7 we saw how this could be achieved, and the possibilities this affords for LFG, both in terms of descriptive power and in terms of potentially further-reaching formal or architectural changes.

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Appendix A:

Glossary

Mary Dalrymple
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↑ (‘UP’)	In an annotation on a daughter category in a phrase structure rule, the f-structure corresponding to the mother node. See Belyaev 2023c: 4.2 [this volume].
↓ (‘DOWN’)	In an annotation on a daughter category in a phrase structure rule, the f-structure corresponding to the daughter node on which the ↓ annotation appears. See Belyaev 2023c: 4.2 [this volume].
$\hat{*}$	In an annotation on a daughter node in a phrase structure rule, the mother node in the constituent structure tree. See Belyaev 2023c: 4.2 [this volume].
$*$	In an annotation on a daughter node in a phrase structure rule, the daughter node on which the $*$ annotation appears. See Belyaev 2023c: 4.2 [this volume].
$<*$	In an annotation on a daughter node in a phrase structure rule, the immediate left sister of the daughter node on which the annotation appears. See Belyaev 2023a: 4.2.1 [this volume].
$*>$	In an annotation on a daughter node in a phrase structure rule, the immediate right sister of the daughter node on which the annotation appears. See Belyaev 2023a: 4.2.1 [this volume].
←	In an off-path constraint, the f-structure immediately containing the feature on which the annotation appears. See Belyaev 2023a: 3.2.2 [this volume].

Mary Dalrymple. 2023. Glossary. In Mary Dalrymple (ed.), *Handbook of Lexical Functional Grammar*, 2127–2149. Berlin: Language Science Press. DOI: 10.5281/zenodo.10186056

$\rightarrow$ In an off-path constraint, the f-structure value of the feature on which the annotation appears. See Belyaev 2023a: 3.2.2 [this volume].

$>_f$ See Functional precedence.

$=_c$ See Constraining equation.

$\multimap$ See Linear implication.

$\wedge$ See Conjunction.

$|$ See Disjunction.

$\vee$ See Disjunction.

/ At the end of the list of daughters in a phrase structure rule: see 'Ignore' operator.

\ Following an f-structure reference: see Restriction.

_ After a symbol: see Instantiated symbol.

, (COMMA) Between daughter categories in a phrase structure rule: see ID/LP rule. Between sequences of categories enclosed by square brackets in a phrase structure rule: see 'Shuffle' operator.

ϕ PROJECTION The ϕ projection is a projection function from nodes of the constituent structure to their corresponding functional structures.

$^{-1}$ See Inverse correspondence function.

ϵ The empty string.

X^0 In X-bar theory, a zero-level or lexical category, usually a single word. For example, the noun *horse* is of category N^0, and can appear as the head of a phrase of category NP.

X' In X-bar theory, a single bar level category, projected from the X head.

$\widehat{X}$ See Non-projecting word.

A-STRUCTURE The linguistic representation of the information in argument structure.

ADJ The adjunct grammatical function. At functional structure, a feature whose value is a set of f-structures.

ADJUNCT CONTROL A construction in which a control relation holds between an argument in the matrix clause and an unexpressed argument in an adverbial subordinate clause. See Vincent 2023 [this volume].

ANAPHORIC CONTROL A control construction in which an argument of a matrix clause is required to corefer with the subject of a closed clause such as COMP. See Vincent 2023 [this volume].

ANNOTATED PHRASE STRUCTURE RULE A phrase structure rule in which the daughter categories are annotated with constraints on the functional structures and other levels of representation to which they correspond. See Belyaev 2023c: 4.2 [this volume].

ARGUMENT STRUCTURE A level of linguistic structure which represents the aspects of meaning that are relevant for determining the syntactic role of the argument of a predicate. Its representation is referred to as A-structure. See Findlay et al. 2023 [this volume] and, for a historical perspective, Booth & Butt 2023: 3.2 [this volume].

ATOMIC VALUES Feature values which have no internal structure, as opposed to complex values such as functional structures or semantic forms.

ATTRIBUTE See Feature.

ATTRIBUTE-VALUE MATRIX See Attribute-value structure.

ATTRIBUTE-VALUE STRUCTURE A structure containing attributes (features) and values, usually represented graphically as a list in which each line contains an attribute followed by its value, with the entire list enclosed in square brackets. Functional structure is generally represented as an attribute-value structure.

BACKWARD CONTROL A control construction in which the controller appears overtly in the embedded clause and the controlled argument is in the matrix clause. See Vincent 2023 [this volume].

BACKWARD RAISING A construction which shares all the distributional properties of a raising construction except that the embedded subject appears in the embedded clause and not in the matrix clause. See Vincent 2023 [this volume].

C See CP.

C-COMMAND A relation between nodes of the constituent structure tree. Several slightly different definitions of c-command have been proposed, but a commonly accepted one states that a node *n*1 c-commands a node *n*2 if and only if all of the nodes which dominate node *n*1 also dominate node *n*2.

C-PRECEDENCE The left-to-right precedence relation holding between nodes of the constituent structure tree. See Belyaev 2023a: 3.2.6 [this volume] and Rákosi 2023: 2.3 [this volume].

C-STRUCTURE See Constituent structure.

CAT PREDICATE A predicate relating a functional structure to the category labels of the constituent structure nodes that correspond to it via the inverse of the ϕ projection. CAT takes two arguments: an f-structure, and a set of constituent structure category labels. The CAT specification requires that at least one of the c-structure nodes corresponding to the specified f-structure has one of the labels in the set. For instance, assume that an f-structure f is related via the inverse ϕ correspondence to c-structure nodes labeled NP, N′, and N; in this case, all of the following predicates hold: CAT(f, {NP, N′, N}); CAT(f, {NP}); CAT(f, {NP, AP}). The CAT predicate is interpreted distributively and thus may help in describing unlike category coordination: if f is a set of f-structures representing a coordination, each f-structure in f must correspond to at least one node with a label in the set. For example, the specification CAT(f, {AP, PP}) allows f to correspond to a conjunction of APs, a conjunction of PPs, or a conjunction of unlike categories composed of APs and PPs. See Patejuk 2023 [this volume]. A related definition is sometimes assumed: in Belyaev 2023c [this volume], Bond 2023 [this volume], and Sadler 2023 [this volume], CAT is a function over f-structures, returning the set of labels of the c-structure nodes to which the f-structure corresponds. According to this definition, if f is related to c-structure nodes with categories NP, N′, and N, CAT(f)={NP, N′, N}.

CLAUSE-TYPE Feature whose value is the type of the clause. Typical values are DECL for declarative, IMP for imperative, and INT for interrogative. Sometimes as CLTYPE.

CLTYPE See CLAUSE-TYPE.

Codescription The simultaneous description of more than one level of linguistic structure, as opposed to description by analysis. See Belyaev 2023c: 5 [this volume].

(F-structure) Co-head At constituent structure, an X^0 node is an f-structure co-head with another X^0 node if both nodes correspond to the same functional structure.

Coherence The requirement that an f-structure may not contain governable grammatical functions that are not selected by the predicate (the semantic form value of the pred feature). See Belyaev 2023a: 3.4.3 [this volume].

comp A grammatical function typically associated with sentential complements.

Comp,X In constituent structure, the complement of X; that is, the non-head daughter of X′ which is sister to the head, X^0. See X-bar theory.

compform Feature whose value is the form of the complementizer, for example that or whether for English. Sometimes as comp-form, especially in the ParGram grammars.

Completeness The requirement that all governable grammatical functions required by the predicate (the semantic form value of the pred feature) must be present. See Belyaev 2023a: 3.4.2 [this volume].

Complex category A constituent structure category consisting of a category label (such as I, NP, or V′) and a set of features or parameters. For example, VP[fin] is a complex category, with category VP and parameter ‘fin’ for finite. See Booth & Butt 2023: 4.2 [this volume], and for an implementational perspective, Forst & King 2023: 2.2 [this volume].

Complex predicate A construction in which there is a mismatch in the number of predicates at functional structure and the number of forms at constituent structure which express them. See Andrews 2023b [this volume].

concat Built-in template in XLE taking two or more arguments. All arguments except the last one are concatenated, and the result is the final argument. For example, in @(CONCAT look ‘- up %FN) the first argument is ‘look’, the second argument is ‘-’ (which must be explicitly quoted with the back quote in XLE), the third argument is ‘up’, and %FN would be ‘look-up’.

concord Feature whose value is an f-structure containing certain agreement features, typically including the features gend, num, and case and their values. See Haug 2023a: 3 [this volume].

Configurational language See Configurationality.

Configurationality A language type in which grammatical functions are often or always associated with particular constituent structure positions. Also see Non-configurationality.

conj Feature whose value is the form of the conjunction in a coordinate phrase, for example and or or in English. Sometimes represented as conjform or conjtype.

conjform See conj.

conjtype See conj.

Conjunction of functional descriptions Conjunction of functional descriptions is usually implicit, but is sometimes represented as $\wedge$.

(Principle of) Conservation A general constraint on linguistic derivations that requires a bounded relationship between the amount of information (the sizes) of every pair of corresponding structures. This is a sufficient condition for the decidability of many important computational problems. See Kaplan & Wedekind 2023 [this volume].

Consistency The requirement for a feature to have exactly one value, and not more than one. See Belyaev 2023a: 3.4.1 [this volume].

Constituent structure The linguistic level representing word order and phrasal constituency, represented as a phrase structure tree. See Belyaev 2023c: 3 [this volume] and Andrews 2023a [this volume]; for a historical perspective, see Booth & Butt 2023: 4 [this volume].

Constrained lexical sharing A restricted theory of lexical sharing. See Booth & Butt 2023: 4.4 [this volume].

Constraining equation An equation that must hold of the minimal f-structure solution to all of the defining equations in a functional description. Constraining equations are distinguished from defining equations by the presence of a subscript *c* on the equals sign: $=_c$. See Belyaev 2023a: 3.2.2 [this volume].

Constructive case The view that case specifications on an argument determine its grammatical role. Formally, constructive case specifications are encoded by means of Inside-Out Functional Uncertainty. See Butt 2023 [this volume].

Control a) Structures in which an overt argument in one clause is partially or fully co-referential with and determined by an expressed argument in another clause, most commonly but not necessarily a higher clause. There are various sub-types: adjunct, backward, exhaustive, implicit, partial, split control. b) The mechanisms by which such structures are analysed, namely functional control, anaphoric control, quasi-anaphoric control. See Vincent 2023 [this volume].

Copy raising A construction in which the subject argument of an embedded predicate is realized as the grammatical subject of the matrix verb, and its place in the embedded clause is occupied by a pronominal copy, as in English *Sarah*$_i$ *seems like she*$_i$ *is asleep*. See Vincent 2023 [this volume].

Correspondence function A function which relates components of one level of linguistic structure to components of another level. For example, the ϕ projection is a correspondence function relating nodes of the constituent structure to functional structures.

CP Originally 'complementizer phrase', a constituent structure category. Now used for a phrase that consists of a full clause and possibly additional material such as a complementizer or a displaced phrase.

D Determiner. See DP.

Decidability theorems for LFG Decidability can be relevant for parsing, generation, or other properties of linguistic systems. For example, if the parsing problem for a linguistic system is decidable, it is possible to determine for any given sentence whether it is licensed (admitted) by a particular grammar of that system in a finite number of computational steps. If it is not always possible to make that determination, the parsing problem for that system is not decidable. The parsing problem for LFG has been shown to be decidable under certain constraints: the Nonbranching Dominance Constraint of earlier formulations has now been replaced by the linguistically more appropriate Proper Anchoring Condition. See Kaplan & Wedekind 2023 [this volume].

Defining equation An equation requiring an f-structure to contain a feature with a particular value. See Belyaev 2023c: 4.1 [this volume] and Belyaev 2023a: 3.2.1 [this volume]. Also see Constraining equation.

Description by analysis The description of one level of linguistic structure on the basis of properties of another level, as opposed to codescription. See Belyaev 2023c: 5 [this volume].

Differential object marking Non-uniform grammatical marking of objects. See Zaenen (2023) and Laczkó (2023).

Direct Syntactic Encoding, Principle of A principle stating that syntactic rules may not alter grammatical functions, originally proposed by Kaplan & Bresnan (1982). For example, according to the Principle of Direct Syntactic Encoding, passivization cannot be treated as a syntactic operation that converts an active clause into a passive clause by converting the object into a subject.

dis A grammatical function for displaced phrases, for example the displaced or fronted object in an example like *Who did you meet?*. Sometimes as op or udf. Also see Overlay function, and Kaplan 2023 [this volume] for discussion of an alternative analysis in terms of information structure.

Discourse configurationality A language type in which discourse functions are often or always associated with particular constituent structure positions. See Zaenen (2023), Booth & Butt (2023), and Laczkó (2023).

Disjunction A disjunction over functional descriptions or over sequences of categories on the right-hand side of a phrase structure rule is generally enclosed in curly brackets, with the options separated by a vertical line: ‘A or B or C’ is represented as {A|B|C}. Sometimes ∨ is used instead of the vertical line: {A∨B∨C}. If the scope of the disjunction is clear, the curly brackets are sometimes omitted.

Distributive/nondistributive feature If the value of a distributive feature is specified for a set of attribute-value structures, each structure in the set is required to have the specified value for that feature. If the value of a nondistributive feature is specified for a set of attribute-value structures, the set of f-structures as a whole has the specified value for the feature. The distributive/nondistributive distinction is relevant only when specifying the value of a feature for a set of attribute-value structures. See Haug 2023a [this volume].

DP Determiner phrase (a constituent structure category).

Economy of Expression A principle of competition among different potential constituent structure analyses for a sentence which allows only the smallest constituent structure analyses, and rules out larger structures.

Endocentricity A principle of phrasal organization which requires phrases of a particular phrasal category to contain a head of the same category. It is a central principle of X-bar theory. For growth of endocentric structure in historical change, see Booth & Butt 2023: 4.3 [this volume].

Equi A label for the class of control verbs in which the controlling argument has a semantic role with respect to both the matrix and the embedded predicate. This class is traditionally contrasted with raising verbs, in which the shared argument has a semantic role only in the embedded clause. See Vincent 2023 [this volume].

Evidentiality The linguistic marking of the nature of evidence for a given statement. See Laczkó (2023).

Exhaustive control Control constructions in which the embedded argument is coreferential with the controlling argument. See Vincent 2023 [this volume]. Also see Partial control.

Existential constraint A requirement for the presence of a feature in the minimal f-structure solution to all of the defining equations in a functional description, but with no constraints on the value of that feature. For example, the requirement for a clause to be tensed can be enforced by the existential constraint (f tense), which requires the f-structure f for the clause to contain the tense feature, without specifying a particular value for tense.

Exocentric category A phrasal category which does not contain a head in the sense of X-bar theory, but can be headed in the sense of the mapping from constituent structure to functional structure by a node of any category with annotation $\uparrow=\downarrow$. LFG assumes at least one exocentric category, the clausal category S. See Belyaev 2023a: 2.1 [this volume].

Extended Coherence Condition An extension of the Coherence condition which requires f-structures with non-argument roles such as dis, focus, or topic to be integrated into the f-structure by functionally or anaphorically binding an argument. See Kaplan 2023 [this volume].

Extended Head See (F-structure) co-head.

f-command There are several definitions of f-command. According to a commonly assumed definition, an f-structure $f1$ f-commands an f-structure $f2$ if $f1$ does not contain $f2$, and there is some f-structure g which immediately contains $f1$ and also contains $f2$. F-command is analogous to the c-command relation on constituent structure nodes.

f-description See Functional description.

f-precedence See Functional precedence.

f-structure See Functional structure.

Feature An attribute which has a value in an attribute-value structure. For example, the f-structure [tense pst] has the feature/attribute tense with value pst.

focus The new information contributed by a sentence, or the portion of a sentence which contributes the new information. At functional structure or information structure, the value of the focus feature is the linguistic material associated with the focus role. See Zaenen 2023 [this volume].

form Feature whose value is the form of a particular word. For example, weather verbs in English (such as *rain* or *snow*) require their subject to have the form *it*. To allow this requirement to be enforced, one of the lexical entries for *it* has the feature form with value it, and accordingly the verb *rain* requires its subject to include the feature form with value it.

Fragmentability of language A principle stating that incomplete fragments of utterances are able to be assigned partial syntactic and semantic analyses on the basis of their lexical and phrasal properties.

Function-Argument Biuniqueness A principle of alignment between the semantic roles and grammatical functions of a predicate, stating that no grammatical function can be associated with more than one semantic role, and no semantic role can be associated with more than one grammatical function.

Functional category A phrase structure category generally associated with closed-class function words. Commonly assumed functional categories are D/DP, C/CP, and I/IP. For the emergence of functional categories in historical change, see Booth & Butt 2023: 4.3 [this volume].

Functional control A control construction in which an argument of a matrix clause is also the subject of an open grammatical function such as XCOMP or XADJ. See Vincent 2023 [this volume].

Functional description A set of defining equations and constraining equations describing a set of linguistic structures and the relations among them. See Belyaev 2023c: 4.1 [this volume] and Belyaev 2023a: 3.2.1 [this volume].

Functional precedence A precedence relation holding between f-structures, defined in terms of the c-precedence relation at constituent structure. See Belyaev 2023a: 3.2.6 [this volume].

Functional structure The linguistic level representing grammatical functions such as subject and object, and grammatical features such as voice, person, number, and case. See Belyaev 2023c: 4 [this volume].

Functional uncertainty A type of constraint on the relation between two attribute-value structures which is stated in terms of a regular expression over a sequence of features. See Belyaev 2023a: 3.2.3 [this volume] and Kaplan 2023 [this volume]. Also see Inside-Out Functional Uncertainty.

Generation In LFG, the problem of finding the set of sentences that the grammar assigns to a particular functional structure, if the f-structure is realized by the grammar. Also see Realization.

GF Metavariable representing any grammatical function.

$\widehat{\text{GF}}$ The grammatical function borne by the thematically most prominent argument. See Belyaev 2023b [this volume].

GGF Metavariable representing any governable grammatical function.

Glue A theory of the syntax-semantics interface which expresses constraints on the combination of meanings via statements in a resource logic, Linear logic. See Asudeh 2023 [this volume].

Governable grammatical functions Governable grammatical functions are those which can be subcategorized, or required, by a predicate. The governable grammatical functions that are usually assumed are SUBJ, OBJ, OBJ_θ, COMP, XCOMP, and OBL_θ.

GRAMMAR WRITER'S WORKBENCH A computational grammar development platform for LFG, developed in the 1980s and 1990s at the Xerox Palo Alto Research Center. See Forst & King 2023: 1.1.3 [this volume].

GRAMMATICAL FUNCTION HIERARCHY An ordering of grammatical functions, with SUBJ at the top of the hierarchy, followed by OBJ and OBL_θ. See Belyaev 2023b [this volume].

GWW See Grammar Writer's Workbench.

I See IP.

ID/LP RULE A phrase structure rule in which precedence relations are specified separately from mother-daughter relations: an ID (Immediate Dominance) rule specifies the permissible daughters of a mother node, and an LP (Linear Precedence) rule specifies the permissible order among the daughters. In an ID rule, the daughters are separated by commas.

'IGNORE' OPERATOR (/) In a phrase structure rule, the Ignore operator is written as a forward slash at the end of the rule, and is followed by the Ignore category sequence. Such a rule licenses any number of instances of the Ignored category sequence, interspersed at any position among the specified daughter nodes. For example, the rule 'VP⟶ [V NP]/AdvP' (VP dominates V and NP, ignoring AdvP) is a shorthand for 'VP⟶ AdvP* V AdvP* NP AdvP*' (using the Kleene star '*'), allowing VP to dominate any sequence of categories containing V and NP, and also any number of AdvPs in any position.

IMPLICIT CONTROL Structures in which a missing argument is inferred from the extrasentential context rather than being determined within the clause by a controlling argument. See Vincent 2023 [this volume].

INDEX Feature whose value is an f-structure containing the INDEX feature bundle, typically including the features PERS, NUM, and GEND and their values. See Haug 2023a: 3 [this volume].

INFORMATION STRUCTURE The linguistic level representing how linguistic information is structured for presentation in a particular context, distinguishing old from new information, focused from background information, and other distinctions. See Zaenen 2023 [this volume] and, for historical change, Booth & Butt 2023: 4.5.2 [this volume].

Inside-out functional uncertainty A type of constraint on the relation between two attribute-value structures, stated in terms of a regular expression, and specified in terms of the position of the more embedded of the two attribute-value structures. See Belyaev 2023a: 3.2.3 [this volume].

Instantiated symbol A feature value which can be instantiated only once. A well-formed functional description may not contain more than one equation specifying an instantiated value. Notationally, an instantiated symbol ends with an underscore: X_.

int Interrogative. Sometimes as inter.

Inverse correspondence function The inverse of a function α, written α^{-1}, reverses the argument and result of α. For example, the ϕ projection is a function from c-structure nodes to f-structures, and the inverse ϕ^{-1} projection is a relation between f-structures and the c-structure nodes to which they correspond.

IP Originally 'inflection(al) phrase', a constituent structure category. Now used for a clausal constituent. Also see CP.

Kleene star (*) In a regular expression, an operator that allows repetition of a string zero or more times.

KP 'Case phrase', consisting of a nominal phrase with a case clitic (a constituent structure category. See Belyaev 2023a: 2.1 [this volume].

LDD See Unbounded dependency.

Lexemic Index (LI) A unique identifier associated with a morphological root in the lexicon. See Asudeh & Siddiqi 2023 [this volume].

Lexemic entry An entry in the lexicon specifying the form of a root morpheme, any non-predictable morphological alternations, the syntactic, semantic, and other information associated with the root, and a lexemic index for the root. See Asudeh & Siddiqi 2023 [this volume].

Lexical (redundancy) rules Rules stating generalizations over classes of lexical items.

Lexical Integrity Principle The principle that the properties of words are established in the lexicon, and cannot be modified in the course of syntactic derivation. See Belyaev 2023a: 2.2 [this volume] and Asudeh & Siddiqi 2023 [this volume].

Lexical Mapping Theory A version of Mapping Theory which assumes that the relation between argument roles and grammatical functions is established in the lexicon. See Findlay et al. 2023 [this volume].

Lexical Sharing The view that a single word can be dominated by more than one node in the Constituent structure tree. See Belyaev 2023a: 5.2.2 [this volume] and, for a historical perspective, Booth & Butt 2023: 4.4 [this volume].

Lexicalist Hypothesis See Lexical Integrity Principle.

LFG-DOP A hybrid grammatical model combining LFG and Data-Oriented Parsing. See Cahill & Way 2023 [this volume].

Linear implication A linear logic connective similar to implication, written as ⊸. See Asudeh 2023 [this volume].

Linear logic A resource logic in which each premise is a resource which can be used only once. See Asudeh 2023 [this volume].

Linking rules See Lexical Mapping Theory.

LMT See Lexical Mapping Theory.

Local name A name used to refer to a particular f-structure in a functional description. The reference of the local name is restricted to the functional description in which it appears. A local name begins with a percent sign, %. See Belyaev 2023a: 3.2.5 [this volume].

Logical subject The most prominent argument of a predicate at argument structure.

Long-distance dependency See Unbounded dependency.

Macro A macro is used in capturing generalizations across phrase structure rules. It associates a name with a sequence of annotated constituent structure categories. As with templates, a call to a macro is preceded by an ‘at’ sign, @.

Mapping Theory The theory of the relation between argument structure and functional structure roles. See Findlay et al. 2023 [this volume] and, for a historical perspective, Booth & Butt 2023: 3.2 [this volume].

Maximal projection In X-bar theory, the XP level. LFG often assumes a two-level version of X-bar theory in which XP = X″.

Meaning constructor In the glue theory of the syntax-semantics interface, a complex expression with two parts: one part expresses a linguistic meaning, and the other part is an expression of linear logic expressing how the meaning combines with other meanings in semantic composition. See Asudeh 2023 [this volume].

Minimal Complete Nucleus Relative to a designated f-structure f, the smallest f-structure which properly contains both f and a PRED feature. The minimal complete nucleus is often assumed to be relevant for specification of anaphoric binding constraints: see Rákosi 2023 [this volume].

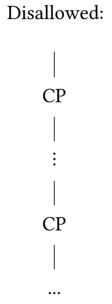
Minimal Finite Domain Relative to a designated f-structure f, the smallest f-structure which properly contains both f and a feature specifying a value for the TENSE feature. The minimal finite domain is often assumed to be relevant for specification of anaphoric binding constraints: see Rákosi 2023 [this volume].

Morphological Blocking Principle A principle stating that the existence of a more specified form blocks the use of a less specified form. See Asudeh & Siddiqi 2023 [this volume] and Kuhn 2023 [this volume].

N Noun. See NP.

Negative existential constraint A constraint forbidding the appearance of a feature in an attribute-value structure. For example, the constraint $\neg(f$ TENSE$)$ prevents the f-structure f from having an attribute TENSE with any value.

Nonbranching Dominance Constraint A constraint disallowing constituent structure trees in which two nodes of the same category dominate the same terminal substring, as in the illustration. This constraint is sufficient to ensure decidability of LFG parsing, but is not sufficient to ensure decidability of LFG generation. The stronger principles of Conservation and Proper Anchoring guarantee decidability of both computational problems. See Kaplan & Wedekind 2023 [this volume].



Non-configurationality Refers to a language type in which grammatical functions are not associated with particular constituent structure positions, but can often be identified via agreement and/or casemarking. Also see Configurationality.

Nondistributive feature See Distributive/nondistributive feature.

Non-projecting word A word that does not project a larger phrase and so cannot have a phrase structure complement or specifier. Non-projecting words of category X are annotated with a circumflex, as $\widehat{\mathrm{X}}$. See Belyaev 2023a: 2.1 [this volume].

Nonthematic argument An argument that is not assigned a semantic role. In English, the pleonastic/‘dummy’ subject *it* of a weather verb like *snow* is a nonthematic argument, as is the raised argument of a raising verb like *seem*.

NP Noun phrase (a constituent structure category).

nsem Feature whose value is a bundle of syntactically relevant semantic features of nouns and noun phrases. Used in ParGram grammars. The value of this feature is an f-structure with features common, number-type, proper, time.

nsyn Feature whose value is a bundle of syntactic features of nouns and noun phrases. Used in ParGram grammars. The value of this feature is an f-structure with features common, pronoun, proper.

ntype Feature whose value is an f-structure containing the set of syntactic and semantic features of nouns and noun phrases. Used in ParGram grammars. The value of this feature is an f-structure with two features, nsyn and nsem.

$\pm o$ ‘Objective’ (object-like) feature cross-classifying grammatical functions. The objective grammatical functions obj, obj2, obj$_\theta$ are $+o$, and the non-objective grammatical functions subj, obl$_\theta$ are $-o$. Used in Mapping Theory (see Findlay et al. 2023 [this volume]).

obj The grammatical function borne by (primary) objects.

obj$_\theta$ The grammatical function borne by thematically restricted objects.

obj2 The grammatical function borne by secondary objects.

obl$_{\text{agent}}$ The grammatical function borne by oblique agent phrases.

Oblique argument An argument of a predicate which is marked by an adposition or by casemarking marking a particular semantic role. See Belyaev 2023b: 3.5.2 [this volume].

obl$_{\theta}$ The family of oblique grammatical functions associated with particular semantic roles: for example, obl$_{\text{agent}}$.

OCR Optical character recognition: converting an image of text into the corresponding text.

Off-path constraint A constraint on a feature which specifies required properties of the f-structure containing the feature, or of the f-structure value of the feature. See Belyaev 2023a: 3.2.2 [this volume] and Kaplan 2023 [this volume].

op See dis.

Open grammatical function Grammatical function corresponding to a phrase which does not contain an internal subj, and whose subject is functionally controlled by an external argument. The open grammatical functions that are usually assumed are xcomp and xadj. See Vincent 2023 [this volume].

OT-LFG Optimality Theoretic LFG, a hybrid grammatical model combining LFG and Optimality Theory. See Kuhn 2023 [this volume] and, for a perspective from historical change, Booth & Butt 2023: 5 [this volume].

Overlay function A secondary grammatical function which may be borne by an argument. Overlay grammatical functions are sometimes associated with discourse functions such as focus or topic.

P Preposition or postposition. See PP.

ParGram A consortium of grammar development efforts by industrial and academic institutions, with the aim of producing computational LFG grammars for a typologically diverse set of languages, written under a commonly-agreed set of linguistic assumptions. ParGram grammars are written using the XLE grammar development platform. See Forst & King 2023: 3 [this volume].

Parsing In LFG, the problem of finding the set of functional structures that the grammar assigns to a particular sentence, if the sentence is recognized by the grammar. Also see Generation.

Partial control Control constructions in which the reference of the controlled argument includes but is not restricted to the controlling argument. See Vincent 2023 [this volume]. Also see Exhaustive control.

passive Feature encoding voice. When this feature appears, its value is + if its clause is passive, and either − or absent if its clause is not passive. A common alternative is to encode voice via a voice feature with values such as active or passive.

pcase Feature encoding the grammatical function borne by a prepositional phrase, as required by the preposition. For example, the English preposition *to* is associated with the oblique goal function, so it would contribute a pcase feature with value OBL_{GOAL}.

Phrase structure rule A rule specifying well-formed phrase structure configurations involving a mother node and its daughters. In LFG, the right-hand side of a phrase structure rule is a regular expression. See Belyaev 2023c: 3 [this volume].

pivot (grammatical function) A grammatical function which plays a role in connecting its clause to other clauses. pivot is often assumed to be an overlay function.

poss (grammatical function) The grammatical function borne by possessors in a nominal phrase.

PP Prepositional or postpositional phrase (a constituent structure category).

pred The f-structure feature whose value is a semantic form. See Belyaev 2023a: 3.3.4 [this volume].

predlink (grammatical function) The grammatical function of a predicative complement. The English verb *be* is sometimes analyzed as taking as its arguments a subj and a predlink.

Priority union (/) An operation that combines two attribute-value structures, with one of the structures having a distinguished status: the priority union of f with g, where f is the distinguished structure, is written as f/g. The features of the resulting structure are the union of the features in f and g, and the value of each feature a in the resulting structure is the value of a in f if it exists, and otherwise the value of a in g (in cases of conflict, the distinguished structure 'wins'). Unlike unification, priority union does not fail.

Projection architecture Levels of linguistic representation and the relations among them. See Belyaev 2023c: 5 [this volume].

Projection function A projection function relates components of one level of structure to components of another level. For example, the ϕ projection is a function relating c-structure nodes to their corresponding f-structures.

Proper Anchoring Condition A specific, easily computable condition on strings, constituent structures, and functional structures that guarantees that they satisfy the bounding requirement of Conservation. See Kaplan & Wedekind 2023 [this volume].

Proto-Role argument classification A classification of roles at argument structure which distinguishes roles in terms of their agent-like or patient-like properties. See Findlay et al. 2023 [this volume].

Quasi-anaphoric control A control construction in which an argument of the matrix clause co-refers with the subject of the embedded clause but where the connection is defined in semantic rather than syntactic terms. See Vincent 2023 [this volume]. Also see Anaphoric control.

$\pm r$ (mapping feature) 'Restricted' feature cross-classifying grammatical functions. The (thematically) unrestricted grammatical functions subj, obj are $-r$, and the restricted grammatical functions obj_θ, obl_θ are $+r$. Used in some versions of Mapping Theory (see Findlay et al. 2023 [this volume]).

Raising A construction in which the subject argument of an embedded predicate is realized as the grammatical subject or object of a matrix predicate, but does not receive a semantic role from the higher predicate. The term is still widely used as a descriptive label even when, as in LFG, the argument in question is not thought to have undergone a syntactic movement process. See Vincent 2023 [this volume].

Realization In LFG, the problem of determining whether there exists at least one sentence that is assigned to a given f-structure by a given LFG grammar. Also see Generation.

Recognition The problem of determining whether a given sentence belongs to the language of a grammar. Also see Parsing.

Re-entrancy See Structure sharing.

Regular expression An expression that allows the combination of regular predicates via disjunction, conjunction, or negation. A regular expression describes a *regular language*. The right-hand side of a phrase structure rule in LFG is a regular expression; see Belyaev 2023c: 3 [this volume]. Regular expressions are also used in the encoding of functional uncertainty.

Regular predicate An expression that can include disjunction, optionality (via parentheses), and unbounded repetition (via the Kleene star). In LFG, regular predicates can also include operators such as the 'Ignore' operator and the 'Shuffle' operator.

Restricted grammatical functions (OBJ_θ, OBL_θ) See $\underline{+}r$.

Restriction (\) In a functional description, the Restriction operator is written as an f-structure reference, followed by a backslash, followed by one or more features: for example, $f\backslash_{\text{SUBJ}}$ refers to the f-structure f with the attribute SUBJ and its value restricted out. The f-structure $f\backslash_{\text{SUBJ}}$ has all of the features and values of the f-structure f except for the feature SUBJ and its value, which may then be specified differently from the value of SUBJ in f.

Resumption A construction involving an unbounded dependency containing a resumptive pronoun.

Resumptive pronoun A pronoun which participates in an unbounded dependency and is bound by an overlay function. See Sadler 2023 [this volume].

S The clausal category S is exocentric, meaning that it has no head. See Belyaev 2023a: 4.3.5 [this volume].

Semantic form Value of the PRED feature at functional structure, encoding syntactic predicate-argument structure. A semantic form consists of the name of the predicate and its arguments, with thematic arguments enclosed in angled brackets, and nonthematic arguments outside the angled brackets. A semantic form is instantiated to a unique value on each occasion of use of the word or construction which contributes it. See Belyaev 2023a: 3.3.4 [this volume].

‘Shuffle’ operator (,) In a phrase structure rule, the ‘shuffle’ operator indicates that two sequences of daughters can be interspersed. Each sequence is enclosed by square brackets, and the two sequences are separated by a comma. For example, the rule ‘S $\longrightarrow$ [XP1 XP2], [XP3 XP4]’ licenses any order of the four daughters XP1, XP2, XP3, XP4 as long as XP1 precedes XP2, and XP3 precedes XP4. See ID/LP rule.

Spec,XP In constituent structure, the specifier of XP; that is, the non-head daughter of XP which is sister to the head X′. Also see X-bar theory.

Split control A control construction in which two different matrix arguments taken together provide the antecedent for the unexpressed subject argument of an embedded clause. See Vincent 2023 [this volume].

Structure sharing The situation when two features in an attribute-value structure share the same value. See Belyaev 2023c: 4.4 [this volume].

Structure-Function Mapping A general term for the mapping between structure (in LFG, usually constituent structure) and syntactic function (in LFG, usually functional structure).

subj The grammatical function borne by subjects.

Subject Condition The requirement for clausal functional structures to contain a subj. See Belyaev 2023b: 4.2 [this volume].

Subject, logical See Logical subject.

Subsumption An f-structure f subsumes an f-structure g ($f \sqsubseteq g$) if all of f’s features and values are also in g. Notably, g may contain additional features that are not present in f. For example, if f is the structure $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ and f subsumes g, then g contains the feature a with value b and the feature c with value d, and may also contain additional features and values.

Template A template associates a name with a set of constraints, and allows that name to be used to represent those constraints. See Belyaev 2023a: 5.1 [this volume].

Thematic argument An argument of a predicate which is associated with a semantic role.

TOPIC (grammatical function) A grammatical function associated with the information structure role of topic. When it is assumed, TOPIC is usually analyzed as an overlay function.

UD (UNIVERSAL DEPENDENCIES) A system for annotating grammatical functional dependencies. See Haug 2023b [this volume].

UDF See DIS.

UNBOUNDED DEPENDENCY A potentially unbounded relation between a displaced constituent and the position normally associated with its syntactic role. See Kaplan 2023 [this volume].

UNIFICATION ($\sqcup$) An operation that combines two attribute-value structures. If the structures are compatible, the resulting structure contains all of the structure from both of the input attribute-value structures. If the structures are not compatible, unification fails. There is a straightforward relation between unification and conjunction of descriptions: if f-structure $f1$ satisfies a description $d1$, and $f2$ satisfies a description $d2$, then if $d1$ and $d2$ are consistent, $f1 \sqcup f2$ satisfies $d1 \cup d2$.

UNIQUENESS See Consistency.

V Verb. See VP.

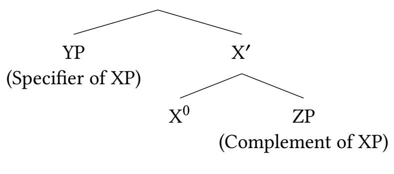
VERBAL MODIFIERS (VMS) A categorially heterogeneous group of constituents that must occupy the immediately preverbal position in neutral sentences in some Finno-Ugric languages. See Laczkó (2023).

VFORM Feature whose value specifies the form of a verb, for example PPART for past participle. Also see VTYPE.

VP Verb phrase (a constituent structure category).

VTYPE Feature whose value specifies verb type. Typical values are FIN for finite, INF for infinitive, and PST.PTCP for past participle.

X-BAR THEORY A theory of the organization of constituent structure. Many LFG analyses assume the version of X-bar theory that is depicted in the figure, ignoring linear order (that is, the specifier may precede or follow the X′ head, and the complement may precede or follow the X head. See Belyaev 2023a: 2.1 [this volume].



xadj The open grammatical function borne by adjunct phrases.

xcomp The open grammatical function borne by complement phrases.

xcomp-pred (grammatical function) A grammatical function for a non-verbal open grammatical function. Used in ParGram.

XLE A computational grammar development platform for LFG, developed at the Xerox Palo Alto Research Center. See Forst & King 2023: 1.1.3 [this volume].

Name index

Handbook of Lexical Functional Grammar

Lexical Functional Grammar (LFG) is a nontransformational theory of linguistic structure, first developed in the 1970s by Joan Bresnan and Ronald M. Kaplan, which assumes that language is best described and modeled by parallel structures representing different facets of linguistic organization and information, related by means of functional correspondences. This volume has six parts. Part I, *Overview and introduction*, provides an introduction to core syntactic concepts and representations. Part II, *Grammatical phenomena*, reviews LFG work on a range of grammatical phenomena or constructions. PartIII, *Grammatical modules and interfaces*, provides an overview of LFG work on semantics, argument structure, prosody, information structure, and morphology. Part IV, *Linguistic disciplines*, reviews LFG work in the disciplines of historical linguistics, learnability, psycholinguistics, and second language learning. Part V, *Formal and computational issues and applications*, provides an overview of computational and formal properties of the theory, implementations, and computational work on parsing, translation, grammar induction, and treebanks. Part VI, *Language families and regions*, reviews LFG work on languages spoken in particular geographical areas or in particular language families. The final section, Comparing LFG with other linguistic theories, discusses LFG work in relation to other theoretical approaches.