Moritz Cordes (Ed.)

Asking and Answering

Rivalling Approaches to
Interrogative Methods

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Preface and Introduction

In December 2019 two things happened, which can be described in ascending order of historical influence: (i) Enough funding was acquired for an in-person conference to be held in Greifswald in 2020 on the topic of asking and answering with invited speakers from seven different countries. (ii) First cases of Covid-19 were registered in Wuhan. The effects of both events played out in such a way that, indeed, a conference took place in September 2020 but, due to what had become a pandemic, nobody travelled to Greifswald. Instead the contributors met in the digital realm. In order to adjust to the medium the planned presentation time (without discussion) was cut in half, prereads were requested and the time alotted to the discussions was doubled. This contributed to what at least some experienced as a very cooperative and communicative workshop. Fears of ›screen fatigue‹ proved to be unfounded. Instead the participants had many discussions that made the phenomenon of progressive mutual comprehension palpable.

As became clear when the date of the conference drew near, the request of prereads would result in a situation where each participant had carefully prepared a text which they deemed fit for distribution among peers and which, soon, they reflected on under the remarks and attacks from the other participants at the workshop. These texts eventually became the body of this volume. The contributors were given opportunity to revise the prereads. Commentary sections were added by other participants in order to echo some of the communicative aspects of the workshop as well as to enhance the cognitive experience associated with a scientific collective volume.

As to the content, the conference and the volume acknowledged that questions are everywhere and, since the ubiquitous activities of asking and answering, qua human activities, are susceptible to failure, the systematic study of questions and the surrounding activities is desirable. Such study works toward supporting and improving these activities and makes them less vulnerable to failure, whatever constitutes failure. Admittedly, the reflection on questions and their systematic employment are activities which have been pursued long before the dawn of modern erotetic logic, as is evident, for instance, from Plato's framing of Socrates' style of conversation, from Aristotle's eighth book of the *Topics*, from the style of oral and written philosophy in the scholastic era, from Kant's three (or four) leading questions of philosophy, and from the

logical empiricists' criticism of traditional problems as pseudoquestions – to name only a few. In fact, from this motley one might get the impression that asking questions is as important in philosophy as argumentation or concept formation. At any rate, it seems that for a long time there has been an implicit or explicit need to provide frameworks for the methodic use of questions in science, philosophy, and everyday life. Such frameworks may take or, in fact, took the shape of categorizations of questions and answers or of the elucidation of their systematic relations or of the reconstructive or stipulative setting of rules which regulate the practice of asking and answering.

In more recent times, scholars, some of whom were present at the workshop, developed various theories of questions by providing (i) ways to formalize ordinary language questions, (ii) semantics for (formalized) questions, and (iii) rules for (formalized) questions. An incomplete list: Åqvist (1975), Belnap and Steel (1976), Ciardelli, Groenendijk & Roelofsen (2018), Groenendijk and Stokhof (1984), Hartmann (1990), Hintikka (1999), Kubiński (1980), Wiśniewski (1995). The listed efforts largely agree on the relevance of questions in many areas and on their general amenability to methodic treatment, which is either supported or even enabled by their formalization. Obviously, questions, and their answers, are considered cognitive entities at least in the sense that their utterance is part of human efforts to achieve knowledge, truth and other epistemic goods. As proposals from logicians they are to be distinguished from similiar efforts in informal philosophy of language, informal epistemology, psychology or linguistics, although the lines may blur depending on the approach. Most question logicians are not in the business of making claims about what role questions play in our minds nor do they set out to formally reconstruct all aspects of ordinary language questions. They rather focus on those aspects that are ›cognitively relevant‹ or ›epistemically relevant‹.

Despite these common features, the efforts have not yet lead to a ›mainstream‹ in question logic – erotetics remains "multi-paradigmatic" (Peliš 2016:14). On the one hand, this pluralism is fruitful, since it provides for so many different ways to investigate questions. On the other hand, the result of (mostly) mutually incompatible approaches is dissatisfying. It also raises the question of *who got it right* or, more circumspectly: Which proposal is preferable with respect to certain aims which one supposedly wants to achieve by a formal treatment of questions?

Accordingly, the reader will find in the present volume contributions that approach questions and answers from very different angles. In addition, even if the comment sections are discounted, the style of the contributions is diverse. A brief walkthrough may help the interested reader:

1. *Ivano Ciardelli*, who gave the opening lecture,[1] launches a general defense of a semantics for questions. In doing so he identifies research topics (compositional semantics, logic, propositional attitudes, discourse) where such a semantics plays a major role. His own proposal is known as Inquisitive Semantics, of which he is a/the main proponent. Due to the pivotal character of the paper, two commentators with vastly different backgrounds were admitted. Dorota Leszczyńska-Jasion's comment constructively combines structural proof theory and Inquisitive Semantics while criticizing Ciardelli's view on the distinction between answers and resolutions. Manfred Krifka subscribes to the idea of a question semantics but has significantly diverging ideas about what are the semantic entities associated with questions/interrogatives.
2. The latter's approach is spelled out in much more detail in his own chapter. *Manfred Krifka* develops the theory of Commitment Spaces and includes interpretations for a large number of different kinds of natural language questions. At the core of it lies the insight, that many polar questions (yes/no-questions) are, in fact, to be understood as monopolar, favoring one of the answering options. The connections between the semantic entities associated with questions and partialist understandings of questions (incl. monopolar readings) are sketched in the comment by the volume's editor. This closes a unit on question semantics (i.e. chs. 1 and 2).
3. *Andrzej Wiśniewski* presents in his chapter an overview of Inferential Erotetic Logic (IEL), the research programme that he created. Due to the introductory character it can be seen as a preliminary to the chapters by David Hitchcock and Dorota Leszczyńska-Jasion. It will also help to understand parts of the contributions from Ivano Ciardelli, Jared Millson, and the editor. In the face of these further studies relating to IEL, no comment was included in this chapter.[2]
4. *David Hitchcock*'s chapter can be read as a straightforward application of IEL but it is also kind of a pilot study about how speech agents argue for questions. The results are ambivalent, indicating that not always arguments run along the lines of evocation and erotetic implication, as

1 This lecture is publicly available to be rewatched at https://www.youtube.com/watch?v=uxGSXztKG_A (2021-09-02).

2 I would like to draw specific attention to Millson's comment on Leszczyńska-Jasion's chapter (ch. 5), the former of whom includes a wide-angle survey of IEL's main features and its relation to rivalling approaches. It is a historical complement to Wiśniewski's chapter.

suggested by IEL. Commentator Victoria Oertel further qualifies this result by observing that what is usually taken as an argument for (posing) a question is, in fact, a means to delimit the spectrum of answers available to the addressee of the question.

5. In the following chapter, *Moritz Cordes* considers how we arrive at a formal framework for questions as well as how we arrive at posing a specific question within a given framework for formal questions. The paper is programmatic; it merely indicates specific answers to either of these two dimensions. In a way, Lani Watson, in her comment, gives a more specific answer to the second dimension: She sketches a virtue-epistemological theory of questioning in inquiry-like settings.
6. *Dorota Leszczyńska-Jasion* draws a connection between proof theory and IEL relating the heuristic asking of questions and the development of proofs. She takes a first step toward showing how proof theory is able to elucidate a fundamental epistemic procedure. Possibly it connects to traditional philosophical concepts like Reichenbach's distinction between context of discovery and context of justification. Jared Millson, in his comment, continues Leszczyńska-Jasion's discussion of rules of inference, specifically of structural rules, and assesses their relation to real processes of asking and answering.
7. In his own chapter, *Jared Millson* considers what kinds of acts are the acceptance and rejection of questions and how such acts are performed. He sees intra- and extra-conversational reasons for such moves. His ideas are formulated in the context of a bilateralist inferentialism. Joshua Habgood-Coote's comment suggests some improvements to Millson's ideas. Most importantly, the former wonders whether the acceptance and/or rejection of questions is amenable to the weak/strong distinction. What does it mean to weakly ask a question?[3]
8. The final chapter, authored by *Floris Roelofsen*, takes a more linguistic turn, echoing the initial chapters of the volume. Roelofsen addresses the connections between indefinite and interrogative pronouns, setting up a dynamic semantics that operates with (indeterminate) discourse referents. His idea suggests that wh-questions do not come with a presupposition that precludes a negative answer – in contrast to what wh-questions are usually taken to presuppose. In other words: To answer

3 It appears to me that, e. g., the asking of deliberative questions, like those considered in sect. 2.12 by Krifka, constitute ›weak askings‹, partly because they exert less communicative pressure on addressees or, possibly, they are even ›unaddressed‹ in some sense – even if speakers are aware that there are recipients to their utterances.

> 'Nowhere.' to the question 'Where is god?' does not infringe on any alleged existential presupposition. David Hitchcock's comment is valuable especially due to his efforts at locating Roelofsen's ideas in a spectrum of theories of meaning. The commentator does not miss out on the opportunity to demand further elaboration of the approach.

This last directive act can be generalized so as to include the other approaches represented in the chapters. One aspect of filling this desideratum is the further interpollination between the different schools – an effort that has only begun in this volume. In doing so, differences need not be swept under the carpet. In fact, at neuralgic points in this volume, decisions between various ways to develop theoretic superstructures are marked and recognized as non-trivial. This holds, among other things, for the following issues: What shape should a question semantics take? What suggestions should one read into the simplest of questions? What role can formal frameworks play in reading and structuring processes of question asking and answering?

Original Conference Schedule

The conference was held on September 17th to 19th, 2020. The following list provides the speakers and titles of all talks in the order in which they were given.

1. Ivano Ciardelli: *Why We Need a Question Semantics* (public opening lecture).
2. Manfred Krifka: *Questions in Commitment Spaces*.
3. Lani Watson: *The Social Virtue of Questioning: A Genealogical Approach*.
4. David Hitchcock: *Justifying Questions: What Kinds, How, and Why*.
5. Yacin Hamami: *Interrogative Games*.
6. Andrzej Wiśniewski: *The Logic of Questions as a Formal Logic*.
7. Moritz Cordes: *How to Arrive at Questions*.
8. Dorota Leszczyńska-Jasion: *The Method of Socratic Proofs: From Questions to Proofs*.
9. Jared Millson: *Bilateralism for Erotetic Logics*.
10. Joshua Habgood-Coote: *Group Inquiry*.
11. Floris Roelofsen: *Questions, Indeterminate Reference, and Dynamic Logic*.

The decision of some speakers to not have their talk included in this volume was made individually.

Editor's Acknowledgements
The conference was funded by the Theoria program of the federal state of Mecklenburg-Vorpommern as part of the project *Logik des Fragens: Zur Reglementierung des interrogativen Vollzugs* (UG 15), supervised by Geo Siegwart. This is also the main source of funding for this volume. Additional funding for the volume was provided by the Netherlands Organization for Scientific Research (NWO) as part of the project *Inquisitiveness Below and Beyond the Sentence Boundary* (arranged by principal investigator Floris Roelofsen) and by the European Research Council ERC, Advanced Grant 787929 *SPAGAD: Speech Acts in Grammar and Discourse* (arranged by Manfred Krifka). Gratitude is due toward those individuals who were involved with the administration of these projects.

I would like to thank all persons who helped to make the conference an enjoyable event and/or to make the volume a pleasure to prepare, namely Ivano Ciardelli, Joshua Habgood-Coote, Yacin Hamami, David Hitchcock, Catherine Hundleby, Manfred Krifka, Dorota Leszczyńska-Jasion, Jared Millson, Victoria Oertel, Floris Roelofsen, Lani Watson, Andrzej Wiśniewski. The project was also tremendously supported by friends and colleagues in Greifswald: Lea Cordes, Gerhard Gentzen, Friedrich Reinmuth, Steffi Schadow, Manuela Schlünß, Laura Schmalenbach, Geo Siegwart, and Lucas Treise. It is with great regret that I have to see this volume as my last effort at the University of Greifswald. Hans Rott and Tim Kraft from the University of Regensburg are to be thanked for providing an environment in which the volume could be finalized. Kalle Jonsson, of whose work in music and visual arts I am a great afficionado, kindly provided the cover design for free.[4] The personnel at Narr/Francke/Attempto was very helpful, open, cooperative, and, when problems arose, accommodating; Tillmann Bub and Mareike Wagner should receive the main credit for the resultant enjoyable experience. Many of the persons named above put an amount of trust in me that I consider beyond warranted due to some of the non-standard choices that I deliberately made. I hope that the final product does not entirely disappoint – despite the fact that some ideas were not successfully translated to reality.

Moritz Cordes, November 2021.

4 Coincidentally, one of the two works by Jonsson that provoked me to ask him for the cover design was for composer/musician Wojciech Golczewski, who shares his hometown with the two Polish contributors to this volume, i. e. Poznań.

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1 Why We Need a Question Semantics

Ivano Ciardelli[1]

Abstract
In this paper I discuss the role that question contents should play in an overall account of language, thought, and communication. Based on these considerations, I argue against the Fregean view that analyzes questions as distinguished only at the level of force. Questions, I argue, are associated with specific semantic objects, which play a distinctive role in thought and in compositional semantics, stand in logical relations to one another, and can act as contents of multiple speech acts. In the second part of the paper, I present a recent approach to the semantics of questions – inquisitive semantics – and discuss how the notion of question content it provides can be fruitfully put to use in the different roles we identified.

1.1 Introduction

The title of this contribution can be read in two ways. The first reading is: *For what purposes* do we need a question semantics? What roles should question semantics play in an overall theory of language and thought? One of the aims of asking this is to identify certain desiderata for formal theories of questions, which can then be assessed and compared by asking whether the notion of question content that they yield is suitable for these various roles.[2]

1 I am indebted to Moritz Cordes for interesting discussions that pushed me to reflect more systematically on the issues discussed in this paper, and for the opportunity to present these ideas at the *Asking and Answering* conference. Thanks also to the audience of the conference, in particular to Manfred Krifka, David Hitchcock, Jared Millson, Andrzej Wiśniewski, Floris Roelofsen, and Moritz Cordes, for precious feedback in the Q&A after the talk.

2 Let me emphasize that the set of roles for question contents that I am going to discuss is not supposed to be exhaustive: There may well be other roles for question contents besides the ones we are going to discuss. But I do take the ones below to be especially important.

The second reading of our title puts focus on the word 'semantics': Why do we need a question *semantics*, and not just a question *pragmatics*? The backdrop for this question is the existence of a tradition, going back to Frege's (1918), which analyzes questions as distinguished only at a pragmatic level: Questions are characterized by their association with a particular kind of speech act – asking – but not with a particular kind of semantic content. The conceptual picture that these accounts advocate looks like this:

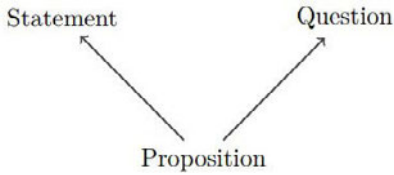

Fig. 1: The Fregean conceptual picture

What we have at the semantic level is just a proposition, which then can be paired at the pragmatic level either with declarative or with interrogative force, resulting in a statement or in a question.

While this view is not popular in linguistics (for reasons that we will discuss) it still has some influence in philosophy. One of my aims in this paper is to argue against it: While questions are indeed conventionally associated with the act of asking – in the sense that, by default, uttering a question counts as asking it – they also play many roles besides being asked. I will argue that the content-force distinction is just as important for questions as it is for statements: It is crucial to distinguish the content of a question from its asking, for exactly the same reasons why it is important to distinguish a proposition from its assertion. The conceptual picture I favor looks like this:[3]

3 I should note that in ordinary usage, the term 'question' is used ambiguously to refer to an interrogative sentence (a syntactic object, as in (a) below), its content (a semantic object, as in (b)), or a particular utterance (a speech act token, as in (c)):
a. In English, questions require a special word order.
b. The main question we face is whether the project is safe.
c. Her question caught me by surprise.
Here, I will use 'question' to refer to the syntactic object, and 'issue' to refer to the corresponding semantic object. Other authors, for instance, Groenendijk & Stokhof (1997), use 'interrogative' for the syntactic object, reserving the word 'question' for the semantic object. This difference is purely terminological, and will not matter for the points we will be making. One reason why the present choice is helpful here is that part of what we want to argue is precisely the need to recognize the kind of object that Groenendijk and Stokhof call 'question'.

	Statement	Question
Content type	Proposition	Issue
Default force	Assert	Ask

Tab. 1: The favored conceptual picture

The arguments in favor of this conceptual picture have been spelled out before: Two key references, which are sources of inspiration for the present paper, are Belnap (1990) and Groenendijk & Stokhof (1997). Here, I will present some arguments from these papers in a novel way, and I will add some new ones.

A further aim of this paper is to briefly illustrate how a recent theory of questions, *inquisitive semantics* (Ciardelli, Groenendijk & Roelofsen 2018), provides us with a notion of question content that can be put to fruitful use in the various roles that we will discuss.[4]

Here is the plan for the paper. We start in section 1.2 by looking at some of the theoretical roles which are standardly played by the notion of proposition. In section 1.3, I argue that the notion of *issue* – the sort of object expressed by a question – has parallel roles to play. In section 1.4, I discuss the Fregean view that identifies questions with asking acts, arguing against such an identification. In section 1.5, I describe the approach to question semantics that I favor – inquisitive semantics – and briefly outline how the notion of question content it delivers can be put to use in the various roles we identified in section 1.3. Section 1.6 concludes.

1.2 Roles for Propositions

In order to discuss what theoretical roles question contents have to play, it is helpful to start out from more familiar territory: the analysis of statements. By 'statement' here I mean a declarative sentence in natural language, as in (1-a), a sentential complement headed by the declarative complementizer 'that', as in (1-b), or a formula in a formal language which is meant to formalize a declarative sentence, as in (1-c).

4 While my coauthors and I have argued elsewhere that this theory improves on previous theories of questions in several respects, I will not rehearse the arguments here. The interested reader is referred to Ciardelli (2017) and §9 of (Ciardelli et al. 2018).

(1) a. Smith stole the jewel.
b. that Smith stole the jewel
c. stole(*s*, *j*)

The semantic content expressed by a statement is normally called a 'proposition'. A proposition is the sort of thing that represents the world as being a certain way, and which may be true or false depending on whether the world is in fact that way. In theorizing about language and thought, we use the semantic notion of a proposition, and the notion of truth of a proposition, in at least four ways: (i) to account for semantic composition, i. e., for how the semantics of a sentence is computed recursively from the semantics of its constituent parts; (ii) to define logical relations; (iii) to analyze propositional attitudes, and (iv) to give accounts of how language is used in communication. Let us briefly discuss each purpose.

1.2.1 Compositional Semantics

One key feature of human languages, both natural and artificial, is that they are *recursive*: they consist of discrete units which can be assembled into larger units by grammatical rules. The semantic value of a complex expression is not conventionally stipulated, but is built up from the semantic values of its constituents according to recursive rules. In both natural and artificial languages, a statement can occur not only as a complete sentence, but also as a constituent part of other, more complex sentences, as the following examples illustrate.

(2) a. Smith stole the jewels.
b. If Smith stole the jewels, he will be out of the country by now.
c. Alice knows that Smith stole the jewels.

When a statement occurs embedded, its semantic value feeds into the compositional process and contributes to determining the semantic value of the larger sentence. Thus, e. g., in (2-b) the proposition that Smith stole the jewels combines with *if* to act as a supposition, and in (2-c) the same proposition is the object argument of the verb 'know'.

1.2.2 Logic

The central concern of logic is the study of the validity of inferences. The notion of validity is, at least traditionally, characterized in semantic terms: An inference is valid if the conclusion is true in all interpretations in which the premises are true. Moreover, logic is supposed to give an analysis of specifically *logical* items in language, such as connectives, quantifiers, and modalities. Such an analysis is normally given in semantic terms, by specifying how the truth conditions of a compound involving these items are derived from the truth conditions of the constituents.

1.2.3 Propositional Attitudes

Our explanations of the behavior of agents involve reference to mental states such as belief, hope, and desire. For instance, we say that Bob is going to a certain café because he wants to meet Alice and he believes he will find her there. Such states are usually analyzed as propositional attitudes. To appreciate the idea, compare (3-a) and (3-b).

(3) a. Bob admires Alice.

b. Bob hopes that Alice called.

Supposing (3-a) is true, what is the object of Bob's admiration? It is a person, namely Alice. Now supposing (3-b) is true, what is the object of Bob's hope? It is a proposition – the proposition that Alice called (or at least, this is the standard answer). Similarly, (4-a) and (4-b) describe Bob as having certain attitudes towards this proposition.

(4) a. Bob thinks that Alice called.

b. Bob considers it unlikely that Alice called.

Thus, propositions play a central role in the mental life of agents like ourselves: They are things that we consider, belief, disbelieve, hope, want, and so on.

1.2.4 Discourse

Statements are by default associated with the speech act of assertion: If one simply utters (5) in a conversation, they are by default taken to be *asserting* that Smith stole the jewels.

(5) Smith stole the jewels.

Speakers use assertions, among other things, in order to exchange information and coordinate their beliefs. How is that achieved? The standard answer, which comes in many variants, is that by uttering a statement, a speaker expresses a corresponding proposition, which represents the world as being a certain way. The speaker is then taken to present herself as accepting the proposition and as recommending that this proposition be accepted by her interlocutors (see, e. g., Stalnaker 1978, Farkas & Bruce 2010, Krifka 2015, 2021).

In addition to assertion, statements are also involved in other speech acts. For instance, by uttering (6-a) or (6-b), the speaker is not asserting that Smith stole the jewels, but instead supposing it or suggesting it as possible.

(6) a. Let's say Smith stole the jewels.

b. Perhaps Smith stole the jewels.

As in the case of assertion, we would like to have an account of how these other speech acts work. Again, such accounts make crucial reference to the proposition that Smith stole the jewels: They typically say that the speaker is proposing to treat this proposition in a certain way – as true by hypothesis, or as an open possibility (see, e. g., Kaufmann 2000, Yalcin 2007, Schnieder 2010).

1.2.5 Summing Up

We can summarize the situation as in the diagram below. Declarative contents are built up compositionally, and they play a role internally to compositional semantics, as they determine the contribution of statements embedded in larger linguistic contexts. Externally to compositional semantics, they feed into logic, where they are used in defining key notions like entailment, philosophy of mind, where they provide the objects of attitudes like belief, and pragmatics, where they are used in characterizing the workings of assertion and other speech acts.

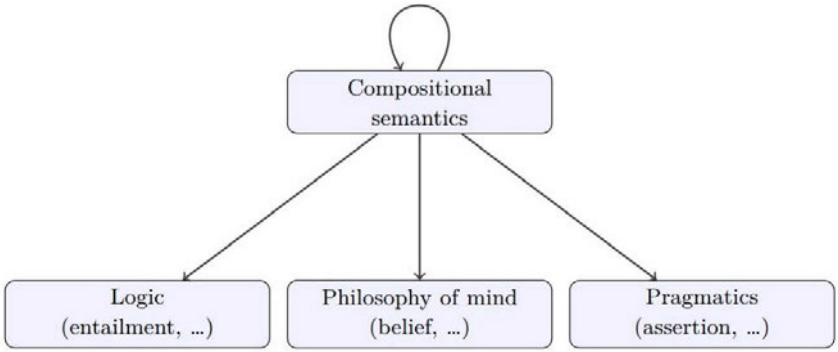

Fig. 2: Disciplines where propositions play a role

1.3 Roles for Issues

Having identified some important roles played by propositions, which are contents of statements, let us now turn to questions. I am using the term 'question', in analogy to 'statement', to refer to an interrogative sentence like (7-a) (also known as a *direct question* in the literature), the corresponding sentential complement (7-b) (also known as an *embedded* or *indirect question*), or to a formula in a formal language which is meant to formalize an interrogative, as in (7-c).

(7) a. Who is the culprit?

b. who the culprit is

c. ?x. culprit(x)

I am using the term 'issue' to refer to the semantic content of a question. So, what roles are there for issues to play in a theory of language and thought? My claim is that these roles are very much parallel to the ones we just identified for propositions.

1.3.1 Compositional Semantics

First, just like statements, questions occur in natural language not just as stand-alone sentences, but also as parts of other sentences, including statements. Here are three examples:

(8) a. If Smith leaves the country, can we get him extradited?

b. Alice knows who stole the jewel.

c. Whether I can go out tonight depends on how much work I get done.

In (8-a), a question is part of a conditional construction which is itself a question. In (8-b), a question is the argument of a knowledge ascription. In (8-c), two questions occur as constituents of a statement that asserts a dependency between them. In each of these cases, the semantics of the embedded question plays a role in determining compositionally the semantics of the entire sentence.

Before moving on to the next topic, let us pause briefly to make two points. First, although we used examples from English, the present point is not restricted to natural languages. Of course, for a formal language, one can freely stipulate what compounds occur, and thus, one can in principle disallow embedded questions. However, when it comes to designing a formal language intended to regiment statements and questions, there is no reason why we should not expect such a language to be able to handle compounds involving questions as constituents, analogous to those in (8). If a given question semantics allows for the construction of formal systems capable of handling embedded questions, that counts as a merit of the approach.

Second, it is worth pausing to discuss the relation between a direct question like 'Who is the culprit?' and its indirect counterpart 'who the culprit is'. As Belnap pointed out, not just questions, but sentences in general have nominalized, embeddable counterparts, as illustrated in the table below, whose "point or function is to permit us to embed in certain larger contexts […] a form of the stand-alone sentences" (Belnap 1983:26).

Stand-alone	Embeddable
Did Mary come?	J asked P whether Mary came.
Mary came.	J told P that Mary came.
Come!	J ordered Mary to come

Tab. 2: Stand-alone and embeddable forms of sentences

The claim that the direct question 'Who is the culprit?' and its indirect counterpart 'who the culprit is' are at some level associated with the same content is

known in the literature as the *equivalence thesis*.[5] It has been explicitly defended as a desideratum for a theory of questions by Belnap (1983) and Groenendijk and Stokhof (1984), and it is a standard assumption in the linguistic literature on questions. Let me mention a couple of observations that support the view. First, the content of a direct question can be appropriately reported by using its indirect counterpart, as in the following dialogue.

(9) A: Did Smith steal the jewels?
B: Sorry, I couldn't hear you. What did you just ask?
A: I asked whether Smith stole the jewels.

This is hard to explain if the two versions of the question do not share the same content. Second, and most strikingly, in an embedded context, an indirect question makes exactly the same contribution as an anaphoric particle that refers back to the direct question, as the following examples illustrate.

(10) A: Who is the culprit?
B: Nobody knows [that/who the culprit is].
B: The police will reveal [that/who the culprit is] in tonight's press conference.

For further discussion, see Belnap (1983) and Groenendijk and Stokhof (1984).[6]

1.3.2 Logic

Like statements, questions are linked by interesting logical relations. Let me give just one example. Assume as a premise that:

- A = 'For every x, x is a bachelor iff x is an unmarried man.'

5 The qualification 'at some level' is needed because what we say below is compatible with the hypothesis that the direct question contains something *in addition to* the issue that it shares with its indirect form, something that gives it its particular force (thanks to Manfred Krifka for raising this possibility to my attention). What matters for our purposes is that there is a single semantic object, an issue, which is associated with both forms of a question.

6 In his chapter, Krifka (2021) develops an account which invalidates the equivalence thesis, at least for polar questions. The observations concerning examples (9) and (10) can be seen as raising two challenges for this account.

Then there is an obvious sense in which the question Q below is logically determined by the questions Q' and Q'':

- Q = 'Who are the bachelors?'
- Q' = 'Who are the men?'
- Q'' = 'Who is married?'

This relation is semantic in nature: It holds because, on the basis of A, the contents of the relevant questions are bound to be related in a certain way.

Let us refer to the sort of logical relation illustrated by the previous example as a *dependency*. Dependency is a logical notion of great interest. For instance, the *predictive power* of a (scientific) theory can be taken to consist in the dependencies that it puts in place. One may say that a theory T is predictive of Q given Q_1, ..., Q_n if on the basis of T, Q is logically determined by Q_1, ..., Q_n (see (Ciardelli 2016b) for further discussion). Moreover, dependency is also the pattern that underlies the notion of *supervenience*, which plays such a central role in modern analytic philosophy. For instance, to ask if the mental state of an agent supervenes on the physical state of her brain is to ask if the question *what the agent's mental state is* is determined, over a relevant space of possibilities, by the question *what the agent's neurological state is*.

A theory of questions should provide us with the means to characterize the relation of dependency, as well as other logical relations involving questions, and to build formal systems that allow us to study these relations and regiment reasoning about them. Question semantics is bound to play a crucial role in this enterprise, just like truth-conditional semantics plays a crucial role in studying logical relations among statements.

1.3.3 Attitudes

Propositional attitudes are mental states with propositional content. But there are also mental states with a different kind of content. Consider:

(11) Alice { wonders / is curious about / doesn't care } who stole the jewels.

What is the object of Alice's curiosity or indifference? Intuitively, Alice's curiosity is not directed to a proposition, which represents the world as being in a particular way, but rather to an object that represents multiple alternative

ways for the world to be. It seems very plausible that the object of the relevant attitudes is nothing but the content of the complement 'who stole the jewels'. And this is indeed the view that has been taken by philosophers of mind who have considered this sort of attitudes (Friedman 2013, Carruthers 2018). We may say that wondering, curiosity, and indifference are *issue-directed attitudes*.

Besides issue-directed attitudes, we also find issue-directed activities, such as those reported by the following sentences.

(12) Alice { is investigating / discussed with Bob } who stole the jewels.

It seems plausible that, in the situation described by such sentences, the object of the activities of investigating and discussing is nothing but the issue expressed by the complement 'who stole the jewels'.

Issue-directed attitudes and activities are central to our life as agents engaged in inquiry, who have to entertain multiple competing hypotheses and to actively seek information to adjudicate between them: A detective's search for clues is oriented by specific issues (how did the murderer get in? what was the murder weapon?) and the beliefs she may eventually reach arise by engaging and deliberating on these issues. Like propositions, issues thus play an important cognitive role: They are objects that we entertain, engage with, investigate, discuss, form opinions about, or suspend judgment on.[7]

1.3.4 Discourse

Finally, questions obviously play a major role in linguistic information exchange. By default, questions are associated with the act of *asking*. If a speaker utters (13), they are normally taken to be asking who stole the jewels.

(13) Who stole the jewels?

7 On the role of questions in cognition, see, among others, Koralus and Mascarenhas (2013), Hoek (2021).

However, like propositions are involved in other speech acts besides assertion, issues are involved in other speech acts besides asking. I will illustrate this with two examples. The first is from Italian:

(14) Chissà chi ha rubato i gioielli.

Chissà who stole the jewels.

(15) I wonder who stole the jewels.

By uttering (14), one does not *ask* the question who stole the jewels, but merely expresses one's state of wondering about this question, making the question salient in the conversation, but without asking it. Such an utterance is appropriate in a situation in which the speaker presupposes that the question cannot be settled in the current exchange.[8] This sentence could be translated in English as (15). The reason why I offer (14) as an example instead of (15) is that in the case of (14) there is no doubt that it is not an assertion about the speaker's state, as the sentence is not even declarative and cannot be judged true or false. Just like the sentences in (6) can be used to perform a non-canonical speech act with a statement, so (14) can be used to perform a non-canonical speech act with a question. I will refer to this speech act as *wondering aloud*.[9]

As a second example, take:

(16) Let's set aside who did it for now. [Let's focus on how they came in.]

By uttering (16), one aims to effect a change to the context which involves the conversational status of the issue expressed by the question 'who did it', removing it as the current question under discussion (using the terminology now standard in formal pragmatics, see Roberts (2012)).

Many more examples could be given, but hopefully these suffice to illustrate that the situation for questions is analogous to the one for statements: Questions are by default associated with a certain speech act, *asking*; but the issue expressed by a question may also serve as the content of different speech acts,

8 This might be similar to the effect of the German "deliberative questions" discussed by Krifka (2021) (sect. 2.12 below), exemplified by:
Ob Max schon angekommen ist?

9 It seems plausible that, in most circumstances, an utterance of (15) in English is not construed as an assertion, but as an act of wondering aloud: By means of such an utterance, one does not mean to describe oneself as wondering, but rather to voice one's wondering and to make the question salient. Krifka (2021) argues for a similar analysis.

such as acts of wondering aloud or context management act that aim to change the question under discussion. We want to use question semantics to provide detailed account of how these speech acts work, in terms of their preconditions and the effects they bring about.

1.3.5 Summing Up

We saw that issues, i. e., question contents, have the same theoretical roles to play as propositions: We want to use them internally to compositional semantics to account for the contribution of embedded questions to larger compounds; in logic, to characterize the relation of dependency and other logical relations involving questions; in philosophy of mind, as contents of attitudes like curiosity or indifference; and in pragmatics, to give accounts of speech acts like asking and wondering aloud. This is summarized by the following picture, parallel to the one we gave above for propositions.

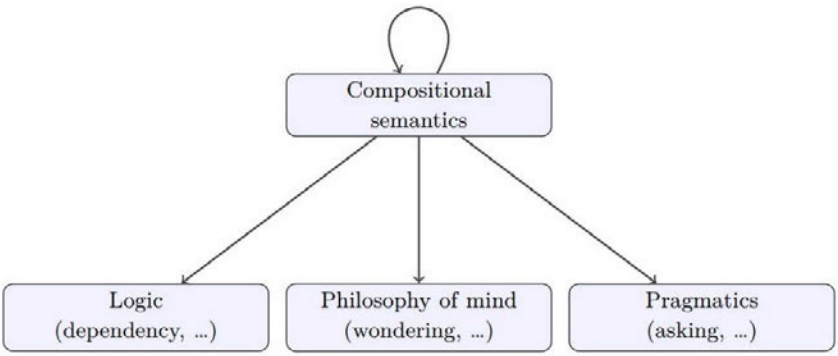

Fig. 3: Disciplines where question contents play a role

As mentioned in the introduction, I do not pretend that the roles we identified exhaust the range of roles to be played by issues. However, these roles do seem to be especially important; a satisfactory theory of questions should, I submit, provide us with a notion of content that can play these roles.

1.4 Questions without Question Semantics?

According to the conceptual picture I presented so far, statements and questions are sentences of different syntactic categories, which are associated with different kinds of semantic contents (propositions vs. issues) and different default speech acts (asserting vs. asking).

As mentioned in the introduction, however, there is an alternative view which has enjoyed some popularity in philosophy. This view goes back to Frege (1918), and has been taken up multiple times in the literature, for instance by Stenius (1967) and Searle and Vanderveken (1985). According to it, statements and questions are not distinguished at the semantic level – where they both have propositions as contents – but only at the level of force: Whereas a statement presents a propositional content with an assertive force, a question presents a propositional content with an asking force. Thus, the picture that this sort of account presents is the following.

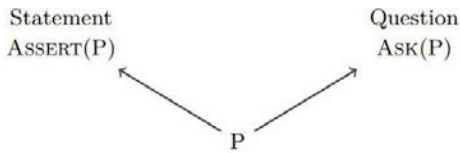

Fig. 4: Distinguishing statement and question at the level of force only

This kind of view recognizes just one type of content – propositions – and views questions as distinguished only at the pragmatic level. What is specific to a question is that it indicates a certain force, namely, asking force.[10]

1.4.1 On the Importance of Distinguishing Questions from their Asking

Building on the discussion in the previous section, I now want to argue that the view I just outlined is not quite right: The asking force is not everything there is to a question; questions play distinctive roles in many contexts where no speech act of asking is involved – in fact, where no *speech* is involved.

Firstly, as we saw, questions play a role in compositional semantics: They occur embedded within other sentences. When they do, it is not plausible to maintain, in general, that their contribution has to do with asking. In the following examples, for instance, the embedded polar questions are not *asked* in any reasonable sense.

10 In a pre-read paper for the *Asking and Answering* conference, Cordes (cf. 2021) proposes a formalization of questions which shares some key features of the Fregean view. In particular, in this formalization questions are only distinguished at the level of force. For instance, a polar question is analyzed as having the form WHETHER(p) and as being on a par with performative formulas like ASSERT(p) or SUPPOSE(p). The main points in this section apply to this approach as well, although at some points the discussion might have to be reformulated slightly.

(17) a. I don't care whether you come into the office.

b. John knows of most employees whether they came into the office.

The role of an embedded question is not to contribute a certain force, but to contribute a semantic content. Moreover, as we will argue below, this content is not a proposition.

Second, we saw above that questions are linked by interesting logical relations. Such relations are not relations between speech acts – they do not concern speech at all. They pertain to the same realm as the usual relation of entailment investigated in logic. In standard logic, whether an entailment holds is a matter of whether the relevant sentences are semantically related in a certain way. The same holds for the above dependency relation. For instance, who is a bachelor is logically determined by (i) who is a man and (ii) who is married. This is not a fact about discourse; it is a semantic fact. Questions are logically related to each other on the basis of their semantics. A logical system to study the relation of dependency, as well as other logical relations involving questions, should come with a language containing question formulas which are not force-imbued.

Third, as we pointed out, questions are part of our mental life: We entertain them, investigate them, set them aside, suspend judgment on them, and so on. When we investigate whether Smith stole the jewels, what we are investigating is not a speech act; it is an abstract content that we can grasp in thought. It is the sort of content that *can* be asked, but whose reality is independent of asking – indeed, independent of linguistic interaction altogether. This is parallel to the case of statements: When we believe that Smith stole the jewels, what we believe is not an act of assertion, but a certain content – the sort of content that *can* be asserted. Once more, we find that the identification of questions with asking acts is too narrow: Questions are primarily associated with certain contents, which play a specific role not just in discourse, but also in thought.

Lastly, questions are indeed tied to asking by default, like statements are by default tied to asserting. However, we saw in the previous section that issues, like propositions, are not in fact tied to a single speech act. For instance, consider someone uttering one of the following:

(18) a. Did Smith steal the jewels?

b. I wonder whether Smith stole the jewels.

c. Let's set aside whether Smith stole the jewels.

The same issue is at stake in each case, but the speech act is different.[11] Again, identifying a question with its asking is too narrow: There can be many speech acts sharing the same question content but differing in force, just like there are many speech acts sharing the same propositional content but differing in force. We need a force-neutral content for the question that can be recognized as being common to sentences with different force. Here is Belnap (1990:4–5) making this point:

> "I understand that there are many speech acts that share a propositional content but differ in illocutionary force; good. And there are many other speech acts that share an interrogative content but differ in illocutionary force, and others that share an imperative content but differ in illocutionary force. So the program [of speech act theory] is a healthy one; the only – but serious – mistake is to suppose that you can identify the content of all speech acts with propositional content, that is, with the content of declarative speech acts or assertions. […]
> [Avoiding] the Declarative Fallacy requires the recognition that interrogatives and imperatives are not just marked differently from declaratives, but possess fundamentally different underlying content structures."

On the view Belnap and I are advocating, one and the same propositional content p can feed into several force operators, and so can one and the same issue $\mathcal{I}$.

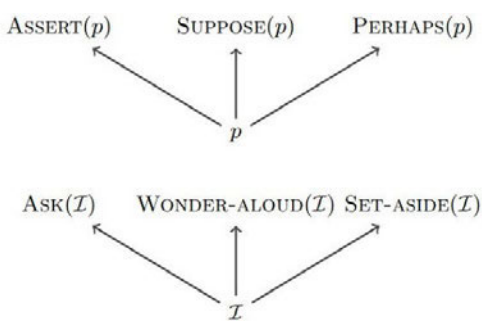

Fig. 5: Propositions and issues with different forces

11 If you think the second sentence should be viewed as an assertion, feel free to use the Italian example in section 1.3.4, which, as we discussed, is definitely not an assertion.

We can sum up the discussion as follows. Question contents – issues – bear exactly the same relation to asking that propositions bear to asserting. They are the things we ask – they provide the contents of asking acts. But they have a rich life independent of asking: They play a role in compositional semantics, they bear interesting logical relations to each other, they are the objects of a variety of mental attitudes and intensional activities, and they act as contents of other speech acts besides asking, with their own specific discourse effects. The reasons why it is crucial to distinguish propositions from their assertion are exactly the same reasons why it is crucial to distinguish issues from their asking.

1.4.2 Against Propositions as Contents of Polar Questions

Besides linking questions too tightly to asking, thereby failing to appreciate their multiple roles, another problematic aspect of the view presented above is that it assigns to questions the same sort of content that statements have: a proposition.

As Frege himself realized, this strategy is not viable in general. It was intended for polar questions like (19-a), but it is a non-starter for other classes of questions, including alternative questions like (19-b) (on its most salient reading, with falling intonation on the last disjunct) and *wh*-questions like (19-c). To ask one of these questions is not to inquire into the truth or falsity of a proposition, but rather to inquire into which among several propositions is true.

(19) a. Is Max Austrian?

b. Is Max Austrian, German, or Swiss?

c. Where is Max from?

This, by itself, does not mean that the view is wrong insofar as polar questions are concerned: Perhaps polar questions do indeed have propositional contents, while non-polar questions have other types of contents. However, once it is granted that the content of an asking act is at least sometimes not a proposition, it becomes much less appealing to hold that it is *sometimes* a proposition; it seems more natural to assume that the content of a question is always a semantic object of the same kind, just like the content of a statement is generally a proposition, regardless of the specific form of the statement.

Moreover, if polar questions and non-polar questions really have different types of content, we would expect this to be reflected in their ability to embed in various syntactic environments. Polar questions should be acceptable in syntactic environments which expect a proposition, in analogy to declarative

clauses and in contrast to alternative and *wh*-questions. But this is not what we find: Polar questions pattern with other kinds of questions, and differently from declaratives, in their embedding behavior, as the following examples show.

(20)	Alice believes/hopes	that Max is Austrian. *whether Max is Austrian. *whether Max is Austrian or German. *where Max is from.
(21)	It is possible/true	that Max is Austrian. *whether Max is Austrian. *whether Max is Austrian or German. *where Max is from.
(22)	Alice wonders/ is investigating	*that Max is Austrian. whether Max is Austrian. whether Max is Austrian or German. where Max is from.
(23)	Whether Max can apply depends on	*that he is Austrian. whether he is Austrian. whether he is Austrian or German. What his nationality is.

The most natural explanation for these patterns is that linguistic environments have selectional restrictions: Some expect a proposition as their argument, other expect an issue. If this is right, then we should conclude from the above observations that the contents of polar questions are issues, not propositions. Moreover, as was argued explicitly by Karttunen (1978), the fact that different

kinds of questions embed in the same linguistic environments speaks in favor of a uniform semantic type for question contents.[12]

Finally, one can argue against the view that the content of a polar interrogative is a proposition on the basis of the compositional contribution of such interrogatives. The following argument was, to my knowledge, first given by Groenendijk and Stokhof (1997). Consider the following sentences:

(24) a. Alice knows that Smith stole the jewels.

b. Alice knows whether Smith stole the jewels.

These sentences express different propositions: For instance, suppose Smith is innocent and Alice knows this; then (24-b) is true while (24-a) is not. Since these sentences only differ in the complement of *know*, the principle of compositionality requires the two complements 'that Smith stole the jewels' and 'whether Smith stole the jewels' to differ in semantic value. It is standardly assumed that the content of 'that Smith stole the jewels' is the proposition that Smith stole the jewels; and this seems right, since (24-a) ascribes to Alice knowledge of this proposition. It follows, then, that the content of the polar question 'whether Smith stole the jewels' is not the proposition that Smith stole the jewels.

In fact, this content must not be a proposition at all, since (24-b) does not describe Alice as knowing a specific proposition, but as knowing either one of

12 As Karttunen (1978) himself observed (p. 5), there are a few sporadic cases of environments in which polar and *wh*-questions come apart. However, these cases do not support the Fregean hypothesis either: In some cases, like (i), statements pattern with polar questions, but in other cases, like (ii), they pattern with *wh*-questions.

(i)
I doubt that they serve breakfast.
I doubt whether they serve breakfast.
I doubt *what they serve for breakfast.

(ii)
It is amazing that he ran so fast.
It is amazing *whether he ran so fast.
It is amazing how fast he ran.

two propositions – either that Smith stole the jewels, or that Smith didn't steal the jewels – whichever of these happens to be true.[13]

Could one grant that the content of the indirect polar question 'whether Smith stole the jewels' is not a proposition, yet insist that the content of the corresponding direct question, 'Did Smith steal the jewels?', is a proposition?

This move amounts to denying the *equivalence thesis*. This seems undesirable since, as we saw in section 1.3, there is much to be said in favor of the equivalence thesis. Even setting this worry aside, we can reproduce the problem without relying on the indirect form of a question, and by using propositional anaphora instead. First, note that the anaphoric particle 'that' can be used to refer to salient discourse referents, including the content of a previous utterance. Consider the following dialogue:

(25) A: Smith stole the jewels.
B: I wish Charlie knew that.

What B is saying is that he wishes Charlie knew that Smith stole the jewels. This reading comes about because the word 'that' in the second sentence can refer to the proposition expressed by the previous sentence, which is available as a salient discourse antecedent after A's assertion. Now consider:

(26) A: Did Smith steal the jewels?
B: I wish I knew that.

If A's question in (26) expresses the same content as A's statement in (25), we would expect the anaphora 'that' to pick out the same content. In that case, B's sentence would mean that he wishes he knew that Smith stole the jewels. That is not what B is saying. What B is saying is that he wishes he knew *whether* Smith stole the jewels. In order to explain how this reading comes about, we have to suppose that the word 'that' can pick out the same semantic object that would be overtly expressed by 'whether Smith stole the jewels'. So, this object

13 This is not necessarily to deny that the argument of *know* in (24-b) is a proposition. For instance, Groenendijk and Stokhof (1984) take the content of 'whether Smith stole the jewels' to be a function from possible worlds to propositions: the function that maps a world w to the true answer to the question whether Smith stole the jewels. In their analysis, the argument of *know* in (24-b) is the value of this function at the world of evaluation, which is a proposition.

must be available as a discourse referent after A asked her question. Why is it available? The natural explanation seems to be that this object is precisely the content expressed by A, in accordance with the equivalence thesis.[14]

1.5 Inquisitive Semantics

In this section, I briefly outline my preferred approach to questions, namely, inquisitive semantics (Ciardelli, Groenendijk & Roelofsen 2018), and discuss how the notion of question content that it yields can be used to play the four roles we identified above.

14 Note that, after the question 'Did Smith steal the jewels?' is asked, the proposition that Smith stole the jewels is also available as an anaphoric antecedent, as the following dialogue illustrates:

(i)
A: Did Smith steal the jewels?
B: That is very unlikely.

Here, 'that' refers to the proposition that Smith stole the jewels. To explain why this is possible, observe that 'that' need not pick up the content of an entire sentence, but can also pick up the content of a constituent. This is illustrated by the following dialogue:

(ii)
A: Charlie thinks that Smith stole the jewels.
B: Well, he can't know that for sure.

Here, the word 'that' in the second sentence does not refer to the proposition expressed by A, but to the proposition expressed by the constituent clause 'that Smith stole the jewels'.
We can account for the anaphora in (i) if we suppose that the content of a syntactic constituent of our polar question is a proposition. This is very natural: Most existing theories about the compositional semantics of questions assume that the derivation of the meaning of a polar question involves a syntactic constituent whose semantic value is a proposition p to which an operator '?' applies to yield a question content $?p$ (cf. Karttunen 1978, Groenendijk & Stokhof 1984, Ciardelli et al. 2018). By contrast, if one wanted to maintain that the content of the direct question 'Did Smith steal the jewels?' is the proposition that Smith stole the jewels, in order to account for the anaphora in (26) one would have to assume that the compositional derivation of this proposition involves a constituent whose semantic value is the issue whether Smith stole the jewels. But this seems to get things backwards – surely the issue whether p is derived from the proposition p, and not the other way around – and I know of no compositional account on which this is the case.

1.5.1 Foundations

In a slogan, the inquisitive semantics approach to questions can be put as follows: To understand a question is to know what information is needed to resolve it. Thus, the idea is that just like the semantics of a statement is traditionally captured in terms of its *truth conditions*, the semantics of a question can be captured in terms of its *resolution conditions*.

What are the objects relative to which a question may or may not be resolved? They are bodies of information, which we call 'information states'. Inquisitive semantics is formulated within the general framework of intensional semantics, where a model comes with a universe W of possible worlds, representing different states of affairs. An information state s is modeled formally as a set of possible worlds: Intuitively, the worlds $w \in s$ are those that are compatible with the information encoded by s, while the worlds $w \notin s$ are those that are ruled out by this information.

Thus, inquisitive semantics is given by a relation called *support* between information states s and questions Q,

(27) $s \vDash Q$

that holds if the information available in s resolves Q. The issue expressed by Q, denoted $[Q]$, can be identified with the set of information states that support Q:

(28) $[Q] = \{s \subseteq W \mid s \vDash Q\}$

This object captures the content of the question Q (in the model at hand). The maximal elements in $[Q]$ in terms of inclusion are called the 'alternatives' for Q.[15]

1.5.2 Illustration

To illustrate these ideas, consider a scenario involving a two-digit secret code, where each digit is either 1, 2, or 3. So there are in total 9 possibilities for the code. Each of these possibilities is a way things might be, and thus a possible world in a model that captures this scenario. So, the universe W of our model is represented by the following picture:

15 The framework can be refined in a natural way to take into account the role of context in fixing the reference of indexical expressions. See van Gessel (2020).

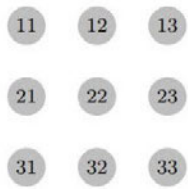

Fig. 6: Example universe W

Now consider three questions about the code:

(29) Q_1 Is the first digit 1?

Q_2 What is the first digit?

Q_3 What is the code?

A state s resolves Q_1 if the information in s determines whether the first digit is 1. This can happen if the information in s implies that the first digit is 1 ($s \subseteq \{11, 12, 13\}$), or if it implies that the first digit is not 1 ($s \cap \{11, 12, 13\} = \emptyset$).

A state s resolves Q_2 if the information in s determines what the first digit is; in our model, this means that either the information in s implies that the first digit is 1 ($s \subseteq \{11, 12, 13\}$) or it implies that the first digit is 2 ($s \subseteq \{21, 22, 23\}$) or it implies that the first digit is three ($s \subseteq \{31, 32, 33\}$).

As for Q_3, this question is resolved only if s determines what the code is; in our model, this means that s must determine exactly which world is the actual one, and so s must be a singleton (or the empty, inconsistent state, which only plays a trivial role in the semantics). Summing up, the support conditions for the above questions in our model are:

(30) $s \vDash Q_1 \iff s \subseteq \{11, 12, 13\}$ or $s \cap \{11, 12, 13\} = \emptyset$

$s \vDash Q_2 \iff s \subseteq \{11, 12, 13\}$ or $s \subseteq \{21, 22, 23\}$ or $s \subseteq \{31, 32, 33\}$

$s \vDash Q_2 \iff s \subseteq \{ij\}$ for some singleton state $\{ij\}$

The corresponding alternatives are visualized in the following pictures:

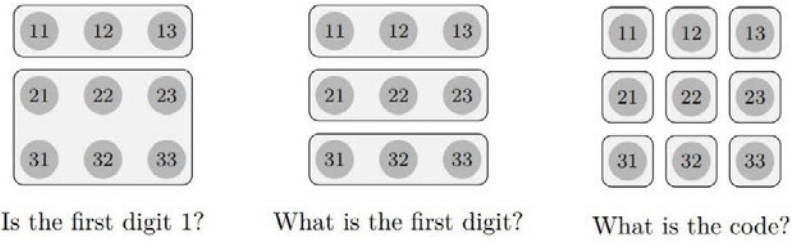

Fig. 7: W with visualized alternatives for three questions

1.5.3 Extension to Statements

We may take statements to be endowed, as usual, with truth conditions relative to possible worlds. As usual, we write

(31) $w \vDash S$

to mean that statement S is true at world w. Once support semantics is in place, it is natural to extend support to statements as well. In the case of a statement, however, its support conditions need not be viewed as primitive, but can be seen as derived from its truth conditions via the following bridge principle: A state s supports a statement S iff s implies that the world is one where S is true. In symbols:

(32) **Truth-support bridge**: $s \vDash S \iff \forall w \in s\colon w \vDash S$

For instance, take the following statement:

(33) S_1 The first digit is 1.

This statement will be supported in a state s iff it is true at every world in s:

(34) $s \vDash S_1 \iff s \subseteq \{11, 12, 13\}$

As illustrated by the following picture, the unique alternative for a statement always coincides with the proposition expressed by the statement, i.e., the set of worlds where the statement is true.

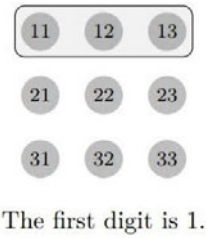

Fig. 8: W with the alternative associated with a statement

1.5.4 Compositional Semantics

To illustrate how the notion of content given by inquisitive semantics can be put to use in compositional semantics, consider the verb 'know'. Inquisitive semantics leads to a smooth uniform account of knowledge ascriptions, in which the complement may be declarative or interrogative.

Following the standard Hintikkan account, with an agent x we can associate an epistemic accessibility relation R_x. The idea is, as usual, that wR_xv holds just in case v is compatible with everything that x knows at w. This means that the set of worlds $R_x[w] = \{v \in W \mid wR_xv\}$ is an information state, which captures the epistemic state of x at w.

A knowledge ascription is a statement, so we specify its truth conditions (which then determine its support conditions in accordance with the truth-support bridge above). These truth conditions are very simple: To say that an agent x knows φ is to say that their epistemic state $R_x[w]$ supports φ. Here is the formal clause:

(35) $w \vDash x \text{ knows } \varphi \quad \Leftrightarrow \quad R_x[w] \vDash \varphi$

On the left-hand side, '$\vDash$' stands for truth; on the right-hand side, '$\vDash$' stands for support. Since support is well-defined regardless of whether φ is a statement or a question, this clause allows us to interpret in exactly the same way ascriptions involving a declarative complement and ascriptions involving an interrogative complement. Thus, the analysis is uniform.

Now let us check that this gives the intuitively correct truth conditions for both cases. Consider two different ascriptions:

(36) a. Alice knows that the first digit is 1.

b. Alice knows what the first digit is.

The complements of these knowledge ascriptions are the embedded forms of the statement S_1 and the question Q_2 discussed above. Recall that the support conditions for these sentences are as follows:

- $s \vDash S_1 \quad \Leftrightarrow \quad s \subseteq \{11, 12, 13\}$
- $s \vDash Q_2 \quad \Leftrightarrow \quad s \subseteq \{11, 12, 13\}$ or $s \subseteq \{21, 22, 23\}$ or $s \subseteq \{31, 32, 33\}$

Combining the clause for 'know' with these support conditions, we get the following truth conditions for the sentences in (36):

(37) $w \vDash \text{a knows } S_1 \quad \Leftrightarrow \quad R_a[w] \subseteq \{11, 12, 13\}$

$w \vDash \text{a knows } Q_2 \quad \Leftrightarrow \quad R_a[w] \subseteq \{11, 12, 13\}$ or $R_a[w] \subseteq \{21, 22, 23\}$ or $R_a[w] \subseteq \{31, 32, 33\}$

For (36-a), where the complement is a statement, we retrieve the predictions of the standard Hintikkan account of knowledge: Alice knows that the first digit is 1 if her knowledge state is only compatible with worlds where the first digit is 1. In fact, it holds in general that when the complement is a statement, our inquisitive account coincides with the Hintikkan one. Using the truth-support bridge, for any statement S we have:

(38) $w \vDash x \text{ knows } S \quad \Leftrightarrow \quad R_x[w] \vDash S$

$\Leftrightarrow \quad \forall v \in R_x[w]\colon v \vDash S$

Thus, our clause above can be seen as a generalization of the Hintikkan account.

For (36-b), where the complement is a question, the account predicts that, in our setting, Alice knows what the first digit is just in case she knows that the first digit is 1, or she knows that the first digit is 2, or she knows that the first digit is 3. This is the intuitively correct result. More generally, the account predicts that when the argument of 'know' is a question, the knowledge ascription is true in case the agent has sufficient knowledge to resolve the question.

This is just an example, but hopefully it suffices to illustrate how the notion of content of a question given by inquisitive semantics can be put to work in giving a compositional semantics for both natural and formal languages.[16]

16 For further literature on questions embedded in different environments in inquisitive semantics, see Ciardelli & Roelofsen (2015, 2018), Ciardelli (2016a), Ciardelli, Groenendijk & Roelofsen (2018), Theiler et al. (2018).

1.5.5 Logic

In the case of statements, semantics is given in terms of truth conditions. The central logical notion of entailment is then defined in terms of preservation of truth in every model. In the inquisitive setting, semantics is given in terms of support conditions. It is then natural to define entailment in terms of preservation of support in every model:

(39) $\varphi_1, \ldots, \varphi_n \vDash \psi \iff$ for every model M and information state s in M:
if $s \vDash \varphi_i$ for every $i \leq n$ then $s \vDash \psi$

As we saw, the support relation is naturally defined for both statements and questions. As a consequence, the above definition yields a relation of entailment in which the premises and the conclusion may be either statements or questions.

In the case of statements, truth and support are linked by the truth-support bridge (32). It is easy to see that this relation guarantees that, for statements, our support-based construal of logical entailment coincides with the standard truth-based construal. This means that the relation defined above is a conservative extension of the standard notion of logical entailment to questions.

On the other hand, entailment relations involving question premises and a question conclusion capture precisely the relation of logical dependency discussed in section 1.3.2. For instance, the example of dependency we gave on page 22 amounts to the validity of the following entailment:

(40) $\left\{ \begin{array}{l} \forall x(\text{bachelor}(x) \leftrightarrow \text{man}(x) \wedge \text{married}(x)), \\ \text{what } x.\text{man}(x), \\ \text{what } x.\text{married}(x) \end{array} \right\} \vDash \text{what } x.\text{bachelor}(x)$

This entailment is valid because for any information state that establishes (i) that the set of bachelors is the intersection of the set of married people and the set of men, (ii) what the set of men is, and (iii) what the set of married people is, that state must also establish what the set of bachelors is. And this is exactly what the logical dependency discussed on page 22 amounts to.

This illustrates how inquisitive semantics provides a suitable foundation for the study of logical relations involving questions. The approach comes with a naturally defined notion of logical entailment, which extends the standard no-

tion of entailment to questions. Interesting logical notions such as dependency turn out to be cases of entailment involving questions.

Moreover, this notion of entailment determines a natural treatment of logical operators (connectives and quantifiers) motivated by algebraic considerations (Roelofsen 2013), which yields well-behaved logical systems in which connectives and quantifiers operate on questions and on statements in a uniform way.

As an example of such a system, consider inquisitive first-order predicate logic, InqBQ. In that system, we have all standard first-order formulas, which receive the usual reading. For instance, the formula $\forall x\,(Px \leftrightarrow \neg Qx)$ expresses, as usual, the fact that the extension of Q is the complement of the extension of P. But we also have new formulas, which are read as questions. For instance, we have a formula $\forall x\,?Px$ that formalizes the question 'which objects are P?', or alternatively, 'what is the extension of P?'. This formula is supported in an information state s if the information available in s determines exactly which objects are P; that is, if the extension of P at each world $w \in s$ is the same.

Now, here is an example of a logical fact: Under the assumption that P is the complement of Q, the extension of P determines the extension of Q. This logical fact is captured by the following entailment in InqBQ:

(41) $\{\forall x\,(Px \leftrightarrow \neg Qx), \forall x\,?Px\} \vDash \forall x\,?Qx$

Being a valid entailment, this dependency can, in fact, be *proved* in a natural deduction system for (a fragment of) InqBQ. Here is what a proof looks like:

$$\dfrac{\dfrac{\forall x? Px}{?Py}\,\forall e \qquad \dfrac{\dfrac{\dfrac{\forall(Px \leftrightarrow \neg Qx)}{Py \leftrightarrow \neg Qy}\,\forall e}{Py \leftrightarrow \neg Qy}\,\wedge e \quad [Py] \quad Py \rightarrow \neg Qy}{\dfrac{\neg Qy}{?Qy}\,?i}\,\rightarrow e \qquad \dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\forall x(Px \leftrightarrow \neg Qx)}{Py \leftrightarrow \neg Qy}\,\forall e}{\neg Qy \rightarrow Py}\,\wedge e \quad [\neg Qy]}{Py}\,\rightarrow e \quad [\neg Py]}{\bot}\,\rightarrow e}{\dfrac{\neg\neg Qy}{Qy}\,\neg\neg}\,\rightarrow i}{?Qy}\,?i}{?Qy}\,?e}{\dfrac{?Qy}{\forall x? Qx}\,\forall i}$$

This is not the place to get into the details, but I included the proof to illustrate that in inquisitive logic, questions can be handled within a rather standard proof system, where connectives are introduced and eliminated in ordinary ways.

In sum, inquisitive semantics provides a solid foundation on which to build logics of questions. This foundation makes the logic of questions contiguous with the logic of statements, and deeply intertwined with it. This is made possible by two features of the approach: first, the fact that inquisitive semantics is similar to truth-conditional semantics in that it is based on a satisfaction relation, which is preserved by entailment; and second, the fact that statements and questions can be interpreted uniformly, which makes it possible to have a single general notion of entailment, and a uniform account of connectives and quantifiers.

1.5.6 Attitudes

Next, consider attitudes. When we say that Alice wonders, or does not care, what the first digit is, we can take these to be attitudes Alice has towards the issue $[Q_2]$ expressed by the question Q_2 = 'what is the first digit?', modeled formally as the set of information states where Q_2 is supported. Similarly, if Alice is investigating what the first digit is, then we can take the object of her investigation to be the issue $[Q_2]$. Thus, the semantics associates to a question a semantic object which we may take to be the intensional content of question-directed attitudes and activities.

We can also give a purely semantic notion of an issue, as a certain kind of family of information states (see §2 of Ciardelli, Groenendijk & Roelofsen 2018, for discussion). This makes room for the natural possibility that an agent entertains or investigates issues which are not expressible in the relevant language.

Issues in inquisitive semantics are intensional objects, modeled in the framework of possible world semantics, so the account does face the same problems that are often raised towards intensional accounts of propositional attitudes, and which have led many towards *hyper-intensional* contents. But here, we will be content if we can have an approach to question contents that does as well as the standard intensional approach to propositional contents.

We can also do something more. Just like in the Hintikkan tradition we use sets of worlds to model the information state of an agent, here we can use issues to model what we might call the *inquisitive state* of an agent, reflecting both what the agent knows and what they are interested in, or curious about. For instance, the two pictures below represent two agents with the same knowledge but with different interests: In both cases, what the agent knows is that the first digit is one; however, the first agent is also interested in what the second digit is, whereas the second agent is indifferent to that.

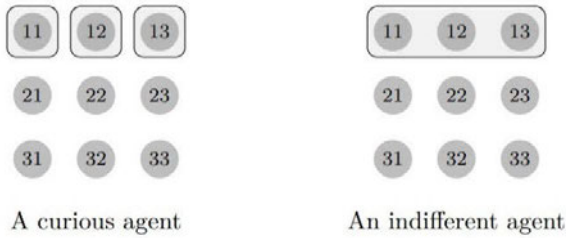

Fig. 9: The inquisitive states of a curious and an indifferent agent

Using this formal representation of inquisitive state of an agent, we can provide a logical analysis of the verb 'wonder', in the spirit of the Hintikkan analysis of 'know' and 'believe'. This yields a ›logic of wondering‹ that accounts, e. g., for the validity of the following inference:

(42) Alice knows that the code is 11 or 12.

Alice wonders what the code is.

Alice wonders whether the code is 11, or 12.

The reader is referred to Ciardelli and Roelofsen (2015, 2018) for the details.

1.5.7 Discourse

Finally, the fact that inquisitive semantics gives us issues that do not bake in a specific force makes it possible to use these issues as contents of a variety of speech acts, including asking, but not limited to it.

For instance, just for the sake of illustration, we could characterize the difference between asking and wondering aloud in terms of the following discourse effects. Suppose $\mathcal{I}$ is an issue. Then we may propose that:

- by performing Ask ($\mathcal{I}$) a speaker commits to believing the proposition $\cup\mathcal{I}$ (the presupposition of the issue $\mathcal{I}$) and proposes that some resolving information $s \in \mathcal{I}$ be established in the conversation;
- by performing Wonder-aloud ($\mathcal{I}$) a speaker commits to believing the proposition $\cup\mathcal{I}$ and to wondering about $\mathcal{I}$.

In both cases, the speaker is putting the same issue $\mathcal{I}$ on the table, but the move they are making is different: In the first case, they are inviting a resolution of the issue in the conversation, whereas in the second case, they

are merely expressing their wondering.[17] And one can see how such a story could be extended with accounts of other discourse moves that have an issue as their content.[18]

1.6 Conclusion

Contents of statements and contents of questions have largely parallel theoretical roles to play: (i) They are involved in the recursive process of meaning composition; (ii) they bear logical relations to each other; (iii) they play a role in our mental life, as contents of our thoughts and activities; (iv) they play a role in communication, acting as contents for a range of different speech acts. A desideratum for theories of questions is that they provide us with question contents that can account for these roles.

A line of thought in philosophy interprets questions only at the discourse level, as asking acts. However, some of the roles above do not involve discourse at all, or they involve discourse but not asking. The upshot of our discussion is that the content-force distinction is just as important for interrogative language as it is for declarative language: The content expressed by a question and the act of asking this content should be carefully distinguished.

In the final part of the paper, we focused on a recent approach to questions, namely, inquisitive semantics. This theory interprets questions by means of a notion of *support* that lays out what information is needed for a question to be resolved. The notion of support extends in a natural way to statements. In inquisitive semantics, statements and questions still express different kinds of semantic objects, but the difference is not one of semantic type.

We discussed how inquisitive semantics can be put to use in the four roles we identified. In compositional semantics, it facilitates uniform theories of environments that embed both statements and questions. In logic, it allows us to generalize the standard notion of entailment to questions, in such a way

17 Of course, in some cases one may express one's wondering with the intention of inviting the interlocutor to resolve the issue; but in this case, the request for information is not part of the conventional effect of the speech act. Rather, it is natural to assume that it comes about as a secondary effect through the hearer's recognition of the speaker's intention.

18 For an account of discourse effects based on inquisitive semantics, see Farkas and Roelofsen (2017). As Farkas and Roelofsen discuss, the uniform notion of semantic content provided by inquisitive semantics may also help to simplify the discourse component of a theory, allowing one to assume that a single default force underlies both asserting and asking. Note that this simplification is *allowed* by the theory, but not *required*: Inquisitive semantics is straightforwardly compatible with the view I outlined above, according to which statements and questions differ in the sort of content they express *as well as* in their conventional force.

that logical dependency comes out as a facet of entailment, and can be studied with standard logical tools. The semantics can be put to use to give formal analyses of question-directed attitudes such as *wondering*. And finally, it gives us force-neutral question contents that can be used in formulating accounts of the discourse effects of different speech acts involving questions.

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1A Comments on *Why We Need a Question Semantics by Ivano Ciardelli*

Dorota Leszczyńska-Jasion

To start with, I would like to thank the conference organizer, Moritz Cordes, for creating the opportunity for an exchange of ideas, which took place on September 17th – 19th, 2020. It was a pleasure to hear the opening lecture under the title *Why We Need a Question Semantics*, given by Ivano Ciardelli, and it is also my pleasure now to take part in recreating the atmosphere of discussion that prevailed during the conference by sharing my thoughts on some of the issues discussed there.

In my comment, I will focus on two threads. Both are somewhat secondary to the main topic of the lecture – I suppose we have no doubts concerning the need of question semantics – which is not to say that the threads are not relevant for the way we build this semantics. The first one exploits the proof-theoretical value of solutions proposed by inquisitive semantics; this thread was raised somewhat marginally during the lecture itself (and during the discussion by me), and it is worth emphasizing, so I will take this opportunity to express my enthusiasm for the use of the tools of structural proof theory in the logic of questions in general, and in particular – for the natural deduction system for logic InqB and InqBQ as proposed by Ciardelli.[1] I also indicate some limitations of this account and list some open problems.

The second thread relates to the question asked during the discussion about the difference between resolving and answering a question. This question leads to another, more general, question about the usefulness and the grounds for the proposed conceptual changes. In my opinion, the answer to these questions obtained during the discussion was not fully satisfactory. In particular, the argument against the use of *answer* and in favor of *resolution* does not seem conclusive to me.

1 Natural deduction systems for inquisitive propositional logic InqB and certain fragments of the first-order system InqBQ were presented in Chapters 3 and 4 of (Ciardelli 2016).

1A.1 Questions in Structural Proof Theory

The main part of the talk argued for the semantic characteristics and analysis of questions – opposing the position initiated by Frege according to which the semantic content of questions is the same as that of declarative sentences – in both cases the semantic content is a *proposition*. The difference between questions and statements – an advocate of Frege's position would say – is in the way they refer to the proposition, hence the essence of questions lies at the pragmatic level in their *illocutionary force*. However, it seems – Ciardelli argues[2] – that Frege's position can be maintained only with regard to polar questions, and a deeper analysis of other types of questions shows a much greater adequacy of modelling the semantic content of questions in terms of *issues*. In the second part of the lecture (see also sect. 1.5 above) it was demonstrated how the analysis of resolution-conditions of questions and statements is performed within the framework of inquisitive semantics, and how this framework successfully fulfills the requirements that emerged from the first part of the lecture.

Inquisitive semantics (Ciardelli et al. 2018) constitutes a general framework unifying the semantic analysis of declarative and interrogative sentences – or *statements* and *questions*, to use the terminology proposed by the speaker. In the inquisitive semantics framework, the informal analysis is performed in terms of, *int.al.*, *information exchange* and *issues raised in a conversation*, thus eliminating the artificial traditional notion of truth conditions. On the formal level, the primary semantic concept is that of *support*, where support can be viewed as a generalization of the traditional concept of *truth*. The benefit of this generalization is the aforementioned unification – semantic properties of questions and statements, and the relations between them, are analyzed in one framework by the same tools.[3]

Similar unification can be then obtained on the syntactic level in the construction of a proof system.[4] As Ciardelli explains in his paper, a theory of questions should address the need for a semantic analysis of the relationships between questions, as well as between statements and questions, but it should also "build formal systems that allow us to study these relations and regiment reasoning about them" (see sect. 1.3.2 of this volume). This next step of formalization – formal systems to regiment reasoning about logical relations

2 Ciardelli follows arguments by Belnap, Groenendijk and Stokhof and also formulates new ones.

3 One can see there a price to be paid, however: Eventually, questions, just as statements, are assigned truth values.

4 Again, for some logicians the lack of syntactic distinction between questions and statements can be a disadvantage.

involving questions – can be fruitful for linguistic considerations, but it is also crucial for further development of the logic of questions, especially in the field of automated deduction and artificial intelligence.

The natural deduction (ND, for short) system for InqB and InqBQ is exactly this kind of a formal system. In (Ciardelli 2016), questions are expressed in the language by the connective of inquisitive disjunction, and the analysis of a question is driven by the rules for this connective. However, in Fig. 1 I use the question mark, as Ciardelli does in his example (41) in sect. 1.5.5 of this volume. (I also intentionally use the symbols from the example.) The figure presents the (special cases of) rules of introduction and elimination of questions.

$$\frac{Qy}{?Qy}\ ?\mathrm{i} \qquad \frac{\neg Qy}{?Qy}\ ?\mathrm{i} \qquad \frac{?Py \quad \begin{array}{c}[Py]\\ \vdots\\ C\end{array} \quad \begin{array}{c}[\neg Py]\\ \vdots\\ C\end{array}}{C}\ ?\mathrm{e}$$

Fig. 1: Introduction and elimination rules for questions in InqBQ

The introduction rules can build a question from a more specific information, e.g. from a formula Qy. Technically, this is analogous to deriving $Qy \vee \neg Qy$ from Qy. Similarly, the elimination rule allows to derive a formula from a question just as the rule for disjunction does. The elimination scheme displayed above can be read as follows: Given that it is legitimate to ask question $?Py$ (where semantically, the legitimacy can be understood as truth of the respective presupposition) and that C can be derived from each of the resolutions of $?Py$ taken separately as an assumption, one can discharge the two assumptions and consider C to be derived from the assumption $?Py$ alone.

It would be an interesting enterprise to analyze the derivability relation generated by the natural deduction systems for InqB, InqBQ in the framework of sequent calculi. I suggest the following sequent-calculus rules as corresponding to the above ND-rules.

$$\frac{\Gamma \Rightarrow Qy}{\Gamma \Rightarrow ?\,Qy}\ ?\,\mathrm{i} \qquad \frac{\Gamma \Rightarrow \neg Qy}{\Gamma \Rightarrow ?\,Qy}\ ?\,\mathrm{i} \qquad \frac{\Gamma, Py \Rightarrow C \quad \Gamma, \neg Py \Rightarrow C}{\Gamma, ?\,Py \Rightarrow C}\ ?\,\mathrm{e}$$

The following (Fig. 2) is a sequent-calculus translation of the example (41) presented by Ciardelli (sect. 1.5.5 of this volume).

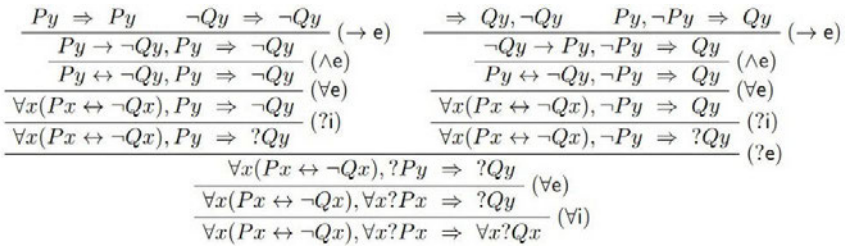

Fig. 2: Sequent-calculus translation of Ciardelli's example

According to sequent-calculus conventions, the rules whose application is indicated to the left should be called left- and right-rules, but I leave the ND-names so the connections between the two presentations of the same example are clearly visible: The elimination rules correspond to the left-rules, and the introduction rules correspond to the right-rules. Let me also observe that the third (from the left) branch reveals the classical character of this particular reasoning[5]; in the ND-proof this is hidden in the treatment of negation. Once structural rules are added to the picture, the tools of a sequent calculus may become more powerful than those of ND. As far as I know, completeness of the ND system for InqBQ has not been achieved.[6] Adding sequents to the picture can be a way to challenge completeness (possibly, rebuilding the system) – the history of the very discipline of structural proof theory[7] shows that sometimes the analysis of a derivability relation becomes easier in the sequent-calculus framework; possibly, though not necessarily, this is the case here.

In the summary of this thread, let me use the following citation from Ivano Ciardelli:

> "[Q]uestions have a very important role to play in inferences: they make it possible to formalize arguments involving generic information of a certain type, such as *where Alice lives* […] [Q]uestions may be used as placeholders for arbitrary information of the corresponding type. By manipulating such placeholders, we may then provide formal proofs" (Ciardelli 2016:77)

5 To simplify matters, I also ›hid‹ the application of contraction which should follow the application of $\rightarrow$e to $\Rightarrow Qy, \neg Qy$ and $Py, \neg Py \Rightarrow Qy$.

6 After writing this comment Ivano Ciardelli made me aware of two publications that I had not considered before. In (Grilletti 2020) the author presents a sound and complete ND-style formalization of an extensive part of the first-order inquisitive logic. In (Frittella et al. 2016) a display-style sequent calculus for inquisitive logic has been developed, but its potential relation with the ND-system by Ciardelli is rather vague.

7 See Troelstra & Schwichtenberg (2000), Negri & von Plato (2001, 2011), von Plato (2016).

This point of view, expressed also in Ciardelli (2018), is definitely convincing, but it raises a number of further, yet unanswered, issues:

- Is it possible to extend the presented ND framework, to account for other types of questions than those expressible by inquisitive disjunction and inquisitive existential (not discussed here)?
- Questions usually have a structure. In which cases and to what extent can we manipulate and analyze this structure, which is in the scope of the operator '?'?[8]
- The rules of InqB, InqBQ in the present formulation do not allow to derive questions from questions only, without the use of statements. On the other hand, reasoning with pure questioning seems to be an important cognitive phenomenon.[9] Can we add ND-rules to account for such phenomena? And more importantly:
- Is the account of questions as information types exhaustive for the roles played by questions in inferences, and more generally, in cognition? Does it sufficiently explain how they become a tool in our targeted cognitive development?

1A.2 Resolutions and Answers

A side comment to the presentation of the ND-rule ?e (see Fig. 1) is that using the term *resolution of* ?*Py* in reference to *Py* and ¬*Py* can never be as natural as calling them *answers* to the question ?*Py*. And this leads me to the second thread mentioned at the beginning.

The inquisitive-semantics (let me use IS, for short) paraphrase of Hamblin's second postulate is 'To understand a question is to know what resolves it.'.[10] According to Ciardelli,[11] the notion of *answer* is not sufficiently clear: There are no precise criteria deciding what is an answer to a question, whereas one can formulate such criteria for the proposed notion of resolution. Hence IS proposes the notion of resolution as primitive; then various kinds of answers can be defined using this notion. During the discussion, Ivano Ciardelli explained that

8 There are some rules to do this in InqBQ, like ⩒-split, which allows to derive formula $(\alpha \rightarrow \varphi) \veebar (\alpha \rightarrow \psi)$ from $\alpha \rightarrow \varphi \veebar \psi$. The point is that the number of possible options in the analysis of this inner structure of a question, as provided by this framework, seems very limited.

9 For a justification of this view, see (Wiśniewski 1995, 2013) or papers by Andrzej Wiśniewski on inferential erotetic logic.

10 The original is "Knowing what counts as an answer is equivalent to knowing the question." (Hamblin 1958:162).

11 See also Ciardelli et al. (2018:ch. 9).

resolution and *answer* sometimes mean the same thing: namely, provided that *answer* is understood as a body of information that resolves the question. But sometimes this is not the case – for example, 'Alice passed the exam' can be regarded as an answer to question 'Who passed the exam', although it does not resolve the question (example from the discussion).

While the very concepts of *issue*, *resolution* and the way they work in IS prove to be a successful way to build a linguistic theory of questions, the argument against the use of *answer*, as referring to the lack of clear criteria of being an answer, seems to arise out of a conceptual confusion. There is no adequate analysis of questions – as they function in natural languages – without analysis of answers to questions. Since in natural languages the two rarely come apart, it is natural to start with interrogatives and answers conceived as statements (Hamblin again!) on the level of theoretical explication of the natural phenomena. The lack of precise criteria is an inevitable feature of natural language occurrences, but not of the theoretical terms that explicate them. Once we build a formally correct theory modelling answering to questions – like the IS framework does in terms of resolutions – we can introduce the key theoretical concept like *answer*, *resolution* or anything else, but the choice must be justified. *If* we decide to use *answer*, then clearly we have two notions of *answer* from different levels: One refers to a natural language, the other is a technical concept. We do know that the statement 'Alice passed.' is *probably* not a direct/just sufficient/proper *answer* to 'Who passed the exam?' – *probably*, because this depends on our reading of the question. Some theoreticians would say that 'Alice passed.' is just a partial answer to the question – the notion of 'resolution' can hardly add anything new to this explanation. In fact, when natural language phenomena are concerned, sometimes we are not able to decide whether something is a question at all, but we do not take it to be a reason to discontinue the use of 'question' as a primitive term for a theory of questions. What is more, when natural language phenomena are concerned, one could say that something counts as an answer to the question *Was this a question?* just in case it counts as a resolution to the issue of whether this was a question. I cannot see how this can change anything in reference to the analysis of a natural language. This is not to say that the conceptual proposal of IS is not justified, I only claim that the argument from ›no clear criteria‹ is not sound.

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1B In Defense of Question Diversity: Comments on Ciardelli

Manfred Krifka

In his paper *Why We Need a Question Semantics* Ivano Ciardelli presents an argument against the view that he traces back to Frege – namely, that assertions and questions are different pragmatic uses of the same semantic object, propositions. This view assigns assertions (statements) the form AS(p) and questions the form QU(p), where p is a proposition, and AS and QU are illocutionary force operators. Instead, Ciardelli proposes that assertions and questions are based on distinct semantic objects, propositions p and question meanings, q, which are turned into assertive or interrogative speech acts by illocutionary operators, AS(p) and QU(q), the default force operators for propositions p and question meanings q, respectively. As Ciardelli remarks, the first view is not prominent in linguistics but has adherents in philosophy. But even though I am a linguist, I would like to argue that the illocutionary question operator QU takes a single proposition.

1B.1 Monopolar Questions

The reason for assuming questions of type QU(p) is that polar questions in natural language are often biased towards one proposition. Consider (1).

(1) Is it raining?

Standard theories of question meanings represent (1) disjunctively; e. g. as set of two propositions. This also holds for Inquisitive Semantics, the framework assumed by Ciardelli, even though this theory does not make a type-theoretic difference between propositions and question meanings, or "issues". The problem of this view is that it makes (1) equivalent to (2) and (3).

(2) Is it not raining?

(3) Is it raining or not?

However, these questions are used differently. With (1) the speaker can confirm evidence that it is raining,[1] with (2), that it is not raining, and (3) comes with a "cornering" effect that forces an answer from an addressee that has not complied so far, cf. Biezma (2009). This has led to proposals that (1) and (2) are based on just one proposition, cf. Biezma & Rawlins (2012).

Let r be the proposition that it is raining at the time and location of the utterance context, and let $\neg r$ be its complement, or negation. (1), (2), and (3) could then be represented as QU(r), QU($\neg r$), and QU($\{r, \neg r\}$). That is, (1) and (2) are interpreted as *mono*polar questions and (3) as a *bi*polar question. Within a framework like Commitment Spaces (cf. Krifka 2015) one can motivate the different uses of such questions. Without going into details in this short comment, the underlying idea is that in assertions AS(r), the speaker S_1 vouches for the truth of r, whereas in regular questions S_1 tests whether the addressee S_2 vouches for the truth of propositions, which can be modelled by restricting the continuations of the current common ground. With QU(r), S_1 tests whether S_2 vouches for r, with QU($\neg r$), for $\neg r$, and for QU($\{r, \neg r\}$), whether for r or $\neg r$; this predicts the pragmatic uses of these questions. Krifka (2021a) discusses additional question types such as declarative questions and high-negation questions that are based on propositions.

There are proposals within the standard theory of question meanings as presenting a disjunction such as $\{r, \neg r\}$ for which it matters which of the propositions are actually realized in the expression, such as r in (1), $\neg r$ in (2), and both r and $\neg r$ in (3) – for example the concept of "highlighting" in Roelofsen & van Gool (2010). These theories broaden the notion of meaning in such a way as to include the anaphoric potential of the propositions. In this way they also transcend the standard meaning representation of polar questions as a disjunction of propositions.

Taking r, $\neg r$ and $\{r, \neg r\}$ as three distinct meanings as building blocks for questions may appear problematic, as these meanings differ in their semantic type (propositions vs. sets of propositions). One way to proceed would be to assume $\{r\}$ and $\{\neg r\}$ as the question meanings instead of r and $\neg r$. However, in Krifka (2015), the formation of questions (1), (2), and (3) can be spelled as QU(r), QU($\neg r$), and QU(r) $\cup$ QU($\neg r$), where speech act disjunction is interpreted by the set-theoretic union of the proposed continuations. This speech act disjunction, expressed by *or* in English and by a dedicated speech act disjunction in some

1 E.g., on seeing a person entering a room with a dripping rain coat (cf. Büring & Gunlogson 2000, Domaneschi et al. 2017).

languages, like Turkish *yoksa*, is characteristic for alternative questions in general, such as (4), which is represented as $\mathrm{QU}(r) \cup \mathrm{QU}(s)$.

(4) Is it raining or is it snowing?

Alternative questions like (4) presuppose that one of the mentioned propositions is true. This follows if the two disjoint questions are monopolar, but not if they are bipolar – another argument for the monopolar analysis of polar questions like (1).

Constituent questions can also be rendered as a disjunction over monopolar questions. Let $r[l]$ be the proposition that it is raining at location l, then (5) can be represented as $\bigcup_{l \in \mathrm{LOC}} \mathrm{QU}(r[l])$, where LOC is the set of pragmatically salient locations.

(5) Where does it rain?

$\Longleftrightarrow$ Does it rain in Berlin, or does it rain in Hamburg, or …

This leads to an attractive analysis of wh-constituents in their use as existential quantifiers that is present in many languages, including German:

(6) Wo regnet es? 'Where is it raining?'

(7) Es regnet wo. 'It is raining somewhere'

While the wh-constituent in (6) scopes over the illocutionary operator, the wh-constituent in (7) scopes over the proposition, resulting in $\bigcup_{l \in \mathrm{LOC}} r[l]$, resulting in the disjunctive meaning $\{i \mid \mathrm{r}_i[l_1] \vee \mathrm{r}_i[l_2] \vee \ldots\}$, which is the proposition to which the assertion operator is applied.

Hence, the monopolar analysis of questions is not only attractive to model biased questions but also for alternative questions and for wh-questions. In addition, Kamali & Krifka (2020) have developed a theory of focus and contrastive topic in polar questions that crucially assumes a monopolar analysis.

1B.2 Embedded Questions

As for embedded questions, Ciardelli proposes a distinction between propositions and question meanings because otherwise it is difficult to see how to distinguish between cases in which a predicate like *know* embeds a proposition vs. a question:

(8) Amy knows that it is raining.

(9) Amy knows whether it is raining.

However, notice that in addition to (9) we also have (10):

(10) Amy knows whether it is raining or not.

The existence of (9) and (10) is evidence for distinguishing between monopolar and bipolar questions with embedded questions as well, otherwise (10) would be redundant.[2] (10) can be derived from (11) by ellipsis.

(11) Amy knows whether it is raining or whether it is not raining.

This suggests an analysis of *whether* phrases as sets of propositions, and for disjunction as set union (different from what is proposed in Krifka (2021a)). In (9) *whether* turns the proposition r to $\{r\}$, and disjunction $\cup$ results for (10) in $\{r\} \cup \{\neg r\} = \{r, \neg r\}$. In contrast, the meaning of the *that*-clause in (8) can be analyzed as just denoting a proposition, r.

For embedded constituent questions we can assume again a disjunctive interpretation of wh-constituents, but now ranging over embedded question meanings, resulting in $\bigcup_{l \in \text{PLACE}} \{r[l]\}$, that is, $\{r[l_1], r[l_2], \ldots\}$, for (12).

(12) Amy knows where it is raining.

Predicates like *know*, *find out* and *tell* can embed propositions as well as such question meanings. There is a rich literature on the intricate meanings of such clauses, see Theiler et al. (2018) for an overview and a new proposal. One line of thought is to trace back question-embedding predicates to proposition-embedding ones, which can be done in the following ways:

2 One argument that single *whether* is not sufficient to express unconditionals, as in *Whether it is raining *(or not), I will take an umbrella with me.*

(13) $\text{PRED}_i(\text{P})$

a. $\forall p{\in}\text{P}[p(i) \rightarrow \text{PRED}_i(p)] \wedge \forall p{\in}\text{P}[\neg p(i) \rightarrow \text{PRED}_i(\neg p)]$

b. $\forall p{\in}\text{P}[p(i) \rightarrow \text{PRED}_i(p)]$

c. $\exists p{\in}\text{P}[p(i) \wedge \text{PRED}_i(p)] \wedge \neg\exists p{\in}\text{P}[\neg p(i) \wedge \text{PRED}_i(p)]$

Reading (a) is the well-established strongly exhaustive interpretation, resulting in 'Amy knows where it is raining and where it is not raining' for (12) and the correct interpretation for (9) under the monopolar interpretation of *whether*. Reading (b) is the weakly exhaustive interpretation, which for (12) allows that Mary believes that it is raining at a location where it is actually not. Under this interpretation, (9) would result in the interpretation 'Amy knows that it is raining' if it is raining, but if it is not raining, the sentence would be a tautology, hence uninformative. Thus, under the condition that the sentence is pragmatically useful, it has the same interpretation as (8), which blocks this reading. Reading (c) is the mention-some interpretation, which for *Amy told me where it is raining* implies that Amy correctly told me for at least one location that it is raining there, and did not tell me about any location where it is not raining that it is raining there. If it is raining, (9) would again result in 'Amy knows that it is raining', and if it is not raining, the sentence would violate the presupposition of *know*, and would produce a contradiction in case of predicates like *tell*. Again, in case the sentence is pragmatically useful it has the same interpretation as (8), blocking this reading.

One important difference between root and embedded questions is that they differ in their syntax, a point that is not appreciated in Ciardelli's paper (whose title, incidentally, has the form of an embedded question). Root questions in English show movement of the auxiliary, as in *where is it raining* vs. *where it is raining*, and embedded questions require in addition a complementizer, like *whether* in *whether it is raining*. In German, embedded questions show verb-final syntax whereas root questions involve movement of the finite verb to an initial position, like *regnet* in *wo regnet es* vs. *wo es regnet*; for German, a similar rule holds for root assertions and embedded indicatives. Verb movement can be seen as an effect of the illocutionary operator QU (for English) and QU and AS (for German), cf. Truckenbrodt (2006), Krifka (2021b). We can assume the following syntactic structures for the *whether* operator that generates embedded interrogatives, and the QU operator that generates root questions:

(14) Embedded interrogatives:

$[_{\text{CP}}\ (\text{wh}_1)\ [[_{\text{C}^\circ}\ (\text{whether})]\ [_{\text{TP}}\ -\ (\text{t}_1)\ -\ ]]]$

(15) Root questions:

$[_{ActP}\ (wh_1)\ [[_{Act^o}\ QU\ AUX_0]\ [_{TP}\ -\ t_0\ -\ (t_1)\ -\ ]]]$[3]

The *whether* operator is only realized for polar questions; it results in the formation of a proposition set $\{p\}$ from a proposition p. The QU operator is spelled out in greater detail in Krifka (2015, 2021a) as a dynamic update of a Commitment Space that leaves the root of the Commitment Space unchanged and restricts the continuation to one in which the addressee commits to a proposition.

Ciardelli argues that the semantic objects of root questions and of embedded questions should be equivalent. In the current proposal, embedding predicates like *know* take sets of propositions (possibly singletons), whereas QU takes propositions:

(16) a. know that it is raining

$KNOW_i(r)$

b. know whether it is raining [or snowing]

$KNOW_i(\{r\}\ [\cup\ \{s\}])$

(17) a. It is raining.

$AS(r)$

b. Is it raining [or is it snowing]?

$QU(r)\ [\cup\ QU(s)]$

This does not satisfy Ciardelli's equivalence hypothesis but is close enough. However, Ciardelli points out the availability of anaphora to questions. The uptake of embedded questions as in (16)(b) by *I wish I knew that* can be explained as *that* has $\{r\} \cup \{s\} = \{r, s\}$ as antecedent. For the uptake of the version $QU(r)$ of (17)(b) I propose a type shift from the antecedent r to the question meaning $\{r\}$ in Krifka (2021a). For the version $QU(r) \cup QU(s)$, one would have to assume anaphoric reference to the sum of the introduced propositions $r+s$, with a type shift to $\{r, s\}$. For constituent questions such as *Where does it rain?*, $\bigcup_{l \in LOC} QU(r[l])$, anaphoric reference would have the propositional function $r[l]$ as

3 It should be noted that subject wh constituents allow the main verb to move, cf. *Who ate the cake?*.

antecedent, with a type shift to $\bigcup_{l \in \mathrm{LOC}} \{r[l]\}$. These anaphoric processes are more complex than the ones that would be available under an analysis of root questions as QU($\{r\}$), QU($\{r, s\}$) and QU($\bigcup_{l \in \mathrm{LOC}} \{r[l]\}$), respectively. As usual, judging between these representations would require consideration of the full range of phenomena to be modelled, and independent evidence for or against individual proposals.

I would like to close with a point that is often not accounted for in semantic theories of questions and is also not thematized by Ciardelli. The complements of ›rogative‹ predicates like *ask* and *wonder* differ syntactically from the complements of *know* and *find out*. In certain varieties of English they can show features of root clauses, as in (18) (cf. McCloskey 2006). In German, they allow for question particles that are characteristic for root questions, as in (19).

(18) Amy asked / wondered / *found out, did it rain / where did it rain.

(19) Amy fragte / wollte wissen / *fand heraus, ob es denn / wohl regnete.

This is not direct speech, as the 3rd person pronoun in *Amy asked will she get wet* can refer to Amy. However, it appears that *ask* and *wonder* can embed semantic objects beyond propositions, or sets of propositions. Sentences like (18) report on a speech act, or on an inquisitive attitude. In Krifka (2021a) and (2021b) I have proposed that the assertion operator AS and the question operator QU contain different levels of meaning, e. g. one in which a common ground is updated by the effect of the assertion or the question, and others in which agents express public commitments or private judgements. Predicates like *ask* and *wonder* appear to select for such projections beyond propositions.

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2 Modelling Questions in Commitment Spaces

Manfred Krifka[1]

Abstract
The paper outlines the analysis of certain question types in the Commitment Space framework, as presented in Krifka (2015). The two basic ideas are: Assertions and most questions involve commitments of speaker and addressee to the truth of a proposition, and questions consist in restricting the continuation of the conversation to answers to the question. The main focus is on breadth, not depth and the detailed comparison with alternative approaches, and on semantic modelling, not on the syntactic and prosodic realizations. Topics are polar questions and their bias, alternative questions, constituent questions, high negation in questions, declarative questions, root vs. embedded questions, and deliberative questions.

2.1 Common Grounds and Context Sets

Common Ground (CG) is "a body of information that is available, or presumed to be available, as a resource of communication" (Stalnaker 1978); communication is seen as a sequential update of the CG. I will provide here a CG model for assertions and questions. As a model, it will not capture all aspects of reality. Important properties of the CG, like anaphoric relations, will not be covered. Also, this short paper cannot go into a detailed comparison of recent alternative accounts that have similar goals, such as Groenendijk (1999), Farkas & Bruce (2010), Farkas & Roelofsen (2017), and Ciardelli et al. (2018).

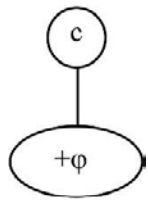
1 I gratefully acknowledge support through the ERC Advanced Grant 787929 SPAGAD – Speech Acts in Grammar and Discourse. Ideas of this paper have been presented at several workshops and conferences, and I thank the many colleagues that helped to refine them. It goes beyond the presentation in the workshop "Asking and Answering" in discussing the issue of embedded questions.

The classical way to model CGs is by propositions or sets of possible worlds ("context sets"), as in Stalnaker (1978). Other models that have been proposed are interpreted pieces of a formal language (Kamp 1981), pairs of assignment functions and propositions (Heim 1983), or sets of propositions (Krifka 2015). Here I will assume the simple classical view, and model CGs as sets of possible worlds.

Let c be a context set, a set of possible worlds {w, w′, …}. Let φ_t be the proposition 'Max arrived' interpreted at t. An update of c at time t_0 can be rendered as follows:

(1) $c +_{t_0} \varphi = \{w \in c \mid \varphi_{t_0}(w)\}$

$= \{w \in c \mid \exists t\, [t < t_0[\text{arrive}_{w,t}(m)]]\} = c'$



The picture on the right margin indicates a change of a context set c at time t_0 to the context set c′ that is generated by updating c with φ. Aspects like the temporal component are not indicated in these representations.

2.2 Commitment States

But how does a speaker bring it about that a proposition becomes established as part of the Common Ground? Lauer (2013) argued that we have to distinguish between different steps in this process. In Krifka (2015) I followed Charles S. Peirce in assuming that a crucial step is the expression of a commitment by the speaker to the truth of the proposition (cf. also Gunlogson 2008, Shapiro 2020). In Krifka (2021) I proposed that there are distinct layers in the syntactic representation of assertions that can house various epistemic, evidential and commitment-related operators. As these meaning aspects are essential for the understanding of questions, I will introduce them here as well.

At the core is the proposition itself that should be communicated, syntactically a TP ("tense phrase"); it is interpreted with respect to parameters s, a, t representing speaker, addressee, time and other aspects of the context of utterance:

(2) $[\![[_{TP}\ \textit{Max arrived}]]\!]^{s,a,t} = \lambda w \exists t'\ [t' < t \wedge \text{arrive}_{w,t'}(m)] = \varphi_t$, for short

The next layer is the judgement phrase JP with head J- that introduces a judge argument j; I follow here X-bar syntax. (3) is the compositional interpretation rule, (4) an example.

(3) $[\![[_{JP}\ [_{J'}\ [_{J^o}\ J\text{-}]\ [_{TP}\ \ldots]]]]\!]^{s,a,t} = [\![J\text{-}]\!]^{s,a,t}([\![[_{TP}\ \ldots]]\!]) = \lambda j\ [\![[_{TP}\ \ldots]]\!]^{s,a,t}$

(4) $[\![[_{JP}\ [_{J'}\ [_{J^o}\ J\text{-}]\ [_{TP}\ \textit{Max arrived}]]]]\!]^{s,a,t} = \lambda j \lambda w \exists t'\ [t < t_0 \wedge \text{arrive}_{w,t'}(m)] = \lambda j\ \varphi_t$

Evidential and epistemic operators like *reportedly* and *probably* are realized within the JP. For example, *probably* expresses that j assigns a probability substantially greater than 0.5 to the proposition. In (5) $P_{j,w,t}(\varphi_t)$ stands for the probability j assigns to φ_t in w at t.

(5) $[\![[_{JP}\ [_{J'}\ \textit{probably}[_{J'}\ [_{J^o}\ J\text{-}]\ [_{TP}\ \textit{Max arrived}]]]]]\!]^{s,a,t} >= \lambda j \lambda w\ [P_{j,w,t}(\varphi_t) > 0.5]$

The next layer is the Commitment Phrase ComP with head[2] $\vdash$ that states that the judge j is publicly committed to the truth of the JP proposition at w and t.

(6) $[\![[_{ComP}\ [_{C'}\ [_{C^o}\ \vdash]\ [_{JP}\ \ldots]]]]\!]^{s,a,t} = [\![\vdash]\!]^{s,a,j}([\![[_{JP}\ \ldots]]\!]^{s,a,t}) = \lambda j \lambda w\ [j \vdash_{w,t} [\![[_{JP}\ \ldots]]\!]^{s,a,j}(j)]$

(7) $[\![[_{ComP}\ [_{Com'}\ [_{Com^o}\ \vdash]\ [_{JP}\ [_{J'}\ \textit{probably}[_{J'}\ [_{J^o}\ J\text{-}]\ [_{TP}\ \textit{Max arrived}]]]]]]]\!]^{s,a,t}$

$= \lambda j \lambda w\ [j \vdash_{w,t} \lambda w\ [P_{j,w,t}(\varphi_t) > 0.5]]$

Commitments can be modified by operators like *truly* and *seriously* that specify the nature of the commitment. There is no established theory of commitment specifiers.[3] For illustration, *seriously* indicates that the commitment is serious, which implies that social sanctions would be more severe if it was done in joke or without sufficient evidence.

2 The turnstile symbol $\vdash$ goes back to Frege (1879), the judgement stroke, which distinguishes between a proposition and the judgement that this proposition is true. Cf. Cordes (2014).

3 Vanderveken (1990) does not propose a semantic representation to his notion of "strength".

(8) $[\![[_{\text{ComP}}\ [_{\text{ComP}'}\ \textit{seriously}[_{\text{Com}'}\ [_{\text{Com}^0}\ \vdash]\ [_{\text{JP}}\ [_{\text{J}'}\ \textit{probably}[_{\text{J}'}\ [_{\text{J}^0}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrived}]]]]]]]]]\!]^{s,a,t}$

$= \lambda j \lambda w\ [j\ \text{serious}(\vdash)_{w,t} \lambda w\ [P_{j,w,t}(\varphi_t) > 0.5]]$

In case there is no judgement or commitment modifier, interpretation is as in (9).

(9) $[\![[_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^0}\ \vdash]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^0}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrived}]]]]]]\!]^{s,a,t} = \lambda j \lambda w\ [j \vdash_{w,t} \varphi_t]$

In a final step, this is turned into a function that takes a context set, speaker, addressee and time and delivers an output context set. I call the syntactic layer ActPhrase, ActP, with • as the head of assertive ActPs. This operator identifies the judge j with the speaker s.

(10) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^0}\ \bullet\ ]\ [_{\text{ComP}} \ldots]]]]\!]^{s,a,t} = [\![\bullet]\!]^{s,a,t}([\![[_{\text{ComP}} \ldots]]\!]^{s,a,t})$

$= \lambda c\ \{ w \in c \mid [\![[_{\text{ComP}} \ldots]]\!]^{s,a,t}(s)(w)\}$

(11) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^0}\ \bullet\ ]\ [_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^0}\ \vdash]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^0}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrived}]]]]]]]]\!]^{s,a,t}$

$= \lambda c\ \{w \in c \mid [s \vdash_{w,t} \varphi_t]\}$

The update of an input context set c by speaker s to addressee a at time t is interpreted by rule (12), exemplified in (13).[4] The output context contains the proposition that s_1 is committed to the proposition that Max arrived.

(12) $c +_{s,a,t} [_{\text{ActP}} \ldots] = [\![[_{\text{ActP}} \ldots]]\!]^{s,a,t}(c)$

(13) $c_0 +_{s_1,s_2,t_0} [_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^0}\ \bullet\ ]\ [_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^0}\ \vdash]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^0}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrived}]]]]]]]^{s_1,s_2,t_0}$

$= \{w \in c_0 \mid s_1 \vdash_{w,t_0} \varphi_{t_0}\}$

In addition to the construction of an assertive update via an ActP, the core proposition of the TP within the ActP remains accessible as well. This can

4 This is a simplification. Update by an assertion is not an informative update about how the world is like (Stalnaker), but rather a performative update that changes the world, as proposed by Szabolcsi (1982). Krifka (2014) proposes an operation that changes a possible world minimally so that a proposition becomes true; using "+" for this update, we may write $\lambda c\{w + [s_1 \vdash_{w,t} \varphi_t] \mid w \in c\}$.

be achieved in various ways. I suggest that the TP introduces a propositional discourse referent (cf. Krifka 2013), which identifies the core proposition that is to be communicated (cf. also Murray & Starr 2020). This aspect of interpretation is not captured in the present modelling.

The core proposition φ_t itself can become part of the context set if the addressee acknowledges the speaker's attempt, e. g. by *okay* or by nodding, or by not objecting to it. Here, the commitment of the speaker s_1 is the reason why the addressee s_2 accepts the core proposition φ_t in the context set. Thus, communication of the core proposition is a conversational implicature (see also Section 2.4).

JP modifiers like *probably* allow the speaker s_1 to communicate the TP proposition φ_t while committing to another one, e. g. that s_1 considers φ_t likely. This is how it works:

(14) $c_0 +_{s_1,s_2,t_0} [_{ActP} [_{ComP} [_{JP} [_{J'}\ probably[_{J'} [_{J^0}\ J\text{-}]\ [_{TP}\ Max\ arrived]]]]]]^{s_1,s_2,t_0}$

$= \{w \in c_0 \mid s_1 \vdash_{w,t_0} \lambda w\ [P_{s_1,w,t}(\varphi_{t_0}) > 0.5]\}$

The speaker s_1 commits to the proposition that s_1 considers φ_{t_0} likely. This proposition cannot easily be disputed by s_2 because s_2 does not have access to the epistemic attitudes of s_1. The plausible purpose of this commitment is that s_1 wants to communicate the TP proposition φ_{t_0} as relevant, following a rule that if a reasonable epistemic source considers a proposition possible or even likely, it should be taken into account (cf. Faller 2019). The commitment of s_1 that motivates this step, however, is weaker – s_1 might express that he or she is certain or considers the proposition probable, or, in the case of reportative evidentials, that some other relevant source is committed to the proposition.

2.3 Commitment Spaces

In contrast to assertions, questions do not add information to the CG but indicate the ways how it should be enriched. The question *Did Max arrive?* indicates an interest whether the input CG can be enriched by the proposition that Max arrived; the question *Who arrived?* indicates an interest which of the propositions of the form 'x arrived', x ranging over persons, can enrich the CG. This can be modelled by taking the possible continuations of the commitment state into account. This leads to the notion of Commitment Spaces (CS) as sets of commitment states (cf. Cohen & Krifka 2014, Krifka 2015).

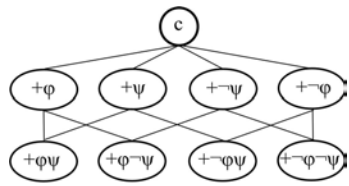
(15) a. A commitment space C is a set of non-empty commitment states.

b. If c, c′ ∈C and c′ ⊂ c then c′ is a possible continuation of c in C.

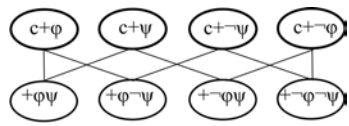
c. √C, the root of C, is defined as {c∈C | ¬∃c′∈C [c⊂c′]}

The root of C is the set of the least specific, i. e. largest commitment states in C.[5] CSs will be illustrated by Hasse diagrams in which the continuations and the root are highlighted as in (16)(a) for a single-rooted and in (b) for a multiple-rooted CS. Simultaneous update with +φ and +¬φ is not possible, as this would lead to the contradictory empty state. Also, pragmatic contradictions like CSs that admit both s⊢φ and ¬φ are ruled out; it is not possible that in one and the same CS, a participant is both committed to s and allows for ¬φ.

(16) a. Single-rooted CS



b. Multi-rooted CS



In a single-rooted CS, the root {c} contains the information that is accepted by the interlocutors; in a multiple-rooted CS, there are alternative CGs, the choice between which is still unresolved. The continuations are the alternatives how this information should preferably develop.

5 The root is restricted to singletons in Krifka (2015), but here we allow for multi-rooted CSs.

2.4 Assertions

Assertive update has to be adapted to Commitment Spaces, that is, should be expressed as a function from an input CS to an output CS. This is achieved by (17), and exemplified in (18).

(17) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ \bullet\ ]\ [_{\text{ComP}}\ \dots]]]]\!]^{s,a,t} = [\![\bullet]\!]^{s,a,t}([\![[_{\text{ComP}}\ \dots]]\!]^{s,a,t})$

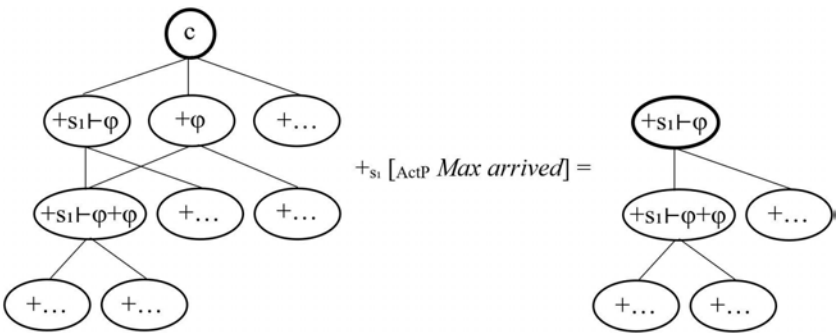
$= \lambda C\ \{c \in C \mid c \subseteq [\![[_{\text{ComP}}\ \dots]]\!]^{s,a,t}(s)\}$

(18) $C_0 +_{s_1,s_2,t_0} [_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ \bullet\ ]\ [_{\text{ComP}}\ [_{C'}\ [_{C^\circ}\ \vdash\ ]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrived}]]]]]]]$

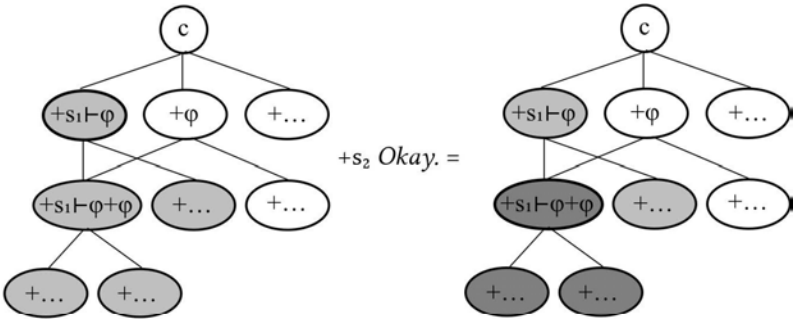
$= \{c \in C_0 \mid c \subseteq \lambda w[s_1 \vdash_{w,t_0} \varphi_{t_0}]\}$

This restricts the input C_0 to those commitment states that contain the information that speaker s_1 is committed to the proposition that Max arrived. See the illustration in (19) or (20)(a), which shows both the input CS and the output CS, in grey. After acceptance by s_2, signaled by *Okay* or nodding, the CS is updated with the communicated proposition φ itself, resulting in the indicated CS in which the proposition that s_1 is committed to φ, as well as φ itself, are established, cf. (20)(b).

(19) Update of CS with assertion

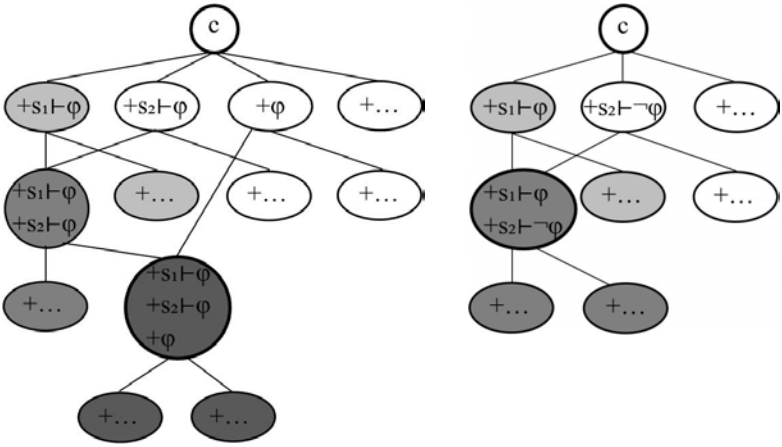


(20) a. Update of CS with assertion b. Further update with proposition



Acceptance as in (20) has to be distinguished from confirmation as in (21)(a), which expresses a commitment by s_2. This also leads to the establishment of the core proposition φ. Contradiction as in (21)(b) commits s_2 to the negation of the proposition, which prevents φ from becoming part of the CS. The resulting CS will contain the information that s_1 and s_2 differ in their commitments about the proposition φ.

(21) a. Confirmation by s_2: *Yes.* b. Contradiction by s_2: *No.*



Thus, the current model keeps a permanent record about which participant is committed to which proposition. In this it differs from Farkas & Bruce (2010) and Farkas & Roelofsen (2017), for whom the CG expresses shared commitments to simple propositions like φ_{t_0}, and the commitments of the individual participants only play a role in the process of getting propositions into the CG.

2.5 Monopolar Questions

With a question, a speaker can indicate a preferred way how the CG should develop, typically by checking whether the addressee would commit to a particular proposition. There are different ways and strategies to ask questions. With a simple polar question *Did Max arrive?* a speaker tests whether the addressee would commit to the proposition 'Max arrived'. We model such questions by an ActPhrase with an interrogative operator ?. The finite verb, which cannot be a main verb in English, moves to the specifier of the ActP:

(22) $[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ ?\ \textit{did}_0\ ]\ [_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^\circ}\ \vdash]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrive}\ t_0]]]]]]]$

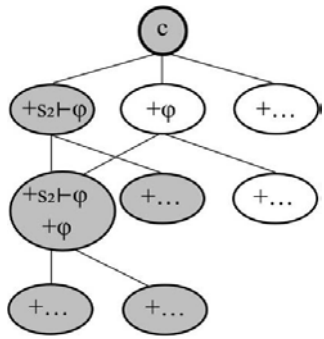
The question operator ? is interpreted as in (23), where the differences to the assertion operator •, cf. (17), are highlighted.

(23) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ ?\ ]\ [_{\text{ComP}}\ \dots]]]]\!]^{s,a,t} = [\![?]\!]^{s,a,t}([\![[_{\text{ComP}}\ \dots]]\!]^{s,a,t})$
$= \lambda C\ [\mathbf{\surd C} \cup \{c \in C \mid c \subseteq [\![[_{\text{ComP}}\ \dots]]\!]^{s,a,t}(\mathbf{a})\}]$

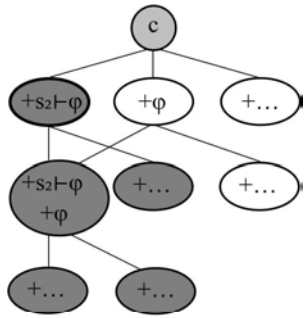
Assuming an input CS C_0, a speaker s_1, addressee s_2 and an utterance time t_0 we have (24), illustrated in (25)(a).

(24) $C_0 +_{s_1,s_2,t_0} [_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ ?\ \textit{did}_0\ ]\ [_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^\circ}\ \vdash]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrive}\ t_0\ ]]]]]]]$
$= \lambda C\ [\surd C \cup \{c \in C \mid c \subseteq \lambda w\ [s_2 \vdash_{w,t_0} \varphi_{t_0}]\}]$

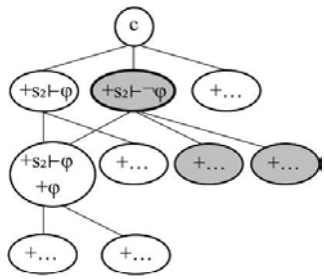
(25) a. Update of CS by *Did Max arrive?*



b. Confirming answer *Yes.*



c. Rejecting answer *No.*: Going back to original CS committing to negation.



In contrast to assertions, the root does not change with a question, cf. (25)(a). The speaker s_1 restricts the continuations to the commitment by s_2 to the proposition. The confirming answer *yes* by s_2 leads to the CS in (25)(b). As for the negative answer, notice that the commitment $s_2 \vdash \neg\varphi_t$ cannot be expressed after the interrogative update (25)(a). In such cases the interrogative update is retracted, going back to the original CS, and the commitment $s_2 \vdash \neg\varphi_{t_0}$ is added,

as in (25)(c). This retraction is modelled in Krifka (2015) with the help of a stack of CSs that correspond to the development of a conversation. In general, a participant, here s_2, can reject a proposed change of the CS if it enforces a commitment or action by that participant, leading to a retraction of the last move.[6]

In the current analysis, a polar question does not offer an alternative between two propositions, like in most other approaches (e.g., Hamblin 1973, Groenendijk & Stokhof 1984, Farkas & Roelofsen 2017 and Ciardelli et al. 2018). Rather, one proposition is more prominent, as it can be answered without retraction of the proposed extension. As this representation has a bias, it can be called *monopolar*. Such readings of simple polar questions have been proposed by Roberts (1996), Biezma & Rawlins (2012), and Uegaki (2014).

2.6 Alternative and bipolar questions

One reason for assuming a monopolar interpretation of simple polar questions is that this allows for a straightforward analysis of alternative questions:

(26) a. *Did Max arrive or did Sue arrive?*

b. *Did Max or Sue arrive?*

(27) a. *Did Max arrive, or did he not arrive?*

b. *Did Max arrive or not?*

In their alternative question interpretation, which involves rising accent on one alternative constituent and falling accent on the other (cf. Bartels 1999, Pruitt & Roelofsen 2013), such questions can be interpreted as disjunctions on the level of the ActPhrase, as union over the individual updates, cf. (28):

(28) $[\![[_{\text{ActP}}\ [_{\text{ActP}}\ \alpha]\ \textit{or}\ [_{\text{ActP}}\ \beta]]]\!]^{s,a,t}$

$= [\![\textit{or}]\!]([\![[_{\text{ActP}}\ \alpha]]\!]^{s,a,t})([\![[_{\text{ActP}}\ \beta]]\!]^{s,a,t})$

$= \lambda A \lambda A' \lambda C\ [A(C) \cup A'(C)]([\![[_{\text{ActP}}\ \alpha]]\!]^{s,a,t})([\![[_{\text{ActP}}\ \beta]]\!]^{s,a,t})$

$= \lambda C\ [[\![[_{\text{ActP}}\ \alpha]]\!]^{s,a,t}(C) \cup [\![[_{\text{ActP}}\ \beta]]\!]^{s,a,t}(C)]$

6 The possibility of rejecting the last move has a similar function as the negotiating table in Farkas & Bruce (2010): It regulates what finally enters the CG. However, in the current framework, rejecting answers to simple polar questions require a more complex mechanism.

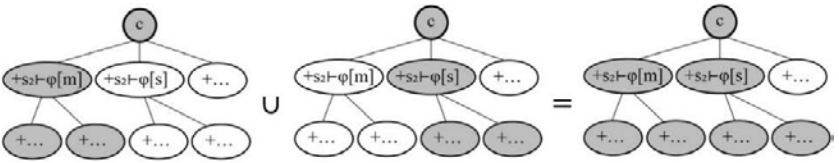
For illustration, consider the following update of a CS with (26)(a), where $\varphi_t[x]$ stands for the proposition that x arrived before t, i. e. $\lambda w \exists t' [t' < t \wedge \text{arrived}_{w,t'}(x)]$.[7]

(29) $C_0 +_{s_1,s_2,t_0} [_{\text{ActP}} [_{\text{ActP}}$ *did Max arrive*$]$ *or* $[_{\text{ActP}}$ *did Sue arrive*$]]$

$= \surd C_0 \cup \{c \in C_0 \mid c \subseteq \varphi_{t_0}[m]\} \cup \{c \in C_0 \mid c \subseteq \varphi_{t_0}[s]\}$

(30) Disjunction of two interrogative updates,

Did Max arrive or did Sue arrive?



Alternative questions come with the pragmatic presupposition that one of the alternants is true. This is expressed by the disjunctive interpretation provided here. If we model each disjunct question, *Did Max arrive?* and *Did Sue arrive?* as allowing equally easily an affirmative and a rejecting answer, then we would not predict this pragmatic presupposition, as the situation where both alternants are false would be as good an option as the others.

Alternative questions with a constituent disjunction like (26)(b) can be analyzed as involving a type-lifted ActP disjunction. The disjunctive constituent, here Max or Sue, moves from within the TP, leaving a trace.

(31) $[\![[_{\text{ActP}} [_{\text{DP}}$ *Max or Sue*$]$ $_x[_{\text{Act}'}$ *did* t_x *arrive*$]]]\!]^{s,a,t}$

$= [\![[_{\text{DP}}$ *Max or Sue*$]]\!]^{s,a,t}$ $([\![_x[_{\text{ActP}}$ *did* t_i *arrive*$]]\!]^{s,a,t})$

$= \lambda A \lambda C$ [A(m)(C) ∪ A(s)(C)]$(\lambda x \lambda C$ [$\surd C \cup \{c \in C \mid c \subseteq \lambda w[a \vdash_{w,t} \varphi_t[x]]\}$)

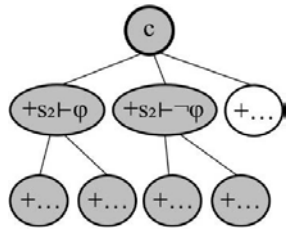
$= \lambda C$ [$\surd C \cup \{c \in C \mid c \subseteq \lambda w[a \vdash_{w,t} \varphi_t[m]]\} \cup \{c \in C \mid c \subseteq \lambda w[a \vdash_{w,t} \varphi_t[s]]\}$]

$= \lambda C$ [$\surd C \cup \{c \in C \mid c \subseteq \lambda w[a \vdash_{w,t} \varphi_t[m]] \vee c \subseteq \lambda w[a \vdash_{w,t} \varphi_t[s]]\}$]

7 For the additional accent marking, *Did /MAX arrive or did \SUE arrive?* cf. Kamali & Krifka (2020).

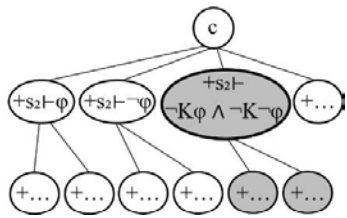
True bipolar questions can be expressed by alternative questions like (27), resulting in interpretation (32). The parts *did Max* and *arrive* can be suppressed. This is a question without bias, see the illustration on the margin in comparison to (25)(a). Speaker s_2 can answer in the affirmative or negative, without going back to the previous CS.

(32) $C_0 +_{s_1,s_2,t_0} [_{ActP} [_{ActP}$ *did Max arrive*$]$ *or* $[_{ActP}$ *not*$]] = \sqrt{C_0} \cup \{c \in C_0 \mid c \subseteq \lambda w\, [s_2 \vdash_{w,t_0} \varphi_{t_0}] \vee c \subseteq \lambda w\, [s_2 \vdash_{w,t_0} \neg\varphi_{t_0}]\}$

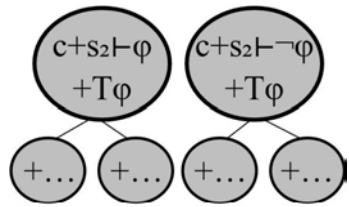


One remark about the architecture of CSs: The grey CS in (32) does not include continuations other than $s_2 \vdash \varphi$ and $s_2 \vdash \neg\varphi$. One possible reaction is that s_2 asserts not knowing the answer, expressing the commitment $s_2 \vdash [\neg K\varphi \wedge \neg K\neg\varphi]$. As this proposition is pragmatically incompatible with $s_2 \vdash \varphi$ and $s_2 \vdash \neg\varphi$, the last move must be retracted first before the update is possible, cf. (33)(a). It is also possible that s_2 makes some other assertion, like *I will think about it*, for which we write $s_2 \vdash T\varphi$, resulting in a multiple rooted CS in which the question needs to be resolved in order to reduce the roots, cf. (33)(b).

(33) a. s_2: *I don't know.*



b. s_2: *I will think about it.*



2.7 Question Bias and the Monopolar Analysis

We have modelled simple polar questions, polar questions with negated core propositions and alternative questions built from them as in (34)(a,b,c), respectively.

(34) a. $[\![\textit{Did Max arrive?}]\!]^{s,a,t}$

$= \lambda C\ [\sqrt{C} \cup \{c \in C \mid c \subseteq \lambda w\ [s_2 \vdash_{w,t} \varphi_t]\}]$

b. $[\![\textit{Did Max not arrive?}]\!]^{s,a,t}$

$= \lambda C\ [\sqrt{C} \cup \{c \in C \mid c \subseteq \lambda w\ [s_2 \vdash_{w,t} \neg\varphi_t]\}]$

c. $[\![\textit{Did Max arrive or not?}]\!]^{s,a,t}$

$= \lambda C\ [\sqrt{C} \cup \{c \in C \mid c \subseteq \lambda w\ [s_2 \vdash_{w,t} \varphi_t] \vee c \subseteq \lambda w\ [s_2 \vdash_{w,t} \neg\varphi_t]\}$

The monopolar question (34)(a) checks whether the addressee would commit to 'Max arrived', whereas the monopolar question with negated proposition (b) checks whether the addressee would commit to its negation, 'Max did not arrive'. Contrary answers require the retraction of the proposed continuation, and hence would be more complex than agreeing answers. Only the bipolar alternative question (c) allows for either answer without retraction. In this sense, (34)(a) is biased to the answer *Max arrived*, (b) is biased to *Max didn't arrive*, and only (c) is biased towards neither answer. For the classical bipolar analyses of simple polar questions the meanings of (34)(a,b,c) are identical.

The classical analyses face the problem that simple polar questions and alternative questions are used in different circumstances. For example, Bolinger (1978) points out (35)(a) is a good question for a speaker interested in marriage, whereas (b) is not.

(35) a. Will you marry me? b. Will you marry me or not?

For factual information questions, Büring & Gunlogson (2000) argue that positive polar questions are not felicitous if there is contextual evidence against the core proposition, and AnderBois (2011) shows that negated polar questions require a negative expectation towards the core proposition. The experimental studies of Roelofsen et al. (2013) and Domaneschi et al. (2017) support the conclusion that speakers avoid reversing responses, given contextual evidence, and prefer the least marked form. Domaneschi et al. (2017) investigate combinations of neutral (0), positive (+) and negative (–) prior expectation and contextual evidence for a proposition φ and find that the (0|+) case (neutral prior expectation, positive contextual evidence) favors positive polar questions and the (0|–) case favors negated polar questions;[8] the (0|0) case favors the unmarked positive polar questions. Avoiding reversing responses is also seen with lexical choices; Trinh (2014) points out that the question *Is Max married?* presupposes that there is contextual evidence that Max is married, which makes the question *Is Max single?* infelicitous in this context.

As for alternative questions like (34)(c) and (35)(b), Biezma (2009) points out that alternative questions of this type are fine if they come late in a series of questions, with the pragmatic effect of ›cornering‹ the addressee into one or the other answer. All these observations are difficult to explain if the questions in (34) have the same interpretation.

Theories that do not assume a monopolar analysis of simple polar questions must deal with their bias in other ways. The examples (34) differ in their syntax, which may differentiate their uses. Roelofsen & van Gool (2010) assume that in (34)(a), the proposition 'Max arrived' is "highlighted"; Farkas & Roelofsen (2017) propose that this highlighting is mediated by the introduction of propositional discourse referents.

However, it is not clear whether discourse referents are sufficient to express bias. Krifka (2013) proposes that the TP as well as the syntactic phrase that expresses negation (NegP) introduces a propositional discourse referent. Using an informal representation, where $\hookrightarrow\varphi_t$ indicates that the constituent above introduces a discourse referent for the proposition φ_t, we have the discourse representations in (36).

8 Negated questions also occur in the (+|–) case but are outnumbered by high negation questions, cf. section 2.8. Positive questions also occur in the (–|+) case but participants more often selected questions marked by *really*. This can be explained under the assumption that *really* is a ComP marker that requests a higher level of commitment.

(36) a. [Did_0 [$_{TP}$ *Max* t_0 *arrive*]]?
↳ φ_t

b. [Did_0 [$_{NegP}$ Max_1 *not* [$_{TP}$ t_1 t_0 *arrive*]]]?
↳ $\neg\varphi_t$ ↳ φ_t

Response particles are anaphors to such discourse referents that assert them (*yes*) or their negation (*no*). For (36)(a) one could construct a bias towards the positive answer (that Max arrived) because this answer can be expressed by the confirming response particle (*yes*), whereas the negative answer requires the more complex operation of negation (*no*). However, the presence of discourse referents does not explain why (36)(b) is biased towards the proposition that Max did not arrive. Both discourse referents $\neg\varphi$ and φ are equally accessible, cf. reactions like *No, he didn't* (addressing φ_t) and *Yes, he didn't* (addressing $\neg\varphi_t$) (cf. Krifka 2013, Farkas & Roelofsen 2017, 2019, Claus et al. 2017). So it appears that propositional discourse referents are not sufficient to capture the bias of questions with negated propositions like *Did Max not arrive?*.

It should be noted that bias of a polar question towards a proposition p does not mean that the speaker considers p more likely than ¬p. The speaker might consider p more informative, and hence less likely, than ¬p (cf. van Rooy & Šafářová 2003). This is the case if there is a prior expectation by the speaker that p is not the case but now there is evidence that p might hold (cf. Sudo 2013, Gärtner & Gyuris 2017). The speaker also might have no prior opinion about p and there is no contextual evidence, but p calls for action and ¬p does not, as in *Is Max infected?*.

2.8 High Negation Questions

There is a syntactically distinct case of a negation in questions, as in (37) (cf. Ladd 1981).

(37) *Didn't Max arrive?*

Actually, (37) is ambiguous between a ›low‹ propositional negation reading and a ›high‹ non-propositional reading, which can be distinguished with negative polarity items:

(38) a. *Didn't Max arrive either?* (≈ *Did Max not arrive either?*)
low negation

b. *Didn't Max arrive too?*

high negation

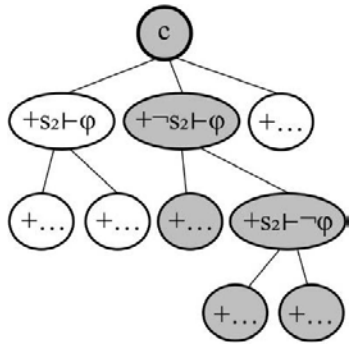
Several theories have been developed to capture the pragmatic function(s) of high negation questions, cf. Romero (2005) for an interaction with a VERUM operator, Repp (2013) for an interaction with a FALSUM operator, Goodhue (2019) for interaction with an epistemic operator, and Asher & Reese (2007), who assume a combination of a question and an assertion.

As already observed by Ladd (1981), high negation is not part of the core proposition. The interpreted syntactic structure proposed here offers a place where it can be interpreted without assuming additional operators, namely as negation of commitments, exemplified in (39) and illustrated to the right (cf. Krifka 2015). This corresponds to the syntactic position of the negation in this case.

(39) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ \textit{did}_i?]\ [_{\text{ComP}}\ \textit{n't}\ [_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^\circ}\ \vdash]$

$[_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max}\ t_i\ \textit{arrive}]]]]]]]]]\!]^{s,a,t}$

$= \lambda C\ [\surd C \cup \{c \in C \mid c \subseteq \lambda w\ [\neg s_2 \vdash_{w,t} \varphi_t]\}]$



As for the pragmatics of high negation questions, we have to compare them with the positive question, *Did Max arrive?* as well with the low-negation question, *Did Max not arrive?*. Compared to checking whether s_2 commits to φ or commits to ¬φ, checking whether s_2 does not commit to φ at t_0 puts a lighter burden on s_2, as s_2 is not required to make any commitment in this issue. The output CS of (39) allows for negative assertions (*Max didn't arrive*) as well as for avoiding assertions (e.g. by expressing ignorance, *I don't know*). Affirming assertions (*Max did arrive*) require going back to the initial CS.

This corresponds to the experimental results of Roelofsen et al. (2013) and Domaneschi et al. (2017). The latter show that high negation questions are preferred in case of prior expectation that the proposition is true (strongly in the (+|0) case but also in the (+|−) case, where low negation questions are an option, too). This is the strategy of speakers that seek confirmation of prior expectations, and facilitates the answer that runs against the prior expectations, as this answer would provide the highest informational gain.

2.9 Constituent Questions

Constituent questions are interpreted like alternative questions. The wh-constituent is similar to a disjunctive phrase like *Max or Sue* in (31), where the wh-constituent expresses a restriction over the type of entities, e. g. *who* for persons and *when* for times.

(40) $[\![[_{\text{ActP}}\ \textit{who}_{\ i}[_{\text{Act}'}\ t_i\ \textit{arrived}]]]\!]^{s,a,t}$

$= [\![\textit{who}]\!]^{s,a,t}\ ([\![_i[_{\text{Act}'}\ t_i\ \textit{arrived}]]\!]^{s,a,t})$

$= \lambda A\lambda C\ [\cup_{x\in \text{PERSON}}\ A(x)(C)]\ (\lambda x\lambda C\ [\surd C \cup \{c\in C \mid c\subseteq \lambda w\ [a\vdash_{w,t}\ \varphi_t[x]]\}])$

$= \lambda C\ [\surd C \cup \{c\in C \mid \exists x\in \text{PERSON}\ [c\subseteq \lambda w\ [a\vdash_{w,t}\ \varphi_t[x]]\}]$

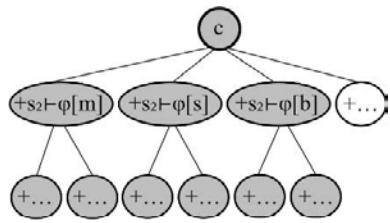
Assume that there are three persons under discussion, Max, Sue, and Bill, and let s_2 be the addressee. We then get the interpretation (41).

(41) $\lambda C\ [\surd C \cup$

$\{c\in C \mid c\subseteq \lambda w\ [s_2\vdash_{w,t_0}\ \varphi_{t_0}[m]\} \cup$

$\{c\in C \mid c\subseteq \lambda w\ [s_2\vdash_{w,t_0}\ \varphi_{t_0}[s]\} \cup$

$\{c\in C \mid c\subseteq \lambda w\ [s_2\vdash_{w,t_0}\ \varphi_{t_0}[b]\}]$



This analysis generalizes to multiple constituent questions, like *Who ate what?* where we assume that all wh constituents undergo wh movement. For the modelling of the various readings of such questions cf. Kamali & Krifka (2020).

Our analysis of assertions in (17), of polar questions in (23) and of constituent questions in (40) provides for a new take on the issue of Frege (1918) whether

assertions and questions have propositions as their core semantic objects. Assertions and polar questions do, and constituent questions are disjunctive quantifications over polar questions.

We have derived a biased question meaning for simple polar questions like *Did Max arrive?*, and have seen that there are arguments for doing so. However, such questions can also be used in an epistemically unbiased context. For example, in a game of guessing the outcome of a throw of dice, (42) is adequate even without prior speaker expectation.

(42) [Guessing results of dice rolls:] *Is it an odd number?*

How can we reconcile this with the suggested monopolar interpretation? One strategy is to stick to the literal biased interpretation and explain why this is nevertheless the optimal option in this context: It is simpler than the non-biased questions *Is it an odd number or not?* and *Is it not an odd number?* And it is equally good as the question *Is it an even number?*.

Kamali & Krifka (2020) offer another proposal. Let us first consider a question with focus on the subject. Our standard example would have the interpretation in (43).

(43) $[\![[_{\text{ActP}}\ \textit{Did}\ ?\ [_{\text{ComP}} \vdash [_{\text{TP}}\ \textit{MAX}_{\text{F}}\ \_\ \textit{arrive}]]]]\!]^{s,a,t}$

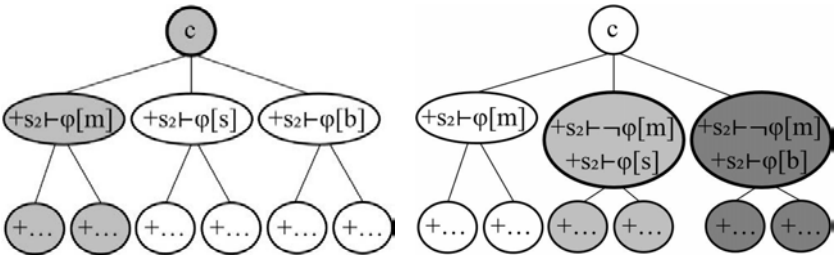
condition on input CS

$= \lambda C\ .\ C = \surd C \cup \bigcup_{x \in ALT(m)} \{c \in C \mid c \subseteq \lambda w\ [a \vdash_{w,t} \varphi_t[x]\} \ .\ \{c \in C \mid c \subseteq \lambda w\ [a \vdash_{w,t} \varphi_t[x]\}$

Focus expresses a condition on the input CS C that the question for which x, where x are alternatives to Max, the addressee would commit to the proposition that x arrived. It is as if the question *Who arrived?* had been asked. The affirming answer *yes* is straightforward, cf. (44)(a). The rejecting answer *no* requires backtracking to the previous CS, where update with the commitment by the addressee that Max did not arrive leads to a multiply rooted CS that requests further information, cf. (44)(b). Therefore, *no* is incomplete, and requires completion by, for example, SUE_{F} *did*, represented by the dark area in (44)(b).

(44) a. Input condition
+ *Did MAX*$_F$ *arrive?*

b. Rejecting answer *No, Bill did.*



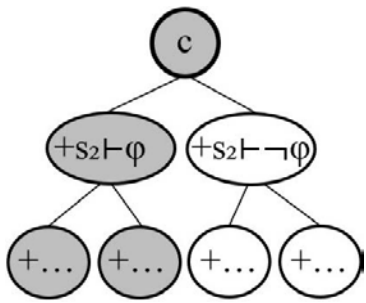
For polar questions, Kamali & Krifka (2020) assume an optional polarity operator λp.p with alternatives {λp [p], λp [¬p]}. For English, this operator is plausibly related to the finite auxiliary verb, e. g. *did*. This results in an input CS condition that a bipolar question is asked, of which one alternative, the positive one, is singled out. (45) indicates a possible derivation with a PolP with head POL to which the past auxiliary *did* moves and where it is focused, and from where it is moved in turn to the head of the ActP.

(45) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ ?\ \textit{DID}_i]\ [_{\text{ComP}} \vdash\ [_{\text{PolP}}\ [_{\text{Pol}'}\ [_{\text{Pol}^\circ}\ \text{POS-t}_k]_i]_F$
$[_{\text{TP}}\ \textit{Max}\ \text{PAST}_k\ \textit{arrive}]]]]]]\!]^{s,a,t}$

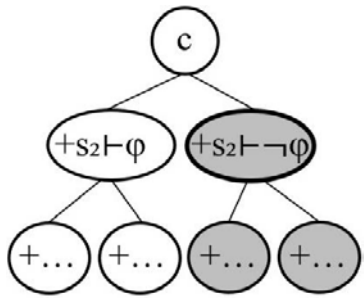
$= \lambda C\ .\ C$

$= \sqrt{C} \cup \bigcup_{M \in \{\lambda p[p],\ \lambda p[\neg p]\}} \{c \in C \mid c \subseteq \lambda w\ [a \vdash_{w,t} M(\varphi_t)\}\ \{c \in C \mid c \subseteq \lambda p\ [p](\lambda w\ [a \vdash_{w,t} \varphi_t)\}$

(46) a. Input condition
+ *DID Max arrive?*



b. *No.*
Retraction and remaining option



The effect of this question is illustrated in (46)(b). If answered negatively, retraction is required, and the only remaining continuation is the commitment by the addressee that Max did not arrive, cf. (46)(b). In this way, questions like (45) are both bi- and monopolar: They presuppose a bipolar question (this is the question that is of interest) and select, more or less arbitrarily, one of the options (this is the monopolar question).

After having discussed polar, alternative, and constituent questions, one issue that naturally arises is whether there is a feature of a CS that indicates whether a question is asked. This is indeed the case: If all the continuations of the root √C of C are enriched by one particular proposition (e.g. $s_2 \vdash \varphi$) or one of a limited set of propositions (like $s_2 \vdash \varphi[x]$, $x \in \{m, s, b\}$) , then C is awaiting the solution to a question.

2.10 Declarative Questions

Declarative questions have the grammatical form of assertions, yet are identified as questions by their high boundary tone (Bartels 1999, Gunlogson 2002, 2008, Trinh 2014, Malamud & Stephenson 2015):

(47) *Max has already arrived?* H%

Such questions are appropriate if the speaker is biased towards a positive answer, i. e. in the (0|+) case. They can contain epistemic operators that do not occur in regular questions, cf. (48). Yet they are questions because they do not result in a commitment by the speaker, cf. (49).

(48) a. *#Did Max certainly / probably arrive already?*

b. *Max has certainly / probably arrived already?*

(49) s_1: *Max has arrived already?*

s_2: *#You are a liar!*

Declarative questions can be modelled by assuming that they express a commitment by the speaker, like assertions. This corresponds to their declarative syntactic structure and to the presence of assertion-specific epistemic operators. However, they express just a proposal for an assertive update insofar as they do not change the root of the input CS. This meaning component is due to the high boundary tone, H% (Bartels 1999):[9]

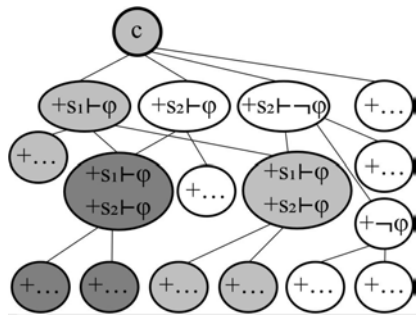
(50) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ \bullet\ ]\ [_{\text{ComP}}\ [_{\text{C}'}\ [_{\text{C}^\circ}\ \vdash\ ]\ [_{\text{JP}}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \textit{Max arrived}]]]]]]]\ \text{H\%}]\!]^{s,a,t}$

$= \lambda C\ [\sqrt{C} \cup \{c \in C \mid c \subseteq \lambda w\ [s_1 \vdash_{w,t} \varphi_t]\}]$

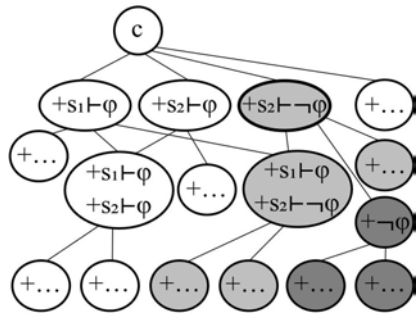
(51)(a) illustrates this declarative question, with a confirming answer resulting in a CS in which both s_1 and s_2 are committed to φ, and φ can be assumed by conversational implicature. The rejecting answer *no* can be interpreted after the declarative question, but would lead to conflicting commitments and block φ. Alternatively, the declarative question can be retracted, allowing for the commitment by s_2 to ¬φ, cf. (b).

9 Regular polar and constituent questions allow for rising and falling boundary tones, where the latter is quite rare (cf. Hedberg et al. 2017). Falling contour questions may be analyzed as propositing a speaker's commitment, just as rising declarative questions, cf. Steedman (2007).

(51) a. s_1: *Max arrived?*,
s_2: *Yes, he did.*



b. s_1: *Max arrived?*,
s_2: *No, he didn't.*



The observation concerning the epistemic adverbials (48) can be explained under the assumption that they are speaker-oriented, and that the addressee cannot express commitments about the speaker's epistemic stances. However, certain epistemic and evidential operators do occur in regular questions, and have been interpreted from the perspective of the addressee ("interrogative flip", cf. Faller 2002, Korotkova 2018, Eckardt 2020). San Roque et al. (2017), in a typological survey, consider interrogative flip an idiomatic property of certain evidential markers.

In English, the epistemic adverb *possibly* can occur in regular polar questions, cf. *Did Max possibly arrive already?*. We predict an addressee-oriented interpretation, cf. (52). A plausible pragmatic motivation is that the speaker invites an agreeing response even in case the addressee does not have conclusive knowledge, which suggests that the speaker has no prior expectation. Hence the use of *possibly* is a de-biasing strategy for monopolar questions.

(52) $[\![[_{\text{ActP}}\ [_{\text{Act}^\circ}\ \textit{Did}_0\ ?]\ [_{\text{ComP}}\ \textit{Max}_1\ [_{\text{C}'}\ [_{\text{C}^\circ}\ \vdash]\ [_{\text{JP}}\ \textit{possibly}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ t_1\ t_0\ \textit{arrive}]]]]]]]\!]^{s,a,t}$
$= \lambda C\ [\sqrt{\mathbf{C}} \cup \{c \in C \mid c \subseteq \lambda w\ [\mathbf{a/s+a} \vdash_{w,t} P_{i,w,t}(\varphi_t) > 0]\}]$

Alternatively, we can allow for so-called "conjectural" questions that involve the judgement of both speaker and addressee (cf. Eckardt 2020 for German *wohl*). For this, the interpretation of ? in (23) can include the addressee, allowing for the sum s+a as judge.[10]

2.11 Root Questions and Embedded Questions

As it is well-known, interrogative sentences do not only express the speech act of questions but also occur in embedded clauses:

(53) a. *Sue knows whether Max arrived.*
b. *Sue knows who arrived.*

Question semantics has taken off from the meaning of embedded interrogatives because they contribute to the truth conditions of the whole sentence, and semantics focused on the derivation of truth conditions. For example, there is an entailment relation between *Sue knows that Max arrived* and *Sue knows who arrived*. Under a model of question meanings as sets of propositions, we can assume syntactic and semantic representations as in (54) (where CP is the syntactic category of a complementizer phrase).

(54) a. $[\![[_{\text{CP}}\ \textit{whether}\ [_{\text{TP}}\ \textit{Max arrived}]]]\!]^{s,a,t} = \{\varphi_t, \neg\varphi_t\}$
b. $[\![[_{\text{CP}}\ \textit{who}_x [_{\text{TP}}\ t_x\ \textit{arrived}]]]\!]^{s,a,t} = \{\varphi_t[m], \varphi_t[s], \varphi_t[b]\}$

If we assume that *know* has a basic meaning taking a proposition as an argument, the interrogative-denoting meaning of *know* can be derived from that: To ›know‹ a set of propositions P is to know for every proposition p∈P that are true that p is true.

10 E.g., by $\lambda C\ [\sqrt{C} \cup \{c \in C \mid \exists x[a \sqsubseteq x \wedge c \subseteq [\![[_{\text{ComP}} \ldots]]\!]^{s,a,t}(x)]\}]$ for (23), where $\sqsubseteq$ is the part relation. The preferred and simplest interpretation is a=x, but *possibly* (also *perhaps* and German *vielleicht* and *wohl* as inferential evidentials) must include the speaker as origo, and hence a+s is the best option.

The meaning of (54)(a) and (b) can be derived as in (55).[11] For (55)(b) this is similar to the generation of a root question, cf. (40), except there the wh constituent scopes over question acts, expressing a disjunction over individual acts.

(55) a. $[\![[_{CP}\ \textit{whether}\ [_{TP}\ \textit{Max arrived}]]]\!]^{s,a,t}$

$= [\![\textit{whether}]\!]^{s,a,t}([\![[_{TP}\ \textit{Max arrived}]]\!]^{s,a,t})$

$= \lambda p\ [\cup_{M\in\{\lambda p\ [p],\ \lambda p\ [\neg p]\}}\ \{M(p)\}](\varphi_t) = \{\varphi_t, \neg\varphi_t\}$

b. $[\![[_{CP}\ \textit{who}_x [_{TP}\ t_x\ \textit{arrived}]]]\!]^{s,a,t}$

$= [\![\textit{who}]\!]^{s,a,t}\ ([\![_x[_{TP}\ t_x\ \textit{arrived}]]\!]^{s,a,t})$

$= \lambda r\ [\cup_{x\in PERSON}\ \{r(x)\}](\lambda x\ [\varphi_t[x]]) = \cup_{x\in PERSON}\ \{\varphi_t[x]\}$

Now, it would be possible to derive a question ActP from an embedded question, assuming the following structure and interpretation:

(56) $[\![[_{ActP}\ [_{Act'}\ [_{Act^\circ}\ ?]\ [_{ComP}\ [_{Com'}\ [_{Com^\circ}\ \vdash]\ [_{CP}\ \textit{who}_i [_{TP}\ t_i\ \textit{arrived}]]]]]]]\!]^{s,a,t}$

$= [\![?]\!]^{s,a,t}([\![\vdash]\!]^{s,a,t}([\![[_{CP}\ \textit{who}_i [_{TP}\ t_i\ \textit{arrived}]]]\!]^{s,a,t})))$

$= \lambda P\lambda C\ [\sqrt{C} \cup \{c\in C \mid \exists p\in P[c\subseteq p]\}](\lambda P'\ \{\lambda w\ [a\vdash_{w,t} p] \mid p\in P'\}(\cup_{x\in PERSON}\ \{\varphi_t[x]\}))$

As the CP denotes a set of propositions, the commitment operator $\vdash$ has to be type-lifted to apply to such sets, and the question operator ? applies to a set of propositions. This works, but is more complex than the direct derivation of root questions in (40). Furthermore, it is not clear how to derive the distinction of embedded vs. root syntax with nonsubject constituent questions, such as $[_{ActP}$ *When did Max arrive?*] vs. $[_{CP}$ *when Max arrived*]. And for polar questions, embedded questions differ from root questions by the presence of a

11 Alternatively, *wh*-constituents can be decomposed, e. g. wh+o, wh+at, wh+en, with a wh component that expresses disjunction $\cup$, and the remnant that expresses a semantic restriction of the trace. (54)(b) is derived as in (i) (with F an appropriate function variable). For (54)(a) we can assume (ii) (with T a variable for truth values)

(i) $[\![[_{CP}\ \textit{wh-}_x[_{TP}\ o_x\ \textit{arrived}]]]\!]^{s,a,t} = \lambda F\ [\cup_{x\in DOM(F)}\{F(x)\}](\lambda x\in PERSON[\varphi_t[x]])$
$= \cup_{x\in PERSON}\{\varphi_t[x]\}$

(ii) $[\![[_{CP}\ \textit{wh-}\ [_{PolP}\ \textit{e(i)ther}\ [_{TP}\ \textit{Max arrived}]]]]\!]^{s,a,t}$
$= \lambda F\ [\cup_{x\in DOM(F)}\{r(x)\}]\ (\lambda p\lambda T\in\{0,1\}\lambda w\ [p(w)=T](\varphi_t)) = \{\lambda w\ [\varphi_t(w)=0], \lambda w\ [\varphi_t(w)=1]\}$

complementizer, *whether*. This argues against a derivation in which embedded questions feed root questions.

However, one phenomenon that seems to argue for the derivation (56) are anaphoric uptakes like the following (pointed out by Ivano Ciardelli, pers. comm.):

(57) s_1: *Who arrived?*

s_2: *I don't know* {*Ø / that / it*} *but Sue knows* {*Ø / that / it*}.

The representation (56) provides for a semantic object as antecedent of *that*, *it* or the null anaphor, namely the CP meaning, whereas the representation (40) appears to lack such an antecedent. However, a closer look at the derivation reveals that the TP from which the wh-constituent is extracted can be interpreted as a function from entities (restricted to persons) to propositions; if the TP introduces a discourse referent with this meaning, this can serve as an antecedent for the subsequent discourse:

(58) $[\![[_{\text{ActP}}\ \textit{who}_x[_{\text{Act}'}\ [_{\text{Act}^\circ}\ ?]\ _x[_{\text{ComP}}\ x[_{\text{Com}'}\ [_{\text{Com}^\circ}\ \vdash]$ $_x[_{\text{TP}}\ t_x\ \textit{arrived}]]]]]]]^{s,a,t}$
$\hookrightarrow \lambda x{\in}\text{PERSON}\varphi_t[x]$

This strategy would not work with the derivation of polar questions as in (23), as they do not involve extraction. Yet the same type of anaphoric uptake is possible, cf. (59)(a).

(59) s_1: *Did Max arrive?*

a. s_2: *I don't know* {*Ø / that / it*} *but Sue knows* {*Ø / that / it*}.

b. s_2: *I don't think so. / I don't believe it / that.*

But note that anaphoric uptake of the proposition φ_t is possible as well, cf. (59)(b), which is difficult to reconcile with a theory that provides for a bipolar question meaning. This suggests that the question in (59) introduces a propositional discourse referent, as in (60).

(60) $[\![[_{\text{ActP}}\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ \textit{did}_0\ ?]\ [_{\text{ComP}}\ [_{\text{Com}'}\ [_{\text{Com}^\circ}\ \vdash]$ $[_{\text{TP}}\ \textit{Max}\ t_0\ \textit{arrive}]]]]]]]^{s,a,t}$
$\hookrightarrow \varphi_t[m]$

This propositional discourse referent is taken up by anaphors like *so*, *it*, *that* in (59)(b) (cf. Meijer 2020). It is also taken up in (59)(a), but *know* can select for a proposition or a set of propositions. We can assume a type shift that takes a proposition p and delivers the question meaning {p, ¬p}, thus feeding the second interpretation of *know*. The shift can be attributed to the factivity of proposition-embedding *know*: When, as in (59), the speaker asks whether φ is the case it is certainly not already established that φ is true.

2.12 Deliberative Questions

There is a type of question that does not put the addressee under an obligation to answer but just raises the issue as being of interest. In German, such ›deliberative‹ questions are expressed by questions with verb-final syntax characteristic of embedded questions and the complementizer *ob* and obligatory high boundary tone, as in *Ob Max schon angekommen ist?*, 'The question is, has Max arrived already?' (Truckenbrodt 2006).[12] Such questions can be analyzed as CPs like (55)(a), corresponding to their syntactic structure, that receive their discourse function by the high boundary tone H%. The input CS is enriched by the propositions in the CP, which leads to a CS with multiple roots, cf. (62)(a).

(61) $[\![[_{CP}\ ob\ [_{TP}\ Max\ angekommen\ ist]]\ H\%]\!]^{s,a,t}$

$= [\![H\%]\!]^{s,a,t}([\![[_{CP}\ ob\ [_{TP}\ Max\ angekommen\ ist]]]\!]^{s,a,t})$

$= \lambda S\ (\lambda C\ \cup_{p \in S}\ \{c \subseteq p\ |c \in C\})(\{\varphi_t, \neg\varphi_t\})$

$= \lambda C\ [\{c \subseteq \varphi_t \mid c \in C\} \cup \{c \subseteq \neg\varphi_t \mid c \in C\}]$

(62) a. s_1: *Ob Max angekommen ist?*
'I wonder whether Max arrived.'

b. s_2: *Ja, er ist angekommen.*
'Yes, he did.'

This CS update differs from the update by *Did Max arrive or not?*, cf. (34)(c): It does not involve any commitment by addressee or speaker, and it does not expect particular continuations, reflecting that such questions do not ask for an answer. But they store a record in an interest in an answer, by the multiple root.

12 Forms like *Whether Max arrived?* are not used in current English, but see Berkeley's *Querist* pamphlets (1735-37), which contain such questions, e. g. *Whether a Foreigner could imagine, that one half of the People were starving, in a Country which sent out such Plenty of Provisions?*.

Any development that introduces one of the proposition, e. g. by s_2 declaring commitment to φ, reduces the root, indicating that an information need of the CS is satisfied, cf. (62)(b).

The analysis of *ob*-questions without commitment phrases is supported as modifiers that are characteristic for ComPs like *ungelogen* 'without lying', *im Ernst* 'seriously' are problematic, cf. *ob Max *ungelogen / ?im Ernst angekommen ist?*. But deliberative polar questions often contain *wohl*, a discourse particle. Following the recent analysis by Eckardt (2020), *wohl* is a marker of defeasible inference. Assuming that x $|\sim_{w,t}$ p stands for 'x considers p true in w at t under circumstances that x considers stereotypical in w at t', with *wohl* a JP operator outside of the TP, we can analyze *wohl* with assertions as in (63). It enriches the input CS with the commitment by s_1 that s_1 considers it true in w at t that Max arrived, under stereotypical circumstances in w at t.

(63) $[\![[_{\text{ActP}}\ \textit{Max}_1\ [_{\text{Act}'}\ [_{\text{Act}^\circ}\ \textit{ist}_0\ \bullet]\ [_{\text{ComP}}\ \vdash\ [_{\text{JP}}\ [_{\text{J}'}\ \textit{wohl}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]$
$[_{\text{TP}}\ \text{t}_1\ \textit{angekommen}\ \text{t}_0]]]]]]]]]^{s,a,t}$
$= \lambda C\ \{c \in C \mid c \subseteq \lambda w\ [s \vdash_{w,t} \lambda w\ [s\ |\sim_{w,t} \varphi_t]]\}$

To extend this analysis of *wohl* to deliberative *ob* questions we have to assume that a CP can host a judge phrase, and that the judge parameter can be fixed by speaker and addressee, as in (64). This generates a two-rooted output CS, where in one branch s+a can defeasibly infer φ_t, but not in the other one. Information that amounts to φ_t, or to $\neg\varphi_t$, will lead to a root reduction of this multiply rooted CS.

(64) $[\![[_{\text{CP}}\ \textit{ob}\ [_{\text{JP}}\ \textit{Max}_1\ [_{\text{J}'}\ \textit{wohl}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \text{t}_1\ \textit{angekommen ist}]]]]\ \text{H\%}]\!]^{s,a,t}$
$= \lambda C\ [\{c \in C \mid c \subseteq \lambda w[s+a\ |\sim_{w,t} \varphi_t]\} \cup \{\ c \in C \mid c \subseteq \neg\lambda w\ [s+a\ |\sim_{w,t} \varphi_t]\}]$

Deliberative questions can also be formed with constitutent questions, in which case the presence of *wohl* is obligatory. We can assume the following analyis, assuming that Max and Sue are the only alternatives, Max m and Sue s:

(65) $[\![[_{\text{CP}}\ \textit{wer}\ [_{\text{JP}}\ \text{t}_1\ [_{\text{J}'}\ \textit{wohl}\ [_{\text{J}'}\ [_{\text{J}^\circ}\ \text{J-}]\ [_{\text{TP}}\ \text{t}_1\ \textit{angekommen ist}]]]]\ \text{H\%}]\!]^{s,a,t}$
$= \lambda C\ [\{c \in C \mid c \subseteq \lambda w\ [s+a\ |\sim_{w,t} \varphi_t[m]]\} \cup \{\ c \in C \mid c \subseteq \lambda w\ [s+a\ |\sim_{w,t} \varphi_t[s]]\}]$

The output CS is a multiple-rooted CS (in the present case just a two-rooted CS) in which speaker and addressee either defeasibly infer that Max arrived, or defeasibly infer that Sue arrived. A later commitment that, e. g., Max arrived, will strengthen the option that Max arrived, and, by scalar implicature, eliminate the other options. In this analysis, we can identify a reason why *wohl* is obligatory in such constituent questions: Without it, the input CS would be enriched in a way that guarantees that one of the options (here that Max arrived, and that Sue arrived) is true. With *wohl*, which is time-indexed, the input is just restricted so that stereotypical knowledge indicates that one of the question options, e. g. that there is defeasible knowledge that Max arrived, or that Sue arrived, is given.

2.13 Conclusion

This article presented two extensions of the familiar notion of Common Ground. First, I have argued for the role of commitments in getting propositions into the CG. I argued for a separate syntactic projection, the ComP, with an operator $\vdash$ that expresses the commitment of a participant for a proposition. I proposed Commitment States to model CGs, which contain information about which participants are committed to which propositions. Second, I have argued that questions restrict the development of the CG, and I proposed the notion of Commitment Spaces (CS) as commitment states plus continuations.

This model differs from the account of Farkas & Bruce (2010) in two respects. First, in the model developed here, the commitments of participants for propositions remain in the CG; in the model of Farkas & Bruce (2010) they play only a role in the process of negotiation. Second, the notion of continuation is more comprehensive in Commitment Spaces; in Farkas & Bruce (2010) continuations play a role only in the negotiation phase, in form of a negotiating "table". The current model differs also from traditional question semantics, including Inquisitive Semantics, as it allows for monopolar questions.

I have shown how a range of question types – polar questions, polar questions with propositional negation, polar questions with high negation, alternative questions and constituent questions – can be handled in the Commitment Space framework. For question tags, not treated here, see Krifka (2015); for focus and topic in questions, see Kamali & Krifka (2020). I have also discussed the relation between embedded questions and root questions, arguing that they are derived in parallel.

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2A Partialism in Krifka's Approach to Interpreting Polar Questions

Moritz Cordes

In his chapter, Manfred Krifka presents the theory of Commitment Spaces and therein he models assertions as well as various kinds of questions. The kinds of questions are individuated mainly by grammatical features. Roughly, there are simple polar questions ('Did Max arrive?'), polar questions with negated core propositions/low negation questions ('Did Max not arrive?'), high negation questions ('Didn't Max arrive either?'), alternative questions ('Did Max arrive or did Sue arrive?'), single constituent questions ('Who arrived?'), multiple constituent questions ('Who arrived when?'), declarative questions ('Max arrived?'), embedded questions ('Sue knows whether Max arrived.', 'Sue knows who arrived.'), and deliberative questions ('Ob Max angekommen ist?'). One major issue with the interpretation of questions of each of these kinds is what further development(s) of the common ground they should be taken to indicate or to suggest. For instance: 'Did Max arrive?' does not say that Max arrived, but does it suggest that he did? Does the question indicate that the speaker prefers to add 'Max arrived.' to the common ground?

Krifka's view is that most of above kinds of (polar) questions asymmetrically suggest (*to a certain extent* and *in one way or the other*) that the addressee of a questions commit to the core proposition. (In the case of low negation questions, it is asymmetrically suggested that the addressee commit to the negation of the core proposition.) Asking 'Did Max arrive?', for example, suggests that the addressee commit to 'Max arrived.' (or, rather, to the *proposition* expressed by 'Max arrived').[1] Let us call this view *partialism*. The opposite view, *impartialism*,

1 Needless to say that Krifka does not claim strict universality. Possibly, he can claim the kind of generality that is also associated with Betteridge's Law of Headlines ("[A]ny headline which ends in a question mark can be answered by the word "no"." (2009)), which, of course, does not hold universally and, incidentally, seems to be somewhat opposed to Krifka's view: While Krifka takes the question to *suggest the affirmative*; Betteridge takes the question to *foretell the negative* (although insinuating(?) the

takes most of these kinds of question to not come with any such suggestions.[2] In what follows I will deliberate about these conflicting views. First, I would like to point to the *gap theory*, not explicitly countenanced by Krifka, as a basis for partialism. Second, I will critically comment on an argument for partialism by Krifka himself. In a third section, I discuss relations between (im)partialism and different views on what is the ›content‹ of a polar question. Finally, the distinction is elevated by receiving an instrumentalist treatment, which relativizes Krifka's empirico-linguistic approach to questions and situates it in a methodological spectrum for the classification of theories of questions. – As a disclaimer, the reader should not expect that this short comment considers all kinds of questions at every turn. In comprehensiveness and theoretical elaboration it is dwarfed by the target paper.

2A.1 Partialism Based on Gap Theory

According to Anna Brożek, questions arise from "gappy" cognitive pictures of situations (2011:102). This is most obvious in constituent questions (wh-questions) where the "gap" is explicitly marked by an interrogative pronoun or a similar kind of interrogative particle. It is not so obvious in polar questions, at least how they usually appear in ordinary English. However, Brożek makes a strong case that, in fact, polar questions should be seen as akin to constituent questions: Both kinds of questions present a gappy picture of a situation and they are posed with *the will of filling the gap*. In the case of polar questions, however, there is, in addition, a "hypothesis of how to fill this gap" (2011:104). To see this, it is important to identify the purported gap in a polar question. Asking 'Did Max arrive?' could be based in a gappy picture with regard to Max or with regard to his possible arrival. In the first case, the question could be rephrased 'Somebody arrived – is it Max?', in the second case 'There was something about Max – did he arrive?'.

Brożek observes that the marking of the gap, in face of its hypothetical filling, is achieved by, for example, intonational stress.[3] Thus, in 'Did /Max arrive?'

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affirmative). – At any rate, I do not wish to suggest that the basis for Krifka's and Betteridge's generalizations are methodically on a par!

2 Toward the end of sect. 2.5 Krifka names some scholars representing what I call partialism and impartialism. To the list of tentative impartialists can be added those who analyze polar questions as constituent questions where the implicit constituent can be made explicit, e. g. by '*x*' in 'Max arrived is *x*', with '*x*' ranging over truth and falsity (Lewis & Langford 1959:333, Ajdukiewicz 1926:195, Moritz 1940:137).

3 Philosophical observations about intonational stress in polar questions are made as early as 1905 by Eduard Martinak, who, by the way, took experience to support a view opposite to Krifka's, namely that simple polar questions come with an expectation of

there is a gap in the picture of the situation with regard to who arrived. In 'Did Max /arrive?' there is a gap with regard to what Max did. The observations are supplemented by Brożek's findings about the grammar of polar questions in certain natural languages (2011:132). In Polish, she observes, the gappy part of a polar question is indicated by putting the phrase that hypothetically fills the gap in end position. In written Armenian the symbol '՞' functions similar to a question mark, but it is not placed at the end of the sentence but, according to Brożek, in conjunction with the last syllable of the emphasized word.[4]

Brożek's theory provides a good reason for taking a partialist position. If a polar question is to be distinguished from a constituent question only by having an additional hypothesis of how to fill a posited gap, then the former should inherit several features from the latter, for example all of its presuppositions, I presume. The constituent question 'Who arrived?' presupposes that somebody arrived – or so theories of questions usually allege.[5] But then the polar question 'Did /Max arrive?' should be taken to presuppose at least as much. Both questions display a will of filling the same gap, as to who arrived. The negative answer to the polar question does not satisfy this will, though; the affirmative answer does. Thus both answers are not on equal footing. The negative answer is discouraged to the extent to which it does not satisfy the will to fill the associated gap. This, quite independently from Krifka, amounts to a partialist view.

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having the core proposition negated (1905:335). Although rather offhand, Martinak's remarks fit Brożek's theory. Furthermore, there is a similarity between Brożek's take on polar questions and van Fraassen's take on why-questions, which the latter takes to be individuated by, among other parameters, a contrast class (1980:ch. 5, sect. 2.8). The similarity is palpable in paraphrases: Brożek is sympathetic to paraphrasing 'Did Max arrive?' as either 'Did Max arrive or somebody else?' or as 'Did Max arrive or was he delayed?'; van Fraassen is sympathetic to paraphrasing 'Why did Max arrive?' as either 'Why did Max arrive and not somebody else?' or 'Why did Max arrive and was not delayed?'. Brożek does not explicitly draw the connection (cf. 2011:159–160).

4 Brożek makes further observation along similar lines, but apparently with a lesser claim to generality, regarding old Polish, 19th century Polish, and Latin (2011:133). While writing the current comment, the author of the target article drew my attention to his with work together with Beste Kamali; they study similar phenomena in the Turkish language (2020).

5 This view on the presuppositions of constituent question is not unopposed. Lewis and Langford (1959:333) frame the negative answer to a constituent question as a "transformation" of a propositional function (included in the question) into a "true proposition […] by generalization", apparently referencing the equivalence between negative existential and universal quantification. They seem to treat this kind of answer akin to "transformation by specification", which yields answers like 'Max arrived.' to 'Who did arrive?'. The answer 'Everybody arrived.' would, it appears, also be arrived at through a "transformation […] by generalization".

2A.2 Partialism from the Composition of Alternative Questions

One abductive argument for a monopolar reading of simple polar questions, and thus partialism, is brought forward by Krifka in sect. 2.6. There are two substantial assumptions in the argument, only the first of which is made explicit: 1. "Alternative questions come with the pragmatic presupposition that one of the alternants is true." 2. Pragmatic presuppositions of alternative questions are determined by pragmatic features of all those simple polar questions that have one alternant as main constituent. This second assumption can be illustrated: The pragmatic presupposition of 'Did Max arrive or did Sue arrive?', i. e. the presupposition that (at least) one of them arrived, is determined by a pragmatic feature of 'Did Max arrive?' and 'Did Sue arrive?', i. e. the speaker's indication that she prefers to develop the common ground by adding 'Max arrived.' or 'Sue arrived.', respectively. If 'Did Max arrive?' and 'Did Sue arrive?' were not to be read as such indications, so the argument implicitly runs, then it would not be clear how the pragmatic presupposition of the alternative questions is effected.[6]

Of course it is possible to reject both assumptions of the argument. 1. If one waits for both, Max and Sue, but one has no idea when their arrival is due, then the question 'Did Max arrive or did Sue arrive?' can be read as devoid of the presupposition that at least one of them (should have) arrived (by now).[7] 2. If one regards simple polar questions and alternative questions as two fundamentally different kinds of questions, similar to how yes/no-questions and wh-question are usually regarded, then one would hardly be inclined to see the pragmatic presuppositions of alternative questions as determined by certain pragmatic features of simple polar questions.

2A.3 (Im)partialism and the Content of Polar Questions

The distinction between partialism and impartialism w.r.t. polar questions can be associated with certain views about the ›content‹ of such questions (cf. Krifka's

6 In sect. 1 B.1 Krifka is as brisk as saying that the alternative question having the presupposition "follows" from monopolarity. This is only correct if additional assumptions are made. Note that Krifka's monopolarity is not formulated in terms of presuppositions but in terms of suggestions.

7 Krifka can acknowledge the existence of scattered cases which do not align with his theory: "As a model, it will not capture all aspects of reality." (sect. 2.1) Note that the intonational stress might be sensitive to whether one expects at least one of the alternants to be the case. With presupposition: 'Did /Max arrive or did \Sue arrive?'. Without presupposition: 'Did /Max arrive or did /Sue arrive?'. At any rate, the existence of these two intonational variants and their presuppositional differences suggests that the dependency between alternative questions and their associated simple polar questions might not hold as generally as Krifka needs it to.

comment ch. 1B on Ciardelli's ch. 1). Many scholars see a proposition/statement/sentence at the core of a polar question – in contrast to constituent questions, which are not regarded thus. 'Did Max arrive.' contains as its main ›content‹ the proposition/statement/sentence 'Max arrived' or 'Max did arrive'. 'Who arrived?' contains what is usually called a 'propositional *function*'. Departing from this widespread[8] view on polar questions, it is interesting to see how questions are individuated by means of the content: If this content is a proposition and we take 'proposition' to mean a set of possible worlds or something similar, then it is hard to see how, with a classical logic in the background, 'Is it the case that Max arrived?' and 'Is it the case that Max did not not arrive?' are different, because, due to double negation elimination, the proposition expressed in both questions is the same. However, both questions can be distinguished clearly from 'Is it the case that Max did not arrive?', whose core proposition is the complement of the proposition of either of the other two questions. Partialists will emphasize this distinction; impartialists not so much. The latter will simply declare that all three questions formulate the same ›issue‹ (Walther 1985:84). This is highly plausible if questions are not associated just with propositions but with sets therof where each element of this set represents some way to answer (cf. Ciardelli 2021). Then all three example questions are associated with the two-element set of the proposition that Max arrived and its complement. Of course, one can always enhance such a semantic view by ranking the two propositions within this set in some way, reflecting the bias needed for a partialist outlook – but this would go beyond, for example, Ciardelli's approach.

On the other hand, if the content of a simple polar question is identified with a statement or a sentence (or a proposition in Geach's highly convincing sense (1965)), in other words: with a syntactic entity or an expression, then all three questions (or rather: interrogatives) are distinct from the beginning. It might, at first, not appear plausible to distinguish between 'Is it the case that Max arrived?' and 'Is it the case that Max did not not arrive?' at first, but one should bear in mind that neglecting a double negation is the first step toward the implausible assumption of logical omniscience. After all, it is not instantly clear whether 'Is it the case that Max did not not not not not not arrive?' is different in content from those two questions, because one at least needs to determine whether the number of occurrences of 'not' is even. But if two negations make a difference regarding the content of a question, then one negation should do so, too. That

8 Brożek and Ciardelli, to name only two, would mostly likely qualify the immediate association of a proposition/statement/sentence with a polar question. See sect. 2 A.1 and ch. 1, respectively.

is, to such a syntactic view partialism appears to come more naturally than impartialism.

However, this appearance is not decisive. If a distinction is made between 'Is it the case that Max arrived?' and 'Is it the case that Max did not arrive?', then, in a given situation, one can motivate choosing one of these formulations above the other by indicating that one persues aims very different from suggesting that the addressee commit to a certain one of the two alternatives. For example, the formulation might be motivated by the aim to minimize changes to sentences uttered beforehand: When going through a list of (n, x) pairs, where 'n' ranges over names and 'x' over positive or negative arrival statuses, the questioner might decide to formulate the question in correlation with each pair in the list. (Sue, +) lets the questioner ask 'Is it the case that Sue arrived?'; (Max, –) lets the questioner ask 'Is it the case that Max did not arrive?'. At the same time the questioner might be totally uninterested in converting the list into suggestions about what commitments the addressee should make. It might even be that the questioner ultimately wants the addressee to commit to the fact that the list is all wrong. Thus, the availability of low negation in polar questions does *not necessarily* support the view that this negation makes a difference with regard to what is being suggested by the questioner – although it might make such a difference in the standard cases. At any rate, partialism does not unqualifiedly follow.

2A.4 Normative (Im)partialism

What is the benefit of understanding simple polar questions in the way Krifka does, i. e. as suggesting that the addressee commit to the affirmative answer? Apart from considerations of the kind presented in sects. 2 A.1 and 2 A.2, it makes what the questioner does more complex. While it is a hardly defensible point of view that somebody who asks 'Did Max arrive?' *presupposes* that he did arrive, from a partialist point of view one can at least claim that the question performs a kind of ›affirmative urging‹, like a *suggestion* to the addressee or an *indication*. It appears as if one cannot ›simply ask‹ a simple polar question. In fact, Krifka's offer to those who want to ask a "true bipolar question" consists in an alternative question with the second alternant being the negation of the first: 'Did Max arrive or not?' (sect. 2.6).

Is this a desirable situation? Should it not be possible that one asks a simple polar question without suggesting anything? It appears strange that one has to utter more in order to say less: With 'Did Max arrive?' Krifka asks a question *and* makes a suggestion, with 'Did Max arrive or not?' he cancels the suggestion but still asks the question. Admittedly, in natural language we often have

roundabout ways of disclaiming, but the need to disclaim usually stems from extralingual conventions. If we ask our partner whether he or she was unfaithful, we would have to go a long way pointing out that we do not want to suggest that he or she was unfaithful. Appending '… or not?', and thus formulating a "tru[ly] bipolar" alternative question, would most likely not do the job. On the other hand, asking our partner whether she or he closed the kitchen window might best be interpreted as suggesting neither affirmative nor negative answer, unless the questioner is already seen as following a certain cognitive agenda. In either case, adding '… or not?' *might* be redundant.

Some of what I am writing here indicates a normative aspect to theories of questions: At this point I do no longer criticize Krifka, who formulates a theory about what we, *in fact*, mean when we make certain utterances. While, elsewhere, I may or may not disagree with him about the generality of his observations, I would like to enhance his insights by wondering out loud, whether we *should* furnish our language in a way that makes it harder to ask a non-biased question than to ask a biased question. Understanding the theory of questions in this normative fashion invites relativization to communicative aims: What aims can one realize (more effectively) if one chooses one way to understand each other over another? It appears to me that the aim of *cognitive straightforwardness* is realized more effectively if simple polar questions are not understood to include any kind of suggestion. In other words, for cognitive purposes, for the purposes of unbiased inquiry, it might be helpful to allocate a way to ask unbiased polar questions by just presenting a proposition/statement/sentence and put it under the aegis of a yes/no-question operator. The resultant unbiased/bipolar question is not to be read as implicitly hypothesizing or suggesting (or as presupposing Brożek's gappy picture of a situation).[9] This, then, could be dubbed 'normative impartialism'. To the extent that I would like natural language speakers to have this way of asking questions, to this extent I am sympathetic to read simple polar questions as unbiased. I am curious about what would be a worthwhile communicative aim to countenance normative partialism.

9 Along the same lines one could argue against van Fraassen and submit that it is sometimes worthwhile to allow for the asking of why-questions that are not equipped with contrast classes.

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3 An Essay on Inferential Erotetic Logic

Andrzej Wiśniewski

Abstract
By and large, Inferential Erotetic Logic (IEL, for short) is an approach to the logic of questions which puts in the centre of attention inferential aspects of questioning. IEL is not an enterprise of the last few years only. The idea originates from the late 1980s. It evolved through time. Initially, the stress was put on the phenomenon of question raising. This changed gradually, as some forms of reasoning that involve questions have appeared to be analyzable by means of the conceptual apparatus developed.[1] In this essay I present the basics of IEL and comment on them. Most, though not all, of the ideas discussed here have been scattered across my earlier publications. The invitation from the organizers of the *Asking and Answering* workshop (Greifswald, September 2020) resulted in an attempt of presenting the themes of IEL in a concise but, as I hope, also comprehensible way.

3.1 Erotetic Inferences

As Sylvain Bromberger puts it:

> "We ask questions for all sorts of reasons and with many different purposes in mind – e.g., to test someone's knowledge, to offer someone the opportunity to show his erudition, to kill time, to attract attention; but questions have one basic function, the asking for information not already in our possession." (Bromberger 1992:86)

1 The monograph (Wiśniewski 1995) summarizes results obtained until the early 1990s. It is concerned, mainly, with first-order languages enriched with questions and supplemented with the standard model-theoretic semantics. The book (Wiśniewski 2013) presents IEL in a more general conceptual setting and overviews new results received till the date of publication.

Yet, before a question is asked or posed, one has to arrive at it. In many cases arriving at questions resembles coming to conclusions: there are premises involved and some inferential thought processes take place. In other words, there exist *erotetic inferences*, that is, thought processes in which one arrives at a question on the basis of some previously accepted declarative sentence(s) and/or a previously posed question. Consider:

(1) There is a cat in this room.

Someone let it in.

Who let the cat in?

and

(2) Where did Andrew leave for?

If Andrew took his famous umbrella, then he left for London.

If Andrew did not take his famous umbrella, then he left for Paris or Moscow.

Did Andrew take his famous umbrella?

As for (1), the set of premises contains declarative sentences only, while in the case of (2) the set of premises comprises declarative sentences and a question. It also happens that no declarative premise occurs, *viz.*:

(3) Did Andrew fly by BA, or by Ryanair, or by neither?

Did Andrew fly by BA?

It can be shown that erotetic inferences are subjected to patterns. This makes their logical analysis possible.

Remark 1. One should differentiate between inferences *about* questions and inferences *with* questions. What I have called above erotetic inferences belongs to the latter category. Here are examples of inferences about questions:

(4) One cannot divide by zero. Therefore the question 'What is the value of $4 \div 0$?' makes no sense.

(5) The question 'How did you solve this problem?' has no answer since you did not solve it. Therefore the question 'When did you solve the problem?' is pointless.

IEL concentrates on inferences with questions.

3.1.1 The Validity Issue

Some erotetic inferences are *intuitively valid*, while others are not. The following can serve as a preliminary test of intuitive validity: put the expression 'so the question arises:' just before the conclusion. If the outcoming description of an erotetic inference is undoubtedly true, the inference can be regarded as intuitively valid. Obviously, (1), (2), and (3) specified above pass the test. Nevertheless, there are cases in which one does not get indisputable results. The intuitive concept of validity is fuzzy or even vague.

IEL offers an account of *validity* of erotetic inferences. Yet, validity is a normative notion and the issue of naturalistic fallacy cannot be ignored. So in order to define validity for erotetic inferences some – not entirely, but still – arbitrary decisions have to be, and actually are, made. This is not a peculiarity of IEL. Logics of other types of inferences had done the same in their accounts of validity of inferences considered, although we usually disregard it as we got used to solutions established in the past.

IEL proceeds as follows. First, some criteria of validity are proposed, separately for erotetic inferences that involve only declarative premises and for those in which an interrogative premise occurs. Once criteria of validity are set, two semantic relations are defined: *evocation* of questions by sets of declarative sentences/formulas, and *erotetic implication* of a question by a question together with a set of declarative sentences/formulas. Validity of erotetic inferences of the consecutive kinds is defined in terms of question evocation and erotetic implication, respectively. Although these concepts differ[2], there is a unifying idea behind defining validity by means of them: each concept is a formal counterpart of the corresponding notion of question raising. The definition of question evocation provides an explication of the intuitive notion 'a question arises from a set of declarative sentences'. The definition of erotetic implication, in turn, is an explication of the intuitive notion 'a question arises from a question

2 However, surprisingly enough, it is possible to define question evocation, in a somewhat tricky way, in terms of erotetic implication; cf. (Wiśniewski 2013:84).

on the basis of a set of declarative sentences'.[3] It is neither assumed nor denied that the relevant set of declaratives is non-empty. The case in which it is empty allows us to deal with validity of erotetic inferences which do not involve any declarative premises (cf., e. g., (3) above). Alternatively, one can use here the concept of *pure erotetic implication*, being a binary relation between questions.

3.2 Syntax and Semantics: General Insights

3.2.1 Syntax

IEL employs formal languages, in which at least two categories of well-formed expressions occur: *declarative well-formed formulas* (d-wffs, for short) and *erotetic well-formed formulas* (hereafter: e-wffs or simply *questions*). Generally speaking, an object-level formal language employed has thus (possibly among others) a ›declarative part‹ and an ›erotetic part‹. The former can be a (modal or non-modal) propositional language, a first-order language (augmented with modalities or not), a higher-order language, etc..

As for questions, IEL prefers a semi-reductionistic approach. The general idea is: e-wffs fall under the following schema:

(6) $?\Theta$

where Θ is an expression of the object-level formal language such that Θ is equiform with the expression of the metalanguage which, in turn, designates the set of *direct answers* to the e-wff.

E-wffs (to be more precise, some of them) are formal counterparts of natural-language questions. An e-wff Q *represents* a natural-language question Q^* *construed in such a way* that direct (i.e. immediate and sufficient) answers to Q^* are represented by the direct answers to Q.[4]

Here is an example how the semi-reductionistic approach works. When we add the question mark ? and the brackets: {, } to the vocabulary of a formal language, we can enrich the language with e-wffs of the form:

(7) $?\{A_1, \ldots, A_n\}$

3 Let me stress: IEL does not provide analytic definitions of the above concepts of 'arising', but their *explications*; cf. (Wiśniewski 1995:ch. 1).

4 A reader not familiar with logics of questions should bear in mind that, at both levels, being true *is not* a prerequisite for being a direct answer.

where $n > 1$ and $A_1, \ldots, A_n$ are pairwise syntactically distinct d-wffs of the initial language; these d-wffs are supposed to be the only direct answers to the e-wff/question.

This is only an example. It cannot be said that each e-wff considered in IEL falls under the schema (7). The semi-reductionistic approach copes with questions having infinitely many direct answers by defining, at the metalanguage level, different infinite sets of d-wffs of required kinds, and then by introducing into an object-level language expressions equiform with the respective metalanguage expressions just defined. For examples, see (Wiśniewski 1995:ch. 3). However, IEL is not committed to the semi-reductionistic approach to questions sketched above. One can work within IEL and introduce e-wffs by applying other patterns known from the literature (for instance, following Kubiński's approach (1980) or Belnap's proposals (Belnap & Steel 1976)). What is needed is a formal language such that: (i) d-wffs and e-wffs occur among its well-formed expressions, where e-wffs are distinct from well-formed expressions of other categories, and (ii) direct answers are assigned, in some way or another, to e-wffs. We are free in designing such a language, but not completely free. Some global constraints are supposed to be met. Here are examples:

- each e-wff has at least two direct answers;
- direct answers are sentences, i.e. d-wffs with no individual or higher-order free variables.[5]

One has to bear in mind that the claims of IEL rely upon, among others, stipulations of the above kind. In practice, this means that when definitions and theorems of IEL refer to questions, the tacit assumption is that only questions which meet the respective stipulations are referred to.

3.2.2 Semantics

IEL does not assume that questions/e-wffs are true or false. Semantic properties of and relations between e-wffs are defined in a way that takes as a prerequisite the existence of assignments of (sets of) direct answers to e-wffs. In order to proceed at the general level, only a semantics of the declarative part of a language is needed. It should be rich enough to define concepts of truth and entailment for d-wffs. A detailed semantic account of e-wffs/questions themselves brings an added value, but definitions of basic notions of IEL do not rely upon any elaborated semantics of questions. Similarly, in its general setting IEL remains neutral in the controversy as to what ›The Logic‹ of declaratives is.

5 As for propositional languages, direct answers are propositional formulas.

One can use either Classical Logic or a non-classical logic. But different logics have diverse semantics. A unifying framework is provided by Minimal Erotetic Semantics (MiES), within which entailment relations determined by different logics can be simulated. Yet, for space reasons, I will not present MiES here.[6]

So let us only assume that the declarative part of a formal language considered is supplied with a semantics rich enough to define some relativized (to a semantic item, such as a valuation, a model of an appropriate kind, and so forth, depending on the logic and its semantics chosen) concept of truth for d-wffs. Having the concept of truth, one can define entailment. It is convenient to operate with the concept of multiple-conclusion entailment (mc-entailment, for short), being a relation between *sets* of d-wffs (cf. Shoesmith & Smiley 1978). The idea is this: A set of declarative sentences, X, mc-entails a set of declarative sentences, Y, iff the hypothetical truth of all the sentences in X warrants the existence of a true sentence in Y.[7] For instance, the set:

(8) {There is a cat in this room. Either Andrew, or Paul, or Dorothy let the cat in.}

mc-entails the set:

(9) {Andrew let the cat in. Paul let the cat in. Dorothy let the cat in.}

We use the symbol $\Vdash$ for mc-entailment. As for the formal languages considered, the definition of $\Vdash$ falls under the following schema:

(10) (Mc-entailment)

$X \Vdash Y$ iff

for each $M \in (\ldots)$: if all the d-wffs in X are true in M, then at least one d-wff in Y is true in M.

where M refers to a semantic item in relation to which truth of d-wffs is defined, and the ellipsis should be filled with an expression denoting a class of such items. Needless to say, single-conclusion entailment, $\vDash$, can be defined by: $X \vDash A$ iff $X \Vdash \{A\}$.

6 For MiES, an interested reader can consult, e. g., (Wiśniewski 2013:chs. 3, 4).

7 The expression 'iff' abbreviates, here and below, 'if and only if'.

Here are examples of semantic concepts pertaining to e-wffs/questions, defined within the framework sketched above:

(11) (Soundness of a question)

An e-wff Q is *sound* in M iff

at least one direct answer to Q is true in M.

(12) (Presupposition)

A d-wff A is a *presupposition* of an e-wff Q iff

A is entailed by each direct answer to Q.

Note that a question having false presupposition(s) has no true direct answer. IEL neither ignores the existence of loaded questions nor stipulates that negations of presuppositions always count as direct answers.

Here are some further useful notions:

(13) (Prospective presupposition)

A d-wff A is a *prospective presupposition* of an e-wff Q iff

A is a presupposition of Q and the set of direct answers to Q is mc-entailed by the (singleton set comprising) the presupposition A.

(14) (Normal question)

An e-wff Q is *normal* iff

Q must have a true direct answer if its presuppositions are all true.[8]

3.3 Question Evocation and Erotetic Implication

We are now ready to introduce the concepts of question evocation and erotetic implication. In order to facilitate reading, the proposed definitions will be illustrated with natural-language examples, and short comments, expressed in general terms, will be added.

By dQ we designate the set of direct answers to a question/e-wff Q. The symbol $\Vdash$ stands for mc-entailment (cf. subsection 3.2.2).

8 More formally: Q has presuppositions, and the set of direct answers to Q is mc-entailed by the set of presuppositions of Q.

3.3.1 Question Evocation

The expression **E**(*X*, *Q*) abbreviates 'a set of d-wffs *X* evokes a question/e-wff *Q*'.

(15) Definition (Question evocation)

E(*X*, *Q*) iff

1. $X \Vdash \mathrm{d}Q$ and

2. for each $A \in \mathrm{d}Q$: $X \nVdash \{A\}$.

For instance, one can say[9] that the following set of declarative sentences:

(16) {There is a cat in this room. Someone let it in.}

evokes the question:

(17) Who let the cat in?

Call a natural-language question *sound* if at least one direct answer to the question is true. (Observe that question (17) need not be sound. It is construed here as not allowing 'No one' and its equivalents as *direct* answers.) Generally speaking, the first clause of Definition (15) amounts to *transmission of truth into soundness*: If only *X* consists of truths, the question *Q* must be sound. (Clearly, if only (16) consists of truths – it need not! – there must be someone who let the cat in.) The second clause amounts to the claim that no single direct answer to *Q* is entailed by *X*. (Obviously, one cannot decide who let the cat in on the basis of (16) only.)

Remark 2. To put it mildly, mc-entailment is not among concepts well-accustomed by non-logicians (and some logicians, too). Can we avoid referring to mc-entailment when defining question evocation? The answer is negative in the general case, but affirmative in some special cases. For instance, when we operate with a language in which all questions are normal (in the sense specified

9 The modality 'can' is used here for a reason. Saying this with certainty would require listing assumptions concerning logical representations of the analyzed natural-language expressions in a formal language, as well as concerning the underlying logic. For obvious reasons, we skip them here. One should bear in mind that an analogous remark pertains to the remaining natural-language examples presented below.

in subsection 3.2.2 above), evocation of Q by X can be defined by the following clauses: (i) X entails each presupposition of Q, and (ii) X does not entail any direct answer to Q. For normal questions which have maximal presuppositions (i.e. single presuppositions that entail all the remaining presuppositions), clause (i) can be replaced with (i′) X entails a maximal presupposition of Q.

When question evocation is defined according to the pattern provided by Definition (15), clauses (i)–(ii) and clauses (i′)–(ii) characterize properties of evocation of normal questions and of normal questions equipped with maximal presuppositions, respectively.

Remark 3. Definition (15) pertains only to questions whose sets of direct answers (or ›principal possible answers‹ labelled differently) are determined one way or another. Strictly speaking, it pertains to e-wffs of formal languages employed in IEL. It is doubtful if every natural-language question can be analysed to the effect that its formal representative is an e-wff having a well-defined set of direct answers. This does not mean, however, that every why-question remains outside the area of applicability of IEL. A reader intrigued by this enigmatic statement is advised to consult (Kuipers & Wiśniewski 1994, Wiśniewski 1999).

Remark 4. The second clause of Definition (15) refers to the lack of entailment. This does not lead into troubles when the entailment relation operated with is decidable. However, it need not be so. It happens that entailment is only recursively enumerable, while the lack of entailment is not even recursively enumerable. First-Order Logic entailment (hereafter: FOL-entailment) provides a paradigmatic example here. As a consequence, in such a situation question evocation relation[10] is not recursively enumerable.

However, one should not confuse the lack of semidecidability of the whole relation with the impossibility of showing that something is an instance of the relation. An example will be of help. Let P, R be distinct two-place predicates, and a, b be individual constants. Although there is no algorithm which ›detects‹ the lack of FOL-entailment in each case of its occurrence, we can still, by the construction of a countermodel, show that neither $P(a, b)$ nor $R(a, b)$ is FOL-entailed by the disjunction $P(a, b) \vee R(a, b)$. Establishing this, we are able to conclude that the question $?\{P(a, b), R(a, b)\}$ is (FOL-)evoked by the singleton set $\{P(a, b) \vee R(a, b)\}$.

Remark 5. Definition (15) provides an explication of one of the intuitive notions of question raising. It does it successfully with respect to the criteria of

10 Understood as the set of all ordered pairs $\langle X, Q\rangle$, where X is a set of wffs of a language, and Q is an e-wff of the language, such that $\mathbf{E}(X, Q)$ holds.

adequacy of explication previously set (cf. Wiśniewski 1995:ch. 1). But questions often arise from inconsistencies. As long as the underlying logic of declaratives validates *Ex Falso Quodlibet* – but please remember that not all logics do! – no question is evoked by an inconsistent set of declaratives. In order to cope with the inconsistency case, one can adopt different strategies (cf., e. g., (Meheus 1999, 2001, Wiśniewski 2015)). There is no room for presenting them here.

Remark 6. One may argue that the concept of question evocation understood according to Definition (15) is too broad. Without discussing this issue, let me only mention that the relations defined below are (interesting) special cases of question evocation defined above.

(18) Definition (Question generation)

G(X, Q) iff

1. $X \Vdash \mathrm{d}Q$, and

2. for each $A \in \mathrm{d}Q$: $X \nVdash \{A\}$, and

3. $\emptyset \nVdash \mathrm{d}Q$.

The third clause of Definition (18) supplements the first one: The transmission of truth into soundness effect takes place, but not just due to the fact that the generated question is always sound.

(19) Definition (Strong evocation)

E*(X, Q) iff

1. $X \Vdash \mathrm{d}Q$ and

2. for each $A \in \mathrm{d}Q$: $X \nVdash \mathrm{d}Q\backslash\{A\}$.

The second clause of Definition (19) ensures that no proper subset of the set of direct answers to Q is mc-entailed by X. Hence X strongly evokes Q just in case the hypothetical truth of all the wffs in X warrants that a truth occurs in the whole set of direct answers to Q, but does not warrant this for any proper subset of the set. In the case of languages in which classical disjunction occurs and questions with finite sets of direct answers are the only ones considered, this happens when X entails a disjunction of all the direct answers to Q, yet does not entail any disjunction of some but not all direct answers to the question.

3.3.2 Evocation and Validity

An erotetic inference of the first kind leads from premises being declarative sentence(s) to a conclusion having the form of a question. IEL proposes the following criteria of validity of erotetic inferences of the first kind (these criteria are supposed to be satisfied jointly):

(C_1) (Transmission of truth into soundness).

If the premises are all true, then the question which is the conclusion must be sound.

(C_2) (Informativeness).

A question which is the conclusion must be informative relative to the premises.

There is no room for an extensive presentation of pros and cons of such a solution. An interested reader is advised to consult, e. g., (Wiśniewski 1995:ch. 8) or (Wiśniewski 2013:ch. 5).

Taken purely syntactically, an erotetic inference from a set of declaratives X to a question Q is simply the ordered pair $\langle X, Q\rangle$. Assume that both the elements of X and Q are expressions of a formal language for which question evocation has been defined. Given this assumption, we introduce:

(20) Definition (Validity of an erotetic inference)

An erotetic inference $\langle X, Q\rangle$ is *valid* iff $\mathbf{E}(X, Q)$.

Definition (20) pertains only indirectly to erotetic inferences whose premises and conclusions are expressed in a natural language. But this is not unusual. For instance, we often speak about logical entailment between declarative sentences of a natural language, although logical entailment is, strictly speaking, defined for a (corresponding) formal language. Problems with a transition from a natural to a formal language are well-known, and IEL is neither better nor worse in this respect than other formal logics.

Remark 7. Condition (C_1) of validity and clause 1 of Definition (15) almost mirror each other. Yet, the transition from clause 2 of Definition (15) to condition (C_2) is not immediate. It relies on the assumption that informativeness of a direct answer w.r.t. a set of declaratives is tantamount to the lack of entailment of the direct answer from the set of declaratives. This works in one direction, but not necessarily in the other: A direct answer entailed by a set of declaratives

can be regarded as informative w.r.t. the set when the answer is a ›distant consequence‹ of the set. This gives rise to an issue relevant to the analysis of question raising. However, IEL in its current form simplifies matters in the way presented above. As a consolation, let me only say that, as long as logic is concerned, 'is not valid' is not synonymous with 'is fallacious'.

3.3.3 Erotetic Implication

Let us now define the second central concept of IEL, namely erotetic implication. The expression **Im**(Q, X, Q_1) reads 'an e-wff/question Q_1 is erotetically implied by an e-wff/question Q on the basis of a set of d-wffs X'.

(21) Definition (Erotetic implication)

Im(Q, X, Q_1) iff

1. for each $A \in \mathrm{d}Q$: $X \cup \{A\} \Vdash \mathrm{d}Q_1$, and

2. for each $B \in \mathrm{d}Q_1$ there exists a non-empty proper subset Y of $\mathrm{d}Q$ such that $X \cup \{B\} \Vdash Y$.

For example, the question:

(22) Who let the cat in: Andrew, Dorothy, or Paul?

erotetically implies the question:

(23) Is the cat black, or is it grey?

on the basis of the following set of sentences:

(24) {Andrew let the cat in iff the cat is black.
Dorothy or Paul let the cat in iff the cat is grey.}

The first clause of Definition (21) warrants the transmission of soundness and truth into soundness. (There are cats which are neither black nor grey. But if only question (22) is sound and (24) consists of truths, the cat asked about must be either black or grey.) The intuition that underlies the second clause is this: Each direct answer to an implied question narrows down, together with the respective

set X, the class of ›possibilities‹ or ›options‹ offered by the whole set of direct answers to the implying question. (If the cat occurred grey and (25) consists of truths, only two options would remain: Dorothy or Paul. If the cat occurred black and (25) consists of truths, only one possibility would remain, namely Andrew.) Or, to put it differently, each direct answer to an implied question, when added to X, enables us to answer, partially or directly, the implying question.[11]

Let me stress that erotetic implication defined above is, so to say, ›Janus-faced‹. The first clause of its definition ›looks forward‹ (from an implying question to the implied question), while the second clause ›looks backward‹ (from an implied question to the implying question).

The first clause looks suspicious to those who believe that any question is, as a matter of fact, truly answerable. Yet, IEL does not assume anything like this. On the contrary, loaded questions and/or questions carrying factual presuppositions (and thus not necessarily sound) are not ignored.

Remark 8. Speaking about implication usually presupposes a unique ›direction of flow‹. So, maybe, the term 'implication' is inaccurate for the semantic relation characterized by Definition (21). However, the term was coined in (Wiśniewski 1994a) and is in usage in the field.

Pure erotetic implication, $\mathbf{Im}^{\circ}$, is a binary relation between e-formulas/questions.

(25) Definition (Pure erotetic implication)

$\mathbf{Im}^{\circ}(Q, Q_1)$ iff

1. for each $A \in \mathrm{d}Q$: $A \Vdash \mathrm{d}Q_1$, and

2. for each $B \in \mathrm{d}Q_1$ there exists a non-empty proper subset Y of $\mathrm{d}Q$ such that $B \Vdash Y$.

Here is an example. The question:

(26) What is the breed of this cat: Bombay, European Shorthair, or some other?

implies the question:

11 It is not excluded – but also not required – that direct answers to an implied question are paired with singleton sets of direct answers to the implying question. In such a case we speak about *regular* erotetic implication.

(27) Is it a Bombay cat?

Clearly, $\mathbf{Im}^{\odot}(Q, Q_1)$ holds iff $\mathbf{Im}(Q, \emptyset, Q_1)$ is the case.

3.3.4 Erotetic Implication and Validity

The premises of an erotetic inference of the second kind comprise a question and, possibly, declaratives, while the conclusion is a question. As long as erotetic inferences of the second kind are considered, IEL proposes the following criteria of validity:

(C_3) (Transmission of soundness/truth into soundness).

If the initial question is sound and all the declarative premises are true, then the question which is the conclusion must be sound.

(C_4) (Open-minded cognitive usefulness).

For each direct answer B to the question which is the conclusion there exists a non-empty proper subset Y of the set of direct answers to the initial question such that the following condition holds:
($\Diamond$) if B is true and all the declarative premises are true, then at least one direct answer $A \in Y$ to the initial question must be true.

For a thorough discussion, see (Wiśniewski 2013:ch. 5).

A moment's reflection reveals that the first clause of Definition (21) of erotetic implication expresses in exact terms the idea that lies behind condition (C_3). The same holds true for the second clause of Definition (21) and condition (C_4).

Taken syntactically, an erotetic inference of the second kind is an ordered triple $\langle Q, X, Q_1\rangle$, where Q is the question-premise, X is the set of declarative premises, and Q_1 is the question-conclusion. As before, assume that Q and Q_1, as well as the elements of X, are expressions of a formal language for which erotetic implication has been defined. We put:

(28) Definition (Validity of an erotetic inference)

An erotetic inference $\langle Q, X, Q_1\rangle$ is valid iff $\mathbf{Im}(Q, X, Q_1)$.

The status of Definition (28) resembles that of Definition (20). Comments on the latter (cf. subsection 3.3.2) apply, *mutatis mutandis*, also to the former.

Remark 9. Condition (C_4) is worded semantically, but labelled in pragmatic terms. Note, however, that these are the semantic links between question-con-

clusion and the respective premises that make the question-conclusion cognitively useful. Suppose that the declarative premises are all true. Since each direct answer to the question-conclusion potentially decreases the class of ›options‹ offered by the question-premise, a true direct answer to the question-conclusion, if found, would actually decrease the class. But recall that each direct answer to the question-conclusion has a disposition to act that way. This is why we speak about "open-minded" cognitive usefulness.

Remark 10. Condition (C_4) and its formal counterpart, the second clause of Definition (21), are demanding, since *every* direct answer to the question-conclusion/implied question is required to possess the disposition mentioned above. One may argue that this is too much and that only some of them should do. Without going into details, let me only mention that experiments and corpora studies have shown that transitions to (auxiliary) questions which are useful in the open-minded way occur quite often (cf. Łupkowski et al. 2017, Łupkowski & Ginzburg 2016). Thus erotetic inferences being valid in the sense of Definition (28) are not artefacts.

3.3.5 Question-Evoking Rules and Question-Implying Rules

Once all the details, syntactic and semantic, of a formal language enriched with questions, are fixed, we are able to move from the semantic to the syntactic level. More precisely, we are able to show what questions (of a formal language considered) are evoked by what sets of d-wffs (of the language), and similarly for erotetic implication. 'What' means here 'of what syntactic form', since e-wffs are syntactic entities.

For instance, by using a proof method for FOL and a construction of countermodels, one can prove that the following (A, B, C are here metalanguage variables which vary over *atomic* sentences of a first-order language):

(29) $\mathbf{E}(\{A \wedge B \longrightarrow C, \neg C\}, ?\{\neg A, \neg B\})$

holds provided that $C \notin \{A, B\}$.[12] Observe that it is a metalogical statement. (29) together with the proviso may be used as the basis for the corresponding *question-evoking rule*, schematically displayed as follows:

12 We apply here the symbolism for questions described in section 3.2.1. The proviso amounts to the claim that A, B, C are pairwise syntactically distinct, as ¬A and ¬B are direct answers. Notice that it is important that A, B, C are supposed to be *atomic* sentences only; for obvious reasons, one cannot generalize (29) to all FOL-sentences.

(30) $$\frac{\begin{array}{c}A \wedge B \rightarrow C \\ \neg C\end{array}}{?\{\neg A, \neg B\}} \textit{ provided } C \notin \{A, B\}$$

Similarly, one can prove at the metalogical level that the following:

(31) $\mathbf{Im}(?\{A, B, C\}, \{D \rightarrow A \vee B, \neg D \rightarrow C\}, ?\{D, \neg D\})$

is the case for any FOL-sentences A, B, C, D.[13] This leads to the following *question-implying rule*:

(32) $$\frac{\begin{array}{c}?\{A, B, C\} \\ D \rightarrow A \vee B \\ \neg D \rightarrow C\end{array}}{?\{D, \neg D\}}$$

Remark 11. There are question-evoking rules that share premises, but not conclusions, and similarly for question-implying rules. For example, besides (29) we also have (under the same proviso):

(33) $\mathbf{E}(\{A \wedge B \rightarrow C, \neg C\}, ?\{\neg A \wedge B, A \wedge \neg B, \neg A \wedge \neg B\})$

and the corresponding question-evoking rule:

(34) $$\frac{\begin{array}{c}A \wedge B \rightarrow C \\ \neg C\end{array}}{?\{\neg A \wedge B, A \wedge \neg B, \neg A \wedge \neg B\}} \textit{ provided } C \notin \{A, B\}$$

Thus one can pass from $A \wedge B \rightarrow C$ and $\neg C$ to $?\{\neg A, \neg B\}$ or to $?\{\neg A \wedge B, A \wedge \neg B, \neg A \wedge \neg B\}$, in both cases performing a valid erotetic inference. In this respect IEL is neither worse nor better than Classical Logic and most of its non-classical

13 Since $?\{A, B, C\}$ is a question, A, B, C are supposed to be pairwise syntactically distinct. This time one does not have to restrict oneself to atomic sentences.

cousins. For instance, both B and $\neg(B \longrightarrow A)$ are conclusions of classically valid inferences whose premises comprise $A \vee B$ and $\neg A$.

3.4 IEL vs. Question Asking and Question Posing

From now on, I will be using the expression *interrogative rules* as a cover term for question-evoking rules and question-implying rules.

Interrogative rules, just like other logical rules, can be characterized set-theoretically. However, let me skip this issue here and concentrate upon their cognitive status.

First, and foremost: Interrogative rules *are not* rules which enable questions be proven. Questions as such can not be proven in any reasonable sense of the word 'proof'. IEL does not aim at proving questions.

Second, an agent who performs a valid erotetic inference (valid in the sense explicated above) need not be aware of the interrogative rule which lies behind the inference. Interrogative rules do not function as premises of erotetic inferences. Also, it is not the case that in order to perform a valid erotetic inference an agent has to ›calculate‹ the relevant rule(s) first.

Third, IEL differentiates between *question asking* and *question posing*. The crucial difference between them lies in the fact that a posed question, in contradistinction to an asked question, need not be uttered. In order to pose a question one has to ask the question to oneself. One may then ask an interlocutor the question, but it need not be externalised in this way. When looking for a (justified) answer to a posed question, we can attempt to find it on the basis of what we already know or believe, but we may also turn to an external source of information (a literature on the subject matter, a database, etc.) as well as to ask some interlocutor(s). Moreover, it is not always the case that a question asked and the question posed are identical. Questions asked by examiners or by crime investigators constitute classic examples here. Another feature that differentiates question asking from question posing is this: when we ask an interlocutor a question, we usually believe that he/she knows a satisfactory answer or is able to find such an answer. When we pose a question, we are not always convinced that we or available interlocutors are capable to answer the question. It happens that we pose questions of which we know or believe (rightly or not) that we and available interlocutors cannot manage to find satisfactory answers. Last but not least, sometimes questions are asked but not posed. Questions asked for courteous reasons only provide simple examples here.

Interrogative rules are rules of posing questions having some desired properties with respect to previously accepted (maybe only hypothetically) declarative premises and/or previously posed questions. Question-evoking rules pave the way for arriving at questions which are sound if the premises used are true, and

which are informative relative to the premises. Question-implying rules, in turn, facilitate arriving at questions which are sound relative to questions initially posed and the premises used, and which are cognitively useful in the sense explicated by the condition (C_4) above. This is not much, but still something.

However, one can expect more from a *logic* of questions. It should give an account of what questions *are to be* asked in a given cognitive situation. Moreover, it should shed light on question answering. IEL addresses these issues and proposes some solutions. But interrogative rules are not keys to the solutions offered.

3.5 The Decomposition Issue

Questions and questioning are closely intertwined with problem solving. One of the crucial principles which govern effective problem solving is the following:

(DP) (Decomposition principle).

> Decompose a principal problem (PP) into simpler sub-problems (SPs) in such a way that solutions to SPs can be assembled into an overall solution to PP.

When we are concerned with a problem definite enough to be adequately expressed by a question, its decomposition amounts, generally speaking, to finding an appropriate collection of auxiliary questions. A decomposition can be *static*, that is, resulting in finding a set of mutually independent auxiliary questions such that once *all* of them are answered, the initial problem is resolved. Yet, a more interesting case is that of *dynamic* decomposition that comes in *stages*: the consecutive auxiliary questions (which constitute the sub-goals of the next stage) depend on how the previous requests for information have been fulfilled. The main goal, determined by the principal problem, remains unchanged, but sub-goals are processed in a goal-directed way. Moreover, the erotetic decomposition principle:

(EDP) (Erotetic decomposition principle)

> Transform a principal question into auxiliary questions in such a way that: (a) consecutive auxiliary questions are dependent upon previous questions and, possibly, answers to previous auxiliary questions, and (b) once auxiliary questions are resolved, the principal question is resolved as well.

is observed.

IEL models static decomposition by using a semantic concept of *reducibility of a question to a set of questions* (cf. Wiśniewski 1994b). In particular, many feasibility

results have been proven (cf., e.g., Wiśniewski 1995:194–200 or Leśniewski & Wiśniewski 2001). As for dynamic decomposition, a basic tool of analysis is the concept of *erotetic search scenario*, introduced in (Wiśniewski 2003).

3.5.1 Erotetic Search Scenarios

Erotetic search scenarios (e-scenarios for short) are abstract entities. Let Q be a question and X be a (possibly empty) set of d-wffs. An e-scenario for Q relative to X can be defined either as a family of interconnected sequences of questions and d-wffs, or as a finite labelled tree, where the labels are questions and d-wffs. There is no room for presenting exact definitions here, so I will provide only an informal description based on the labelled trees approach.

The root of an e-scenario for question Q relative to a set of d-wffs X is labelled by question Q, being the *principal question* of the e-scenario. The leaves are labelled by direct answers to the principal question. Nodes of an e-scenario are labelled by questions or by d-wffs. For brevity, let us call the former e-nodes and the latter d-nodes. Questions labelling e-nodes different from the root – *auxiliary questions* of e-scenarios – enter them due to erotetic implication.[14] To be more precise, it is requested that each auxiliary question of a branch (i.e. a maximal path) must be erotetically implied by some question which labels a preceding node of the branch, the principal question included, possibly on the basis of some d-wff(s) which label preceding node(s) of the branch.

An immediate successor of an e-node different from the root is labelled either by a question or by a d-wff. In the latter case it is required that the d-wff is a direct answer to the auxiliary question which labels the node. Moreover, it is requested that each direct answer to the question labels some immediate successor of the e-node. If, however, an immediate successor of an e-node is an e-node, it is the only immediate successor of the first e-node. An auxiliary question of an e-scenario that labels a node whose immediate successors are labelled by direct answers to the question is a *query* of the scenario. Note that an e-scenario may involve auxiliary questions that are not queries. Each d-node is supposed to have at most one immediate successor. A d-wff which labels a d-node of a branch must fulfil at least one of the following conditions: (a) it belongs to the set X, (b) it is a direct answer to the auxiliary question which labels the preceding node of the branch, or (c) it is entailed by some wff(s) which label preceding node(s) of the branch. Observe that it is neither assumed nor denied that each d-wff in X labels some node. These which do are *declarative premises* of an e-scenario.

14 This is the main feature that distinguishes e-scenarios from epistemic erotetic search scenarios (cf. Łupkowski et al. 2018), in which relations between questions are determined by the epistemic erotetic logic of Peliš (2016).

Finally, it is requested that no direct answer to the principal question Q belongs to the set X, and that no auxiliary question is set-theoretically equivalent to Q, that is, the set of direct answers to it equals the set of direct answers to Q. Figures 1 and 2 display examples of e-scenarios. (To enhance readability, e-wffs of the form $?\{A \wedge B, A \wedge \neg B, \neg A \wedge B, \neg A \wedge \neg B\}$ are abbreviated as $?\pm|A, B|$.)

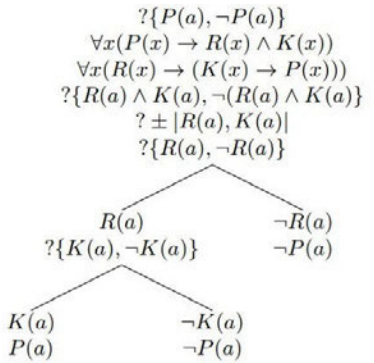

Fig. 1: An example of e-scenario for $?\{P(a), \neg P(a)\}$ relative to the set of d-wffs $\{\forall x\,(P(x) \longrightarrow R(x) \wedge K(x)), \forall x\,(R(x) \longrightarrow (K(x) \longrightarrow P(x)))\}$. ($P$, R, K are one-place predicates, while a stands for an individual constant.)

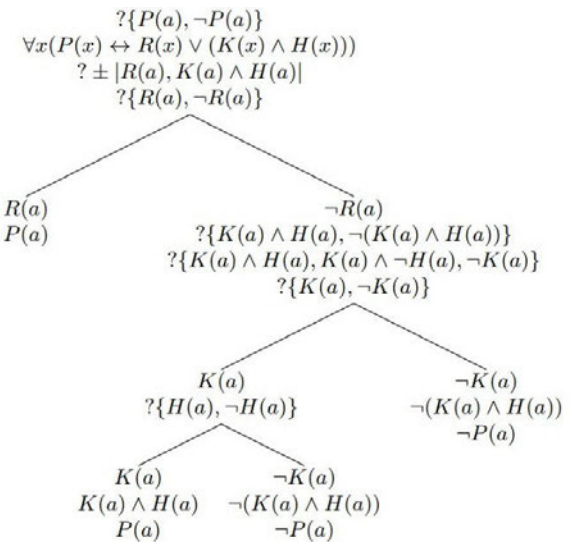

Fig. 2: An example of e-scenario for $?\{P(a), \neg P(a)\}$ relative to $\{\forall x\,(P(x) \leftrightarrow R(x) \vee (K(x) \wedge H(x)))\}$. ($P$, R, K, H are one place predicates and a stands for an individual constant.)

One can prove that if the principal question of an e-scenario is sound and all the declarative premises of the scenario are true, then the e-scenario has at least one ›golden path‹, i. e. a branch whose nodes are labelled by sound questions and true d-wffs. As leaves of an e-scenario are labelled by direct answers to the principal question, a ›golden path‹ leads to a true direct answer to the question.

IEL defines some operations on e-scenarios (cf. Wiśniewski 2013:ch. 11, Chlebowski et al. 2017), which produce e-scenarios from e-scenarios and enable their optimization. This makes possible an automation of e-scenario generation (cf. Chlebowski et al. 2017).

Looking from the pragmatic point of view, an e-scenario for a question Q shows what other questions are potentially worth to be asked in order to answer the question Q. Moreover, it provides us with instructions as to when they are advised to be asked. These instructions pertain to queries. Queries of e-scenarios are carriers of information requests. An e-scenario shows what is the first advisable query, and what is the next advisable query if the information request of a previous query has been satisfied in such-and-such way. The provided instructions are conditional: If one receives answer A_1 to query Q^*, query $Q_1{}^*$ should be asked next. If, however, one receives answer A_2 to Q^*, question $Q_2{}^*$ is the next recommended query, etc.. What is important, an e-scenario does this with regard to any possible way of satisfying the request of a query, where the ways are determined by direct answers to the question which expresses the query. Moreover, an e-scenario behaves in this manner in the case of each query of the e-scenario.

Thus the e-scenarios approach transcends the common schema of ›production of a sequence of questions and affirmations‹. The fact that information requests can be satisfied in one way or another is treated seriously: For any query and any possible way of satisfying the request carried by it there is an instruction concerning ›what to do next‹.

The execution of an e-scenario proceeds from top to bottom: One attempts to resolve the first query and then, depending on the answer received, moves to the query recommended by the e-scenario as the next one, and so forth until there is no further query. When an e-scenario is executed, instruction based on answers different from those actually got will not be activated.

E-scenarios were initially designed as tools which may be useful in formal modelling of problem solving.[15] But the range of applicability of the concept

15 There is no room for showing how the concept has been applied there. Let me only mention that the simple scheme: ›first design a scenario, and then execute it‹ is not the only one used. An interested reader is advised to consult (Wiśniewski 2013:ch. 13) for details.

occurred to be wider. It includes question answering, in particular answering with questions (cf. Wiśniewski 2014) as well as cooperative answering (cf. Łupkowski & Leszczyńska-Jasion 2015), and dialogue modelling in general (cf. Łupkowski 2016). Some applications of the concept in proof theory have also been found.

3.6 IEL meets Proof Theory

3.6.1 From IEL to Proof Theory

The method of synthetic tableaux (cf., e. g., Urbański 2001a, 2001b, Leszczyńska-Jasion & Chlebowski 2019) originates, in a sense, from considerations upon e-scenarios. Another example is provided in (Wiśniewski 2004a), where a proof system for Classical Propositional Logic, in which rules transform e-scenarios into e-scenarios, and proofs are conceived as sequences of e-scenarios, is presented. The philosophical idea that laid behind this, rather specific, proof format, was: In order to prove A, a systematic reflection on possible ways of reaching A which shows that reaching the opposite requires incoherent information, is sufficient. The approach presented in (Wiśniewski 2004a) has not been generalised to other logics, however.

The philosophical idea that lies behind another proof method grounded in IEL, the *method of Socratic proofs*, is different. There are problems which can be solved by pure questioning, that is, by transforming the relevant initial question into consecutive questions until a question which, for obvious reasons, can be rationally answered in only one way, is arrived at. Once this is achieved, a *Socratic proof* of a solution is found. The method of Socratic proofs gives an account of this idea in regard to logical problems concerning, for instance, entailment/derivability, validity/theoremhood, or inconsistency. How is it done? Erotetic calculi are proposed. A calculus of this kind consists of rules which transform questions into questions. There are no axioms. Instead, questions which, if arrived at, turn a transformation into a Socratic proof, are characterized in syntactic terms. An erotetic calculus is grounded in IEL, as it operates with rules which are question-implying rules. Since further general explanations would rather multiply doubts than dissolve them, let me give an example. The erotetic calculus briefly presented below deals with the negation-implication fragment of Classical Propositional Logic. We label this calculus with $\mathbb{E}^{\mathrm{CPL}}_{\neg,\rightarrow}$.

3.6.1.1 The Erotetic Calculus $\mathbb{E}^{\mathrm{CPL}}_{\neg,\rightarrow}$

For brevity, I will be more formal in this section than in the previous ones.

Let L be the language of Classical Propositional Logic (henceforth: CPL) with negation, $\neg$, and implication, $\rightarrow$, as the only primitive connectives. Wffs of L

are defined in the standard manner. The semantics of L is the usual one. A CPL-*valuation* is a mapping v of the set of wffs of L into the set of logical values, {**1**, **0**}, such that for any wffs A, B of L: (a) $v(\neg A) = \mathbf{1}$ iff $v(A) = \mathbf{0}$, and (b) $v(A \longrightarrow B) = \mathbf{1}$ iff $v(A) = \mathbf{0}$ or $v(B) = \mathbf{1}$. A set of wffs X of L *entails* a wff A of the language, in symbols $X \vDash A$, just in case there is no CPL-valuation that assigns **1** to all elements of X and assigns **0** to A.

Now let us consider expressions of the form:

(35) $S \vdash A$

where S is a (possibly empty) finite sequence of wffs of L, and A is a wff of L. Call them single-conclusioned sequents or *sequents* for short. The turnstile $\vdash$ does not occur in the vocabulary of L, so sequents are not wffs of L. However, they can be evaluated in terms of semantics of L. Let $[S]$ stand for the set of all the wffs of L which are terms of the sequence S.[16] We say that sequent $S \vdash A$ is CPL-*valid* if $[S]$ entails A.

Among sequents, the basic ones play a distinguished role. A sequent $S \vdash A$ is *basic* iff (a) A is a term of S, or (b) there exists a wff C such that both C and $\neg C$ are terms of S. Clearly, each basic sequent is CPL-valid, but not the other way round.

Rules of the erotetic calculus $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ operate on expressions of a language L*, which is built on top of L.

The vocabulary of L* includes the vocabulary of L, and the following signs: $\vdash$, ?, ~, &. Sequents are *atomic* d-wffs of L*. The set D of *d-wffs* of L* is the smallest set that includes all atomic d-wffs of the language and fulfils the following conditions: (a) if $\mathfrak{u} \in$ D, then '~$\mathfrak{u}$' $\in$ D; (b) if $\mathfrak{u}, \mathfrak{r} \in$ D, then '($\mathfrak{u}$ & $\mathfrak{r}$)' $\in$ D.

Questions (i.e. e-wffs) of L* are of the form:

(36) $?(S_1 \vdash A_1, \ldots, S_k \vdash A_k)$

where $S_1 \vdash A_1, \ldots, S_k \vdash A_k$ ($k \geq 1$) is a finite sequence of *atomic* d-wffs of L*, that is, of sequents. Each term of the sequence is called a *constituent* of the question.

The set of direct answers to (36) comprises the *affirmative answer*:

(37) $S_1 \vdash A_1 \,\&\, \ldots \,\&\, S_k \vdash A_k$

16 We need this technical notion, since it is neither assumed nor denied that S is a sequence without repetitions.

and the *negative answer*:

(38) $\sim (S_1 \vdash A_1 \,\&\, \ldots \,\&\, S_k \vdash A_k)$

The intuitive meaning of a question of the form (36) is:

(39) Is it the case that: $[S_1]$ entails A_1 and ... and $[S_k]$ entails A_k?

If a question has only one constituent, i. e. is of the form:

(40) $?(S \vdash A)$

its intuitive meaning is:

(41) Does $[S]$ entail A?

Questions of L* are expressions of a language built on top of L. They concern entailment in L, however. The syntax of L* is well-specified and thus L* itself is an object-level formal language, analogously as L is.

L* is supplemented with its own semantics. It is based on the concept of admissible partition.[17] A *partition* of D (i.e. of the set of d-wffs of L*) is an ordered pair:

(42) $\mathrm{P} = \langle \mathrm{T_P}, \mathrm{U_P} \rangle$

such that $\mathrm{D} = \mathrm{T_P} \cup \mathrm{U_P}$ and $\mathrm{T_P} \cap \mathrm{U_P} = \emptyset$. A partition $\langle \mathrm{T_P}, \mathrm{U_P} \rangle$ of D is *admissible* if it fulfils the following conditions:[18]

1. $\ulcorner S \acute{} A \longrightarrow B \acute{} T \vdash C \urcorner \in \mathrm{T_P}$ iff $\ulcorner S \acute{} \neg A \acute{} T \vdash C \urcorner \in \mathrm{T_P}$ and $\ulcorner S \acute{} B \acute{} T \vdash C \urcorner \in \mathrm{T_P}$;
2. $\ulcorner S \acute{} \neg(A \longrightarrow B) \acute{} T \vdash C \urcorner \in \mathrm{T_P}$ iff $\ulcorner S \acute{} A \acute{} \neg B \acute{} T \vdash C \urcorner \in \mathrm{T_P}$;
3. $\ulcorner S \acute{} \neg\neg A \acute{} T \vdash B \urcorner \in \mathrm{T_P}$ iff $\ulcorner S \acute{} A \acute{} T \vdash B \urcorner \in \mathrm{T_P}$;

17 Semantics of this kind are commonly used in IEL; cf. (Wiśniewski 2013:ch. 3).

18 The symbol ´ stands for the concatenation-sign for sequences of wffs of L. Thus $S \acute{} T$ is the concatenation of a sequence of wffs S and a sequence of wffs T. An expression of the form $S \acute{} A$ represents the concatenation of S and the one-term sequence whose term is A. Of course, $S \acute{} A \acute{} T$ is the concatenation of $S \acute{} A$ and T. The letters $\mathfrak{r}$, $\mathfrak{u}$ are metalanguage variables for d-wffs of L*.

4. $\ulcorner S \acute{} T \vdash A \longrightarrow B \urcorner \in \mathrm{T_P}$ iff $\ulcorner S \acute{} A \acute{} T \vdash B \urcorner \in \mathrm{T_P}$;
5. $\ulcorner S \vdash \neg(A \longrightarrow B) \urcorner \in \mathrm{T_P}$ iff $\ulcorner S \vdash A \urcorner \in \mathrm{T_P}$ and $\ulcorner S \vdash \neg B \urcorner \in \mathrm{T_P}$;
6. $\ulcorner S \vdash \neg\neg A \urcorner \in \mathrm{T_P}$ iff $\ulcorner S \vdash A \urcorner \in \mathrm{T_P}$;
7. $\ulcorner (\mathfrak{u}\ \&\ \mathfrak{r}) \urcorner \in \mathrm{T_P}$ iff $\mathfrak{u} \in \mathrm{T_P}$ and $\mathfrak{r} \in \mathrm{T_P}$;
8. $\ulcorner {\sim}\mathfrak{u} \urcorner \in \mathrm{T_P}$ iff $\mathfrak{u} \notin \mathrm{T_P}$.

Note that the above conditions are not *ad hoc*. Conditions 1–6 reflect the behavior of implications, negated implications, and double negated wffs in the context of entailment, while conditions 7 and 8 show that the L*-negation, ~, and the L*-conjunction, &, are classical.

A d-wff $\mathfrak{u}$ of L* *entails* a d-wff $\mathfrak{r}$ of L* iff there is no admissible partition $\mathrm{P} = \langle \mathrm{T_P}, \mathrm{U_P} \rangle$ of the set D of d-wffs of L* such that $\mathfrak{u} \in \mathrm{T_P}$ and $\mathfrak{r} \in \mathrm{U_P}$. Notice that this time we speak about entailment between d-wffs of L*, further on referred to as entailment *in* L*.

The erotetic calculus $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ has no axioms, but comprises the following rules:[19]

$$\mathrm{L}{\rightarrow}\ \frac{?(\Phi; S'A{\rightarrow}B'T \vdash C; \Psi)}{?(\Phi; S'\neg A'T \vdash C; S'B'T \vdash C; \Psi)} \qquad \mathrm{R}{\rightarrow}\ \frac{?(\Phi; S \vdash A{\rightarrow}B; \Psi)}{?(\Phi; S'A \vdash B; \Psi)}$$

$$\mathrm{L}{\neg\rightarrow}\ \frac{?(\Phi; S'\neg(A{\rightarrow}B)'T \vdash C; \Psi)}{?(\Phi; S'A'\neg B'T \vdash C; \Psi)} \qquad \mathrm{R}{\neg\rightarrow}\ \frac{?(\Phi; S \vdash \neg(A{\rightarrow}B); \Psi)}{?(\Phi; S \vdash A; S \vdash \neg B; \Psi)}$$

$$\mathrm{L}{\neg\neg}\ \frac{?(\Phi; S'\neg\neg A'T \vdash C; \Psi)}{?(\Phi; S'A'T \vdash C; \Psi)} \qquad \mathrm{R}{\neg\neg}\ \frac{?(\Phi; S \vdash \neg\neg A; \Psi)}{?(\Phi; S \vdash A; \Psi)}$$

A rule acts upon a constituent of a question with regard to an occurrence of a wff of L in the constituent. The resultant question differs from the initial question only in having one or two new constituents at the place where the initial question had the constituent affected. With the exception of rule $\mathrm{R}_{\neg\rightarrow}$, a new constituent differs from the constituent acted upon only in having a new wff or wffs at the place of the wff acted upon. As for $\mathrm{R}_{\neg\rightarrow}$, one new wff occurs just left of the turnstile, while the other replaces the implication acted upon. Side constituents of the constituent acted upon, Φ and Ψ, if non-empty, are transferred to the resultant question without changing their order.

19 As before, the letters *S*, *T*, *U*, *W* stand for finite (possibly empty) sequences of wffs of L, and ´ is the concatenation-sign for these sequences. The letters Φ, Ψ are metalanguage variables for finite (again, possibly empty) sequences of atomic d-wffs of L*, and the semicolon is used as the concatenation-sign for these sequences. One-term sequences are represented by their terms.

One can prove that each of the above rules ensures erotetic implication and thus is a question-implying rule. To see this, it suffices to observe that if question Q_1 results from question Q by a rule of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$, then the affirmative answers to Q_1 and Q entail (in L*) each other, and the negative answers to Q_1 and Q entail (again, in L*) each other.

Rules of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ enable the so-called Socratic transformations of questions of L*. A *Socratic transformation* of a question Q *via* the rules of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ is a sequence of questions $Q_1, Q_2, \ldots$ such that $Q_1 = Q$ and for each $i \geq 1$, Q_{i+1} results from Q_i by a rule of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$.

Given what has been said above, the following comes with no surprise:

(♡) Each step of a Socratic transformation, i. e. a transition from a question to the next one, is a valid erotetic inference.

In particular, this pertains to the so-called successful Socratic transformations. A Socratic transformation of a question Q via the rules of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ is *successful* if it is finite and each constituent of the last question of the transformation is a basic sequent.

Viewed in the perspective of semantics of the ›initial‹ language L, rules of the calculi $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ have the following property:

(♠) If question Q^* results from question Q by a rule of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$, then all the constituents of Q are CPL-valid iff all the constituents of Q^* are CPL-valid.

Now recall that basic sequents are CPL-valid. Thus, by (♠), all the constituents of the first question of a successful Socratic transformation are CPL-valid. So when a question which has only one constituent, i. e. of the form:

(43) $?(S \vdash A)$

happens to be Socratically transformed (via the rules of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$) *with success*, the sequent $S \vdash A$ is CPL-valid! One does not need any further calculations to establish its CPL-validity. It is established or ›proven‹ by performing a series of valid erotetic inferences, starting with an inference whose premiss is a yes-no question about CPL-validity of the sequent. Now recall that the last question of a successful Socratic transformation asks whether all the basic sequents involved are CPL-valid. But each basic sequent is CPL-valid due to general properties of entailment: Any wff is entailed by a set of wffs which contains the wff, and any wff is entailed by a set of wffs which contains contradictory wffs. In this sense the last question is a ›rhetorical‹ one.

All what has been said above leads to the concept of Socratic proof. A *Socratic proof* of sequent $S \vdash A$ in the erotetic calculus $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ is a successful Socratic transformation of the question $?(S \vdash A)$ via the rules of $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$. Notice that Socratic proofs are not proofs of questions, but proofs of sequents.

Here is an example of a Socratic proof of the sequent:

(44) $p \rightarrow (q \rightarrow r), q \vdash (p \rightarrow r)$

1. $?(p \rightarrow (q \rightarrow r), q \vdash (p \rightarrow r))$
2. $?(p \rightarrow (q \rightarrow r), q, p \vdash r))$
3. $?(\neg p, q, p \vdash r; q \rightarrow r, q, p \vdash r)$
4. $?(\neg p, q, p \vdash r; \neg q, q, p \vdash r; r, q, p \vdash r)$

One can show that each CPL-valid sequent made up of wffs of L is provable in $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$.

3.6.1.2 Other Erotetic Calculi

The erotetic calculus $\mathbb{E}^{\mathrm{CPL}}_{\neg\rightarrow}$ is a toy example. There exist erotetic calculi for full CPL (cf. Wiśniewski 2004b), First-Order Logic (cf. Wiśniewski & Shangin 2006, Chlebowski 2018), and for some non-classical logics. In particular, intuitionistic propositional logic (cf. Leszczyńska-Jasion 2021) and normal modal propositional logics have been dealt with (cf. Leszczyńska 2007, Leszczyńska-Jasion 2008, 2009, 2021), as well as some paraconsistent logics and logics of formal inconsistency (cf. Wiśniewski et al. 2005, Chlebowski & Leszczyńska-Jasion 2015). Needless to say, erotetic calculi dealing with logics other than mere negation-implication fragment of CPL have more complicated setups, both on the syntactic and the semantic level.

One can argue that the existence of erotetic calculi is nothing but a curiosity. A general philosopher might have replied by saying that their existence reveals the priority of questioning over answering. An analytic philosopher might have added that the existence of erotetic calculi sheds new light on analyticity of logic. A logician working on proof-search issues may find it interesting that proofs in the erotetic calculi format can be transformed into proofs in sequent calculi (cf. Leszczyńska-Jasion et al. 2013), proofs in the analytic tableaux format (cf. Leszczyńska-Jasion 2018), and Hilbert-style proofs (cf. Grzelak & Leszczyńska-Jasion 2018). Besides this, the method of Socratic proofs contributes to proof theory in other ways as well. A reader interested in details is strongly advised to consult the monograph (Leszczyńska-Jasion 2021). Last but not least, the method of

Socratic proofs has been applied in formal modelling of abductive reasoning (cf. Urbański & Wiśniewski 2015, Chlebowski & Gajda 2017).

3.6.2 Towards Proof-theoretic Accounts of Question Evocation and Erotetic Implication

The basic concepts of IEL, question evocation and erotetic implication, are semantic. As illustrated in subsection 3.3.5, one can move from the semantic level to the syntactic level by showing what questions are erotetically implied/evoked by what sets of wffs and/or questions, where 'what' means 'of what syntactic form'. As it has been shown in (Wiśniewski 2018), in many cases it is possible to ›extract‹ multiple conclusion-entailment, the basic semantic concept by means of which question evocation and erotetic implication are defined, from the consequence relation of the underlying logic of d-wffs. This, in a sense, grounds IEL in proof theory. However, one may argue as follows. Since validity of erotetic inferences is defined in terms of question evocation and erotetic implication, these concepts function in IEL analogously to the concept of entailment in other logics. It is natural to expect a proof-theoretic account of entailment. So one may expect the same for question evocation as well as for erotetic implication. Until now, there exist only a few logical calculi in which, generally speaking, formulas expressing question evocation, erotetic implication, or both, become provable (cf. Wiśniewski 1985, Meheus 2001, De Clercq & Verhoeven 2004, De Clercq 2005, Wiśniewski 2016, Millson 2019, 2021, Cordes 2020). These calculi differ in many respects. I will not comment here on their pros and cons. However, since work on the subject is, as a matter of fact, in an early stage, let me end this essay with some remarks which, I hope, clarify what ›providing a proof-theoretic account of question evocation and/or erotetic implication‹ aims at.

Let $\mathfrak{L}$ be an arbitrary but fixed formal language enriched with questions (that is, a language of the kind described in subsection 3.2.1), in which the set of d-wffs and the set of e-wffs are disjoint. $\mathfrak{L}$ is an object-level formal language. Assume that the language is supplemented with a semantics rich enough to define the concept of truth for d-wffs and the relation of multiple-conclusion entailment between sets of d-wffs of the language. This allows us to define question evocation and erotetic implication. However, they are semantic relations between d-wffs and e-wffs of $\mathfrak{L}$ defined on the metalanguage level. An object-level formal language usually lacks formulas by means of which relations defined in this way are directly expressed. A solution is to build a second formal language, say, $\mathfrak{L}^{\circ}$, being an extension of $\mathfrak{L}$. One can build such a language in a very simple manner. We extend the vocabulary of $\mathfrak{L}$ with a sign, $\Rightarrow$. The choice of $\Rightarrow$ is arbitrary;

any other sign can do. A reader is advised to suspend any associations he/she may have. Besides $\Rightarrow$, we also need in $\mathfrak{L}^{\circ}$ expressions which refer to sequences of d-wffs of $\mathfrak{L}$ or to sets (possibly multisets) of d-wffs of $\mathfrak{L}$. When we restrict ourselves to finite sets or sequences, this can be achieved relatively easy, by allowing lists of d-wffs of $\mathfrak{L}$ to be constituents of well-formed formulas of $\mathfrak{L}^{\circ}$. In what follows I assume that expressions referring to sequences/sets of d-wffs of $\mathfrak{L}$ occur in $\mathfrak{L}^{\circ}$. I will be using the letters Σ, Γ as metalanguage variables for such expressions. Q, Q_1, ... are supposed to vary over e-wffs of $\mathfrak{L}$.

Well-formed formulas (wffs) of $\mathfrak{L}^{\circ}$ fall into the schemata:

(45) $\Sigma \Rightarrow Q$

(46) $Q, \Sigma \Rightarrow Q_1$

(47) $\Sigma \Rightarrow \Gamma$

Let us now consider the following structure:

(48) $\langle \mathfrak{D} \cup \mathfrak{E}, \mathbf{d}, \models, \mathrm{E}, \mathrm{Im} \rangle$

where $\mathfrak{D}$ is the set of d-wffs of $\mathfrak{L}$, $\mathfrak{E}$ is the set of e-wffs of $\mathfrak{L}$, and $\mathbf{d}$ is a (possibly partial) function from $\mathfrak{E}$ to $\wp(\mathfrak{D})$. Intuitively, $\mathbf{d}$ is the answerhood function: $\mathbf{d}Q$ constitutes the set of direct answers to Q provided that Q belongs to the set of arguments of $\mathbf{d}$. The remaining items, $\models$, E, and Im, are multiple-conclusion entailment in $\mathfrak{L}$, question evocation in $\mathfrak{L}$, and erotetic implication in $\mathfrak{L}$, respectively.[20] The structure (48) is the *intended model* for $\mathfrak{L}^{\circ}$. Let us designate it by $\mathfrak{M}^{\circ}$. The truth conditions are ('$\mathfrak{M}^{\circ} \models \mathfrak{G}$' abbreviates '$\mathfrak{G}$ is true in $\mathfrak{M}^{\circ}$'):

1. $\mathfrak{M}^{\circ} \models \Sigma \Rightarrow Q$ *iff* $\mathrm{E}(|\Sigma|, Q)$.
2. $\mathfrak{M}^{\circ} \models Q, \Sigma \Rightarrow Q_1$ *iff* $\mathrm{Im}(Q, |\Sigma|, Q_1)$.
3. $\mathfrak{M}^{\circ} \models \Sigma \Rightarrow \Gamma$ *iff* $|\Sigma| \models |\Gamma|$.

When Σ is a sequence, $|\Sigma|$ is the set of all terms of the sequence. If Σ is a multiset, $|\Sigma|$ stands for the set of all its elements. If Σ is a set, then $|\Sigma| = \Sigma$.

We need two auxiliary notions.

20 These relations are construed here set-theoretically. Question evocation *in* $\mathfrak{L}$ is the subset of the Cartesian product of $\wp(\mathfrak{D})$ and $\mathfrak{E}$ such that for each ordered pair $\langle X, Q \rangle$ belonging to the subset, $\mathbf{E}(X, Q)$ holds. Similarly for erotetic implication in $\mathfrak{L}$, and mc-entailment in $\mathfrak{L}$.

(49) Definition

$\mathbf{Th}(\mathfrak{M}^{\circ}) =_{\mathrm{df}} \{\mathfrak{G} : \mathfrak{M}^{\circ} \models \mathfrak{G}\}$.

$\mathbf{Th}(\mathfrak{M}^{\circ})$ is thus the set of all the wffs of $\mathfrak{L}^{\circ}$ that are true in the intended model for the language.

(50) Definition

1. $\mathbf{T}_{\mathrm{qe}} = \{\mathfrak{G} \in \mathbf{Th}(\mathfrak{M}^{\circ}) : \mathfrak{G}$ *is of the form* $\Sigma \Rightarrow Q\}$.
2. $\mathbf{T}_{\mathrm{ei}} = \{\mathfrak{G} \in \mathbf{Th}(\mathfrak{M}^{\circ}) : \mathfrak{G}$ *is of the form* $Q, \Sigma \Rightarrow Q_1\}$.
3. $\mathbf{T}_{\mathrm{me}} = \{\mathfrak{G} \in \mathbf{Th}(\mathfrak{M}^{\circ}) : \mathfrak{G}$ *is of the form* $\Sigma \Rightarrow \Gamma\}$.

We are now able to clarify what a proof-theoretic account of question evocation in $\mathfrak{L}$ aims at. A logical calculus accomplishes the task just in case at least some (but ideally all) wffs from $\mathbf{T}_{\mathrm{qe}}$ become calculable by means of the calculus.[21] I intentionally use here the term 'calculable'[22] instead of 'provable', since the former is less loaded than the latter. At this moment I do not want to forejudge the proof format of a calculus. Speaking about becoming calculable presupposes only the existence of rules and, possibly, axioms of some kind or another. Both rules and axioms are supposed to be defined in purely syntactic terms.

One may expect from a logical calculus that provides an account of question evocation being erotetically homogenous, that is, have primary rules which operate only on formulas of the form $\Sigma \Rightarrow Q$ and axioms, if there are any, expressed by such formulas. But no calculus known in the literature is erotetically homogenous. Of course, homogenity of this kind is a matter of elegance only. After all, question evocation is defined in terms of entailment between d-wffs. A calculus whose rules operate, among others, on formulas different from these falling into the schema $\Sigma \Rightarrow Q$, simply reflects this fact. So ›mixed‹ rules, that is, rules involving in their antecedents both schemata of formulas of the form $\Sigma \Rightarrow Q$ and schemata of formulas of the form $\Sigma \Rightarrow \Gamma$ are acceptable, as well as subsidiary rules which do not operate with formulas of the form $\Sigma \Rightarrow Q$ at all. A minimal elegance requirement seems to be: At least one primary rule of a

21 Note that we do not require all the wffs from $\mathbf{T}_{\mathrm{qe}}$ be calculable by means of a calculus. Calculi which ›provide‹ all of them are *complete* w.r.t. the corresponding E. It is already known that in some important cases complete calculi do not exist (cf. Cordes 2020).

22 Borrowed in this context from Cordes (2020).

calculus has schemata of formulas of the form $\Sigma \Rightarrow Q$ both in the antecedent and in the consequent. But, again, even this is not mandatory.

Everything what has been said above on providing a proof-theoretic account of question evocation can be repeated, *mutatis mutandis*, in regard to giving such an account of erotetic implication.

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4 Justifying Questions: What Kinds, How, and Why

David Hitchcock

Abstract
The authors of 200 arguments for questions posed 19 types of questions, justified them in 62 different ways, offered a justification of the question for 50 different types of purposes, and posed the question for 49 different types of purposes. Further consolidation of the categories used in the analysis is desirable and possible. Of the six most commonly posed *types of questions*, only three (yes-no questions, select questions, and either-or questions) are at first glance capable of formal representation in an erotetic language of the sort described by Wiśniewski (1995, 1996, 2013), but all six (including also requests to explain, identify and find a means) can be represented formally using the interrogative operators devised by Kubiński (1980). As for the *types of justification*, four passages argued *against* posing a question by denying one of its presuppositions, a strategy that implies that a question without a true answer is not worth posing. Only 20 passages, however, argued *for* a question by asserting a presupposition – typically in cases where their addressees might think that the premissed presupposition is false. Close analysis of five passages randomly selected from the 200 turned up four distinct conditions assumed to be necessary for a question to be worth posing: absence of a false presupposition, a way of working out a correct answer, an unbiased answerer, and a need to answer the question. The first three of these conditions can generally be presumed to be satisfied, and would need to be mentioned in justifying a question only if there was a suspicion that they were not. The fourth condition, a need to answer the question, typically *does* need to be established, and was the genus of the types of justification identified in half of the passages arguing for a non-rhetorical question. The dominant *purpose for justifying a question*, found in 111 of the passages, was to establish a need to answer the question; given that justifying a question typically amounts to establishing a need to answer it, this purpose is internal to the practice. The most common generic *purposes for posing* the question for which an author

argued were to provoke thought, to introduce subsequent discussion of the question, to indirectly claim something (in the case of rhetorical questions), to issue a challenge, and to seek enlightenment.

4.1 Introduction

People sometimes argue for questions (Hitchcock 2019, 2020). In ground-breaking work, Andrzej Wiśniewski (1995, 1996, 2013) has developed a logic of two kinds of semantic relations that validate inferences to questions, which he calls "evocation" and "erotetic implication". On Wiśniewski's account, a set of statements *evokes* a question if and only if both (1) it entails that the question has at least one true direct answer and (2) it does not entail any direct answer in particular. A question along with a possibly empty set S of statements *erotetically implies* a question if and only if both (1) the set S entails that the implied question has a true direct answer if the implying question does and (2) the implied question along with the statements in S narrows down the search space for the implying question, in the sense that for each direct answer p to the implied question the union of its unit set $\{p\}$ and the set S entails that a proper subset of the direct answers to the implying question contains a true direct answer. Wiśniewski applies these criteria to what he calls "erotetic languages", which have an assertoric part that is any formal language of the usual kind and an erotetic part in which all questions are closed in the sense of having well-defined sets of direct answers.

A search on the Web for natural-language arguments to which Wiśniewski's logic could be applied turned up several examples of arguments for a question from one or more statements (Hitchcock 2019). Most of those arguments were arguments for an open-ended why- or how-question that could not be represented as the set of its direct answers. Nevertheless, it was possible to articulate Wiśniewski-type criteria of inferential validity that were directly applicable to these natural-language arguments, without representing their structure in a formal language.

There are however some reasons to doubt Wiśniewski's criteria for evocation. In the first place, among the 17 arguments for questions discussed in (Hitchcock 2019), five had premises that seemed relevant but made no contribution to satisfying Wiśniewski's criteria. They were all arguments for open-ended why-questions, with a single premiss whose force was to show that the phenomenon for which an explanation was requested is unexpected (Hitchcock 2019:35).

In the second place, Moritz Cordes (2020) has shown that it is impossible to set up a calculus for classical first-order evocation, since the existence of such a calculus would entail the decidability of first-order logic. In the light of this deficiency, Cordes reconsiders Wiśniewski's criteria for an adequate formal explication of the informal concept of the arising of a question Q from a set X of statements, which are as follows:

1. No direct answer to Q belongs to X.
2. No direct answer to Q is entailed by X.
3. If all the formulas in X are true, the question Q must have a true direct answer.
4. Each presupposition of Q is entailed by X. (Wiśniewski 1995:12)

Cordes raises no objection to the first and last of these criteria. He thinks however that in natural-language discourse a question might arise from a set of statements that entail (but do not include) a direct answer to the question, and a question might arise in circumstances where it is not knowable in advance whether the question has a true direct answer.

As a contribution to reflection on the logic of inferences to questions, I propose to collect and examine some natural-language arguments for questions. The sample constitutes a database against which accounts of evocation and of erotetic implication can be tested for their applicability and for their fit with our intuitive judgments. In particular, I propose to consider four questions about the arguments in the sample:

1. For what kinds of questions do people provide arguments?
2. How do people infer questions?
3. Why do people justify raising questions?
4. Why do people raise the questions for which they provide justifications?

I will explore the normative implications of this descriptive information.

4.2 Method

I used Google's search engine to look for attempts to justify a question. As search terms, I used a combination of (1) a phrase that sometimes indicates an inference to a question (such as "so who" or "hence do" or "thus the question") and (2) the name of one of 27 topics taken by stratified random sampling from the Wikipedia article *Wikipedia:List of controversial issues* (en.wikipedia.org/wiki/Wikipedia:List_of_controversial_issues, accessed 2020-04-12).

For each argument in the sample, I entered in a spreadsheet its serial number, the conclusion indicator used in the search for it (e.g. 'so'), the interrogative

word or phrase used in the search for it (e.g. 'why'), the topic used in the search for it, the type of question argued for, the type of justification of the question, the author's purpose for justifying it, the author's purpose for posing it, a hyperlink to its page on the Web, and the date of access. This information is contained in (Hitchcock 2021b). The passages that I analyzed are in (Hitchcock 2021a).

I used my judgment to determine whether a passage was an argument for a question, what type of question was being posed, how it was being justified, why the author was arguing for the question, and why the author was posing it. After entering the data, I consolidated similar distinct types of questions and of justifications. The following example (passage number 32) illustrates the procedure:

> "Anyone who saw the courtroom scene during the trial of Adolf Eichmann will never forget when a cry for justice resounded from the ranks of the onlookers. Life nudges us in our consciences with its still, small voice that justice must be done if not in this world, then in the world to come. Hence, the question rages in our hearts whether death ends that possibility for justice-or guarantees it." (Zacharias 2004:96)

I interpreted this passage as an argument for the question: Does death end or guarantee the possibility for justice? I classified this question as an either-or question; the author's way of justifying it as appeal to a need to answer the question; the author's purpose in offering an argument for the question as to establish a need to answer the question; and the author's purpose in posing the question as to provoke interest.

4.3 The Sample and Its Analysis

I found 200 arguments for questions. These arguments are unrepresentative in many respects of the entire universe of attempts over all time in all human symbolic communication to justify posing a question. They are exclusively or almost exclusively (a) written (b) Web-accessible, (c) in English (d) on controversial topics, (e) produced in the first two decades of the 21st century of the Common Era, and (f) with local references if any to Canada or the United States. Their written form explains the small number of cases (10, or 5%) in which the questioner poses a question in order to find out from an addressee something that the questioner does not know. Nevertheless, given the variety of topics and the varied types of sources, the sample is likely to include the common types of questions that people try to justify, the common ways in which people try to justify posing a question, the common purposes that they have for providing such a justification, and the common purposes that they have for posing a question for which they argue.

The identification of the 200 passages as attempts to justify a question must be regarded as tentative and preliminary. So must the four-way classification of these attempts. Ideally, both the identification and the classification would use procedures like those used in (Hitchcock 2001, 2009) and in (Łupkowski & Ginzburg 2016). Despite its preliminary and tentative character, however, the present sample and its analysis can be used as a reference point for working out or testing (1) what kinds of questions people try to justify, (2) in what ways one can justify posing a question, (3) for what purposes someone might try to justify a question, and (4) for what purposes one might pose a question after trying to justify it. In what follows, I offer some reflections on each of these four questions.

4.4 Types of Questions

The questions posed were of 19 types, shown in Figure 1. The seven most common types, with their frequency and an example (with its passage number), were as follows:

1. rhetorical (17.5%): How could these sexual categories be rooted in our genome? (55)
2. yes-no (15%): Should beliefs aim at truth? (195)
3. explain (14%): Why *do* people submit to rule? (176)
4. select (12.5%): Which discipline should be removed to allow women's canoeing to be part of the Olympics? (170)
5. identify (12%): Who is entitled to the name of citizen? (102)
6. either-or (8.5%): Does death end the possibility for justice or guarantee it? (32)
7. means-finding (6.5%): How can the Catholic Church foster vocations? (158)

The footnote to Figure 1 lists the remaining 12 types with their frequency. Examples of these 12 types can be found by consulting (Hitchcock 2021b) and then (Hitchcock 2021a).

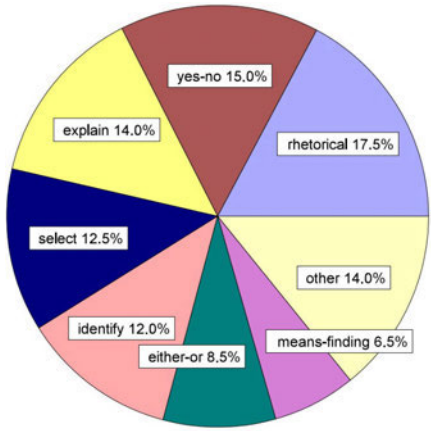

Fig. 1: Types of questions posed in the 200 attempts to justify posing a question.[1]

The most common questions in the sample, rhetorical questions, are so classified on the basis of their pragmatic role as indirect assertions, indirect recommendations, or the like. Syntactically and semantically, they fall into the other types of questions found in the sample. Of the six other common types listed above, Wiśniewski's (1995, 1996, 2013) erotetic languages seem capable, at least at first glance, of representing formally only three: yes-no questions, select questions, and either-or questions. Using Kubiński's (1980) schemes with interrogative operators, one can represent:

- yes-no questions by the scheme $[\alpha]\alpha\varphi$,
- select and identify questions by his scheme $Cz_i\varphi z_i$ or $(1)z_i\varphi z_i$, and
- either-or questions by his scheme $[\beta^n]\beta^n\varphi_1, \varphi_2$.

The either-or questions in the sample all assumed that the alternatives were mutually exclusive, an assumption that could be accommodated by using the scheme $[\beta^n]\beta^n\ \varphi_1 \wedge \neg\varphi_2, \varphi_2 \wedge \neg\varphi_1$. There are prospects for representing explain questions and means-finding questions by Kubiński's schemes.

1 There were 12 uncommon "other" types of questions: infer and predict (2% each); describe, inventory and quantify (1.5% each); degree, evaluate, justify and recommend (1% each); and analyze, criterion and discover (0.5% each).

4.5 Ways of Justifying Posing a Question

I identified 62 distinct types of justification, shown in Figure 2. The eight most common types, with their frequency and an example (with its passage number), were as follows:

1. elimination of alternatives (14%): In his lecture "Politics as a Vocation," he [Max Weber–DH] argues, "The decisive means for politics is violence" (Weber 1919b, p. 121). However, as we have seen above, power is not always exercised through the use of force. Nor would a modern sociologist accept that it is conferred through a mysterious "contract" with the sovereign, as Hobbes argued. Therefore, why *do* people submit to rule? (176)
2. presupposition (10%): Gay men make up only a fraction of the US population – yet Ward says that there are many men not included in that number who engage in homosexual behavior. Why, then, do some men who have sex with men identify as gay, and others identify as heterosexual? (54)
3. apparent conflict (8.5%): Continuity imports certain unity; continuum is truly that whose terminal [sic] are one; out of the other parts the quantity imports the plurality of parts or multiplicity; it is being seen as to have contradiction; hence, it raises the question: How are the parts in continuity: in act or in potency? (33)
4. need (7%): Also there "being" is usually reserved for biological entities – and so it raises the question of non-biological minds, a distinction [sic] possibility in most traditions. (20)
5. prior question (7%): Another fundamental question is who should have to pay the bill – and hence who should buy the insurance – when semi-autonomous or fully-autonomous vehicles are involved in accidents. (93)
6. cause to effect (6%): Like the Ottomans, what country did Pahlavi choose to support during WWII and, consequently, who occupied Iran after the war? (148)
7. obstacle to goal (5.5%): Needless to say, new technologies often produce new kinds of information that may not have been directly associated with the traditional maintenance methodologies. Therefore, how to integrate this new information into maintenance planning to take advantage of the new technologies has become a big challenge for the research community. (115)
8. analogy (3.5%): Interestingly, solar is the major technology in distributed energy generation, so the growth of solar means a major shift in the architecture of the energy grid, potentially. With energy storage growing, we have a real potential for a distributed energy grid (as opposed to current centralized grid that benefits mega-users and utilizes [sic]). Consequently, do the powers that be get to remain? Or do we go the route of the cell phone,

and cut those landlines/get rid of payphones/and give everyone the right to own their energy? (186)

The footnote to Figure 2 lists the remaining 54 types with their frequency. Examples of these 54 types can be found by consulting (Hitchcock 2021b) and then (Hitchcock 2021a).

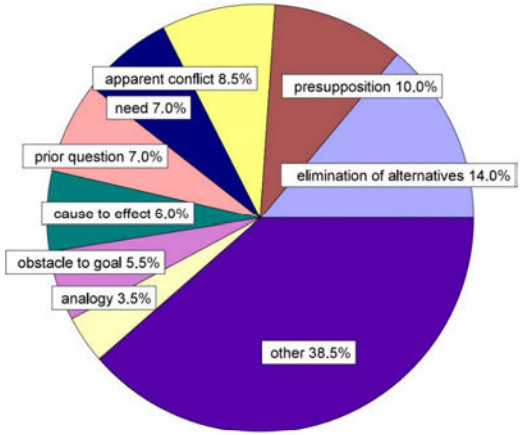

Fig. 2: Types of justification in the 200 attempts to justify a question.[2]

There is obviously a need to consolidate the 62 types of justification of a question identified in this sample into a smaller number of categories on the basis of theoretically defensible principles of division. A first main division is between

2 There were 54 uncommon "other" types of justification: criteria to evaluation and end to means (2% each); criteria to recommendation, existence of alternatives, explanatory gap, non sequitur (i.e. no discernible justification), and rejection of alternative (1.5% each); disagreement, establishment of goal, general to particular, goal already achieved, precedent, presupposition + need, and rejection of presupposition (1% each); and absence of information, alternatives to accepted answer, anticipated benefit, biased sample, borderline case, correlation without sequence, criteria to classification, effect to cause, elimination of likely objections, establishment of alternatives, evaluation by criterion, existence of opportunity, existence of variation, fiscal calculation, goal and initial conditions, interpretation of document, interpretation of prior question, interpretation of text, interpretive adequacy, itemization of present factors, lack of enough data, modus tollens, narrowing of question, necessary condition absent, need to block, need to narrow down, Peircean abduction, population to sample, prevention by prior actions, principle to policy, prior answer, probability, public interest, reason for negative answer, sign, slippery slope, spatial matrix, specification of goal, universal instantiation, and whole to part (0.5% each).

justification by a prior question and justification by statements. In considering how to sub-divide the latter class, it turned out to be helpful to start with four passages in the sample that argued *against* posing a question.

All four of the arguments against questions (in passages 25, 84, 88, and 195) alleged that a presupposition of the question was false. Something is a presupposition of a question if and only if its truth is a necessary condition for the question's having a true direct answer (Belnap 1966:610). Thus the falsehood of a presupposition of a question is a sufficient condition for the question to lack a true direct answer. Hence there are good theoretical grounds for regarding the falsehood of a presupposition of a question to be a sufficient reason for rejecting posing the question.

Contrapositively, it is a necessary condition for it to be correct to pose a question that (ontically speaking) all its presuppositions are true or (epistemically speaking) that the questioner is justified in thinking that all its presuppositions are true. This condition does not necessarily mean, however, that showing that a question is correct involves explicitly asserting that its presuppositions are true. The person trying to show that a question is correct can generally count on the addressees knowing or presuming that the question's presuppositions are true. In that case, an inferentially good argument for a question need not have a premiss that asserts the truth of its presuppositions. It is therefore not surprising that only 20 of the 200 arguments in the sample (i.e. 10% of them) argue for a question by asserting one of its presuppositions, typically where the question has a presupposition that the addressees might think is false.

Other than asserting a presupposition, how else do arguers try to justify questions? In an attempt to get at underlying theoretical commonalities, I made a detailed analysis, using a general conception of consequence (Hitchcock 2011:209, 2017:130), of five passages randomly selected from the 200 in the sample (passages 5, 49, 105, 144, and 174). This analysis led to the conclusion that, according to their authors, an acceptable question:

- has no false presuppositions (5),
- can be answered correctly (144),
- can be addressed by its answerer without influence by irrelevant bias (105), and
- needs to be answered (49, 174).

I hope to publish a longer paper with details of this derivation. Analogous careful scrutiny of other passages in the sample may elicit more candidates for components of question-acceptability (i.e. deserving to be posed).

If this list constitutes at least part of the acceptability of a question, what does it take to justify a question (i.e. to show that it deserves to be posed)? The first three of these conditions can be presumed to hold of any question, unless there is some reason to suspect otherwise. Thus arguments that appeal to these conditions are offering, in terms of Toulmin's (1958) model for the layout of arguments, a *counter-rebuttal* rather than grounds for posing the question. Only the fourth condition, a need to answer the question, constitutes grounds. Thus the typical way to justify posing a question should be to provide evidence that it needs to be answered.

How well do the 200 arguments in the sample fit this conception? Let us consider the eight most common types of justification listed at the beginning of this section: elimination of alternatives, presupposition, apparent conflict, need, prior question, cause to effect, obstacle to a goal, analogy. We can set aside justification by a prior question, which belongs to the other main division of justifications of posing a question. We can also set aside justification by analogy, since all but one of the arguments from analogy were arguments for rhetorical questions, and thus for claims (made implicitly by asking the rhetorical question) rather than for questions. We have identified lack of a false presupposition as a means of justifying a question in situations where there is reason to suspect that the question has a false presupposition. That leaves five ways of justifying a question by statements: elimination of alternatives, apparent conflict, need, cause to effect, obstacle to a goal. Four of these appear to be forms of evidence of the fifth: a need to answer the question. Eliminating answers that the addressees might spontaneously give shows that there is a need to discover the correct answer. An apparent conflict raises the question of how to resolve it. Appeal to a cause shows a need to explore its effects. An obstacle to achieving a goal indicates a need to figure out how to get around the obstacle. Thus, aside from analogy and a prior question, the most common types of justification in the sample fit the conception of how one justifies a question that has emerged from a detailed analysis of five passages chosen at random from the sample.

What are the prospects for representing formally the structure of arguments that successfully refute or justify posing a question on the basis of statements? Rejection of a question, I have suggested, follows logically from denial of a presupposition of the question. The form of such a refutation would be something like the following: $Sound(Q) \longrightarrow p, \neg p \vDash {\sim}Q$ (where Q is a question, p is an assertoric sentence, $Sound(Q)$ means that Q has a true direct answer, and ~Q is to be read as 'Q is not to be posed'). As for justification of a question by assertions, it seems possible to represent formally an assertion that a question needs to be answered. But representing formally each of the ways in which it

can be established that a question needs to be answered seems a daunting task. As to the three types of counter-rebuttals, if one can identify from the form of a question the form of a presupposition that entails all its other presuppositions, then one can represent formally an inference from a question's presupposition to posing the question, as something like: $p \longrightarrow \mathit{Sound}(Q), p \vDash Q$. It seems difficult to represent formally that there is a way to work out an answer to a question or that the person who is going to answer the question can do so in an unbiased way.

Of the 14 passages classified as arguing to a question from a prior question, in only four (99, 123, 156, 179) does the author derive a question from an initial question in the way envisaged by Wiśniewki's erotetic implication: by narrowing the search space for an answer to the original question. Eight passages that argue to a question from a prior question (89, 93, 94, 96, 106, 107, 116, 121) take the correct answer to the prior question to answer the posterior question, thus reversing the order of inquiry from that envisaged by Wiśniewki's erotetic implication. In the remaining two passages, the implied question is a rephrasing (104) or specification (105) of the implying question, meant to bring out what the implying question amounts to. Each of these three ways of justifying a question by a question seems legitimate, and capable in principle of being represented formally.

4.6 Purposes for Justifying Posing a Question

I identified 50 distinct purposes for justifying posing a question, shown in Figure 3. The two most common types, with their frequency and an example (with its passage number), were as follows:

1. establish need to answer question (55.5%): The beauty of the Olympics is every sport is very different – so which should you pick to compete in? (167)
2. justify implicit assertion (15.5%): It's rumored that an average student spends 51 minutes on the Facebook everyday. If you're at Stanford, then you still have to attend classes, write reports, submit homework and take exams. So, where exactly do those 51 minutes come from? They come from time you would presumably have otherwise allotted for social activities. Accordingly, aren't social networking sites actually making us more anti-social? (50)

The footnote to Figure 3 lists the remaining 48 types with their frequency. Examples of these 48 types can be found by consulting (Hitchcock 2021b) and then (Hitchcock 2021a).

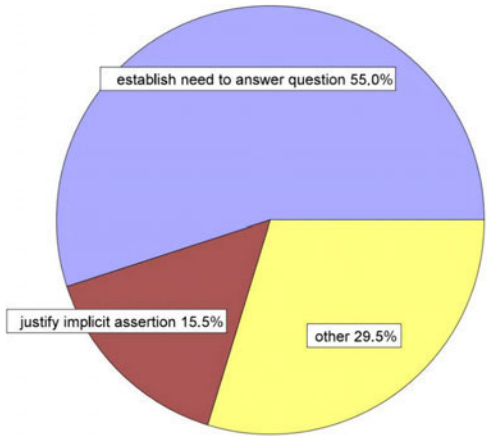

Fig. 3: Purposes for justifying posing a question in the 200 attempts to justify a question. All but one of the questions justified in order to justify an implicit assertion were rhetorical questions.[3]

The strong dominance of establishing a need to answer the question fits the account in the last section of how one justifies posing a question: typically, by showing that there is a need to answer the question. Thus the purpose most commonly identified for justifying a question is not an extrinsic purpose of its justification but is what justifying a question amounts to in these passages.

3 There were 48 uncommon "other" purposes for justifying a question: establish question to be answered, make transition (a non sequitur) (1.5% each); establish reframing of question, establish there is a question, indicate reason for puzzlement, justify implicit recommendation, narrow question to be answered, provide basis for asking, provide basis for challenge (1% each); clarify wording of a previous question, disambiguate a question, eliminate past basis, establish basis for answering question, establish case for further investigation, establish framework for a question, establish framing of legal question, establish hypothesis as possible, establish interest in question, establish legitimacy of question, establish need to justify a demand, establish possibility, establish sub-question, establish that question remains, establish the alternatives, establish the prior question, explain basis for answering, explain how to answer question, explain meaning of title of talk, explain underlying cause, explain why question arose, goal question to intermediate question, institute thought experiment, justify a project, justify alarm, make answer to question obvious, make precise the question at issue, motivate consideration of alternative, motivate question, none (reason from interlocutor), provide basis for addressing question, provide basis for dissent, provide explanatory basis, reframe question to be answered, refute need to answer question, show basic question answered, show that question will arise, show what someone's question is, situate in larger project (0.5% each).

The next most commonly identified purpose, justifying an implicit assertion, was identified almost exclusively in arguments for rhetorical questions; it is constitutive of asking a rhetorical question rather than extrinsic to it. The "other" purposes for justifying a question were identified rarely – in three, two or just one passage. They can however be grouped into broader categories. Several are variants of the purpose of establishing exactly what question is to be posed. Others seem more like purposes for posing the question than purposes for offering a justification for posing it.

4.7 Purposes for Posing a Question

I identified 49 distinct purposes for posing a question, shown in Figure 4. The 11 most common types, with their frequency and an example (with its passage number), were as follows:

1. indirectly assert (14%): Why should we be surprised that the liturgical apprehension of Holy Week's approach – the edgy tone of the readings, for instance, and the muting of church decoration – would be reflected in our own lives, in my own life? (149)
2. provoke interest (14%): It [the Paris agreement, DH] raises the question of discriminating extreme events between those influenced and not influenced by climate change. (100)
3. provoke thought (13%): What role could there be for the government in case the amount of the damage caused by the disaster is higher than normal insurance policies would be able to cover? (98)
4. challenge (7.5%): How can nothing create everything from nothing and out of nothing? (34)
5. introduce answer(s) (6%): How can we start to explain the marked association between smoking and mental health? (181)
6. set research agenda (5.5%): We must first inquire into the nature of a citizen. (102)
7. introduce discussion (5%): Why was the process of proletarianization in Africa so incomplete? (198)
8. introduce possible answers (3.5%): What is inherently good about human finitude and the natural life cycle with its rhythm of rise and fall? (113)
9. frame the discussion (3%): How to validate algorithms if a realistic analytic analysis is not possible any longer? (175)
10. request information (2.5%): Aren't Bengalis Aryans? (15)
11. solicit answer(s) (2.5%): May I buy the vehicle there, possess the title place in my title, but have the vehicle towed house [sic] and kept off the road

> until I will add insurance and it together and acquire my very own tickets? Or is it illegal to tow a vehicle without insurance about [sic] it? (155)

The footnote to Figure 3 lists the remaining 38 types with their frequency. Examples of these 38 types can be found by consulting (Hitchcock 2021b) and then (Hitchcock 2021a).

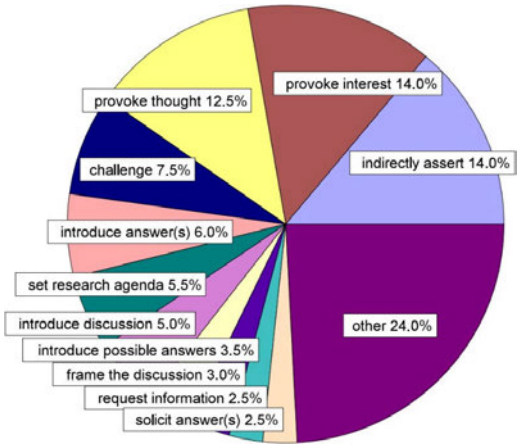

Fig. 4: Purposes of posing the 200 questions in the sample of attempts to justify a question.[4]

The heterogeneity of purposes for posing a question is somewhat superficial, since many of them can be grouped into five broad categories.

The most common of these broad categories was that of *provoking thought* in the reader about the question, which encompasses the following specific purposes: frame the discussion, prompt investigation, provoke discussion,

4 There were 38 uncommon "other" purposes identified for posing a question: indirectly recommend (2%); provoke discussion and *reductio ad absurdum* (1.5% each); introduce reflection, make a suggestion, and suggest investigation (1% each); (n/a: argument is vs. posing), basis for more argument, define problem, describe someone's dilemma, encourage action, endorse others' curiosity, explain failure, guide court decisions, indirectly deny, initiate argument, initiate decision-making, initiate research, introduce interpretation, motivate discussion, offer it as analysis, prompt investigation, provoke consideration, provoke reaction, provoke reflection, provoke response, provoke suggestions, raise objection, reveal a problem, secure premise, sensitize to the question, set agenda for a study, suggest an answer, suggest more research, suggest research agenda, suggest search strategy, support proposed answer, test knowledge (0.5% each).

provoke interest, provoke thought, set research agenda, suggest investigation. Collectively, these purposes were identified in 38% of the passages.

The second most common broad category was that of provoking interest in the questioner's immediately following discussion of the question, i. e. *introducing a subsequent discussion* of the question, which encompasses the following specific purposes: introduce an answer or answers, introduce discussion, introduce an interpretation, introduce possible answers, introduce a reflection, make a suggestion, support a proposed answer. Collectively, these purposes were identified in 17.5% of the passages.

An equally common broad category was that of *indirectly claiming* something, found in the rhetorical questions, whose authors were identified as "asking" the question for the following more specific purposes: indirectly assert, indirectly deny, indirectly recommend, secure a basis for more argument, make a suggestion, provoke a response. These purposes were identified in the 35 passages (17.5%) with justifications for rhetorical questions.

The purpose of *challenging* the addressee or a third party to defend their deeds or words was identified in 7.5% of the passages.

The purpose of requesting the addressee to provide an answer not known to the asker, which we might label '*enlightenment*', was identified in 10 (5%) of the passages, in two forms: requesting information, soliciting an answer or answers.

One purpose for asking questions that is common in everyday life (especially in teaching) but occurred only once in the sample is that of *testing knowledge*.

4.8 Summary

For a summary, see the abstract at the beginning.

Acknowledgements

I thank Andrzej Wiśniewski for helpful correspondence after the September 2020 conference on asking and answering, and in particular for translating for me a passage where he distinguishes asking a question from posing a question (Wiśniewski 1990:123) and for referring me to a distinction made by Ajdukiewicz (1974:92) between posing a question seriously and merely thinking about a question. I thank also Moritz Cordes for having organized the conference and having invited me to participate, and for his review of the penultimate draft of this chapter. I thank as well my fellow conference participants who made helpful comments and questions in response to my presentation of an earlier version of this chapter at the conference: Moritz Cordes, Catherine Hundleby, Manfred Krifka, Dorota Leszczyńska-Jasion, Lani Watson, and Andrzej Wiśniewski.

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4A Justifying Questions: A Key to Understanding Inferences Involving Questions?

Victoria Oertel

Formalizing fragments of ordinary language requires a formal language rich enough to accommodate all the relevant components of which the given fragment is composed of. Logicians have proposed several frameworks to provide means of formalizing types of questions. In the above paper, as well as in previous publications (Hitchcock 2019, 2020), David Hitchcock takes a step back and examines natural language questions accompanied by justificational passages he found via a web search – with the aim of scrutinizing the applicability of Andrzej Wiśniewski's criteria for evocation and erotetic implication in informal contexts. Other than that, this procedure contributes to an understanding of the rules that ordinary English imposes upon authors (and addressees) of questions.

Two remarks: Firstly, while Hitchcock distinguishes several types of questions, justifications and purposes, he does not draw a connection between them in his paper. Secondly, he divides the class of questions/justifications on different grounds in a more or less intuitive manner. While both of these methodological remarks could be conceived as statements hinting at deficiencies, I actually want to utilize them to uncover a potential that could lead to further investigations and insights on inferences involving interrogative speech. As it turns out, the manner in which types of and justifications for questions can be classified rests on the different ways/degrees of an interpretor's understanding of the language items. To render this plausible I will first distinguish between grammatical/structural and semantic understanding based on a fine-grained account of understanding due to Friedrich Reinmuth. In the next step, I will give reasons for a link between, on the one hand, these two aims of understanding and, on the other, the separation of perlocutionary effects from illocutionary acts. Thirdly, I will provide a reading of the data Hitchcock collected, utilizing an interpretation of the most common question types as categories that are based on perlocutionary effects. Finally, I will reflect on the extent to which my perspective may be valuable for David Hitchcock and other question logicians.

4A.1 Aims of Understanding

Understanding language, i.e. understanding texts or understanding general language patterns, comes in various stages and is carried out with different foci. Most relevantly, Reinmuth's dichotomy on the interpretational aims regarding language objects in general distinguishes between a *grammatical-structural* understanding of language and a *semantic/lexical* understanding.[1] Grammatical understanding is attained when knowledge regarding the category or the composition of a linguistic unit is at the interpretor's disposal. The other branch of the dichotomy maps out lexical/semantic understanding, which is attained when certain language rules are known and properly applied. These include speech act rules, definitions, and meaning postulates as well as language-inherent falsa. Nevertheless, semantic understanding has a grammatical aspect when it comes to determining whether the result of an utterance is uttered correctly.[2]

4A.2 Illocutionary Acts and Perlocutionary Effects

Let us now look at the question types distinguished in the above paper, the most common being *rhetorical*, *yes-no*, *explain*, *select*, *identify*, *either-or*, *means-finding*. I will group these categories into grammatical ones (*either-or*, *yes-no*) and semantical ones (*rhetorical*, *explain*, *select*, *identify*, *means-finding*). To identify *either-or* and *yes-no questions*, grammatical understanding is sufficient as they exhibit a characteristic shape. For identifying the other question types semantic knowledge and contextual information play a substantial role.

It seems that *explain*, *select*, *identify* as types of questions are classified due to their intended perlocutionary effect: "Saying something will often, or even normally, produce certain consequential effects upon the feelings, thoughts, or actions of the audience, or of the speaker, or of other persons" (Austin 1962:101). So, if a question type is classified as *explanatory*, it emphasizes the effect this illocutionary act is supposed to produce upon the addressee: She is intended to feel compelled to come up with an explanation. The same holds for *select* (the addressee is intended to feel compelled to select an answer) and for *identify*. Austin keeps open the possibility of default perlocutionary effects attached to certain illocutionary acts even though he rules this out for statements. (Austin 1962:138) The illocutionary act of questioning then may by default intend

1 Reinmuth makes several other distinctions; however, the one on understanding objects *in general* is the most relevant here because the prominent approaches to question logic are involved with understanding questions in general rather than with how questions are to be construed within a specific (corpus of) text.

2 A very detailed and, as I said, fine-grained account of understanding is to be found in (Reinmuth 2014a:ch. 3). (2014b) provides a summary in English language.

to make the addressee feel compelled to give an answer. For *either-or* and *yes-no* questions there might be an additional default perlocution (picking one disjunct; saying 'yes' or 'no'), because their identification through grammatical features is a rather safe operation. The other question types' identification is more complicated and prone to error because grammatical understanding is insufficient, so the addressee must be equipped with further hints on how to react.

4A.3 Justification as Means to Secure Perlocutionary Effect

With the aid of Hitchcock's supplements (2021a, 2021b) I will now explore whether and how justificational passages might help to produce the intended perlocutionary effect. The most common justification types are *elimination of alternatives*, *presupposition*, *apparent conflict*, *need*, *prior question*, *cause to effect*, *obstacle to goal*, and *analogy*. My hypothesis is that the justification is actually a way to secure the perlocutionary outcome of the interrogative act in the majority of cases. Hitchcock observes, that the justification often serves as a kind of "counter-rebuttal" against an expected rejection of the question and this may run almost in the same vein as my hypothesis. My hypothesis would yield though, that it is not the (posing of the) question which is being justified, in fact; it possibly might not even be legitimate to speak of justification at all.

In most cases, *elimination of alternatives*, together with *rejection of alternatives* and *existence of alternatives* was used to argue for *select*, *explain*, and *identify questions* (71% combined). This immediately makes sense if one looks at it in the light of securing the perlocutionary effect in the *select* question cases. For instance, to prevent an addressee from answering with some third option to a two-option *select* question, eliminating alternative answers beforehand seems promising. To classify a question as *identify* question is to assume that the addressee is supposed to feel compelled to identify a person, place, thing, time etc. So, again, elaborating on alternatives beforehand prevents the addressee from doing something else than identifying. Example: 'What are you doing?' (identification request) – 'I just sieve the flour to get a better consistency of the dough and after that I will add some baking soda, before I…' (procedural answer) vs. 'You are not making pizza and you are not baking cookies, that is for sure; so, what are you doing?' – 'I am making a birthday cake.' Similar considerations hold for *explain* questions. Eliminating alternative explanantia avoids that the addressee comes up with that very explanans the questioner is not interested in, thus giving a useless explanation. Pointing out or eliminating alternatives may

also hint at the kind of explanation someone is in search of (causal, procedural, mathematical, justificational, teleological etc.).[3]

Regarding the *presupposition* justification type, I intuitively anticipated that elaborating on presuppositions in the context of question posing will typically stand in close connection to *explain* questions[4] – and it turned out my intuition was not wrong (39% of presupposition justifications were applied to explanation requests). This was to be expected because requests for explanations often face challenges concerning the truth of the explanandum. The precautionary measure of convincing an addressee of the presupposition's truth could be construed as legitimizing the (posing of the) question but also as securing the addressee's willingness to answer it.

Apparent conflict appears in 31% of the cases established in the context of *explain* questions. If *either-or* and *select* questions are combined (which may be legitimate if it is agreed upon that ei*ther-or* questions could be seen as a special case of *select* questions), they make up 38% of the questions justified by statements about apparent conflict. Justifying *select* questions in this way aligns well with the perlocutionary hypothesis, for making the addressee select an option she must be convinced first, that these options exist (and that they are mutually exclusive in case of either-or questions). So, when she is convinced, she will probably be inclined to select one of the offered options rather than doing something else such as select an option not provided or asking a counter question (although that might occur more frequently in spoken discourse: 'What would you like for dinner?' – 'What do you have?' vs. 'I could make pasta, which is tasty but unhealthy, or I could make salad, where it is the other way around, so what would you like to eat?' – 'Definitely pasta.') Justifying *explain* questions with the appeal to *apparent conflict* could amount to stating the explanandum, if it is the very conflict that needs an explanation, hence it would be similar to *presupposition* justification. But that requires probably more of a case by case examination.

Prior question and *analogy* are justification types distinguished by other means, it seems. Analogy as a stylistic device is mainly neutral towards the illocutionary and perlocutionary force it can be uttered with. For questions, it seems, there is a vast variety of perlocutionary effects that can be pursued.

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3 This becomes especially plausible if a characterization of why-questions by contrast classes is accepted, as discussed in (van Fraassen 1980:ch. 5, sect. 2.8). Note that Hitchcock does not restrict explanation requests to why-questions, though.

4 See (Belnap 1966, 1969) for the notion of presupposition that Hitchcock deploys and that I consider compatible with my intuition. A different notion can be found in (Wiśniewski 2013).

Accordingly, there should not be a tendency toward a particular question type to which these justification types apply to. While this prediction was confirmed prima facie for *prior question* justifications (slight tendency toward *identify* questions with 26%, but otherwise spread out very evenly) it was disconfirmed for justification through *analogy*. 86% of the *analogy* type was utilized to argue for rhetorical questions.[5] The strong correlation could be explained away by an author's general dislike to express herself rather straightforwardly. However, to get a grip on this observation I analyzed the respective examples.[6] Assessing my impressions of that close reading I present an educated guess: Arguing through analogies is a very common practice in ordinary language and so is the posing of rhetorical questions. They might go particularly well together because reasoning with analogies is not a truth conservative practice and the rhetorical question in the concluding position places the author in an advanced position of discourse, without having to give conclusive evidence. However, it is hard to see how the *analogy* justification type is generally supporting the intended perlocutionary role of rhetorical questions (i.e. *challenging*, per definitionem given in David Hitchcock's text in this volume). But my reflections on rhetorical questions are to be taken with many grains of salt since their illocutionary status is subject to debate and even competent speakers frequently mistake them for genuine questions.[7]

The justification type *obstacle to goal* did not show any significant tendency toward a question type (27% *means finding*, but I do not consider that significant as there were only 11 items in total). In 50% of the cases *cause to effect* was applied to a rhetorical question; I will not speculate on the grounds since I already indicated the special status of rhetorical questions.

My examination of relations between question types and justification types yields that it is not far-fetched to assume a significant connection between the ›justification‹ and the perlocutionary effect authors of certain types of questions aim at. This insight was a result of David Hitchcock's decision to categorize question types, inter alia, by the kind of addressee activity that

5 Whether analogy arguments are to be considered arguments at all and how they are working is another problem that adds to delicacy of choosing categories/categorization measures.

6 Examples 14, 42, 69, 73, 122, and 183 were the ones that contained analogies culminating in a rhetorical question. 42 and 73 could very plausibly be read as cases of refutation by logical analogy. The other cases I do not feel competent to evaluate with regard to their status as an inference. It is safe to say that the *analogy* justification type class containing the combination of analogy justification and rhetorical question is a heterogeneous one.

7 Maybe it would be beneficial to reassess the data omitting rhetorical questions altogether.

questions target (explaining, identifying, selecting, finding means, challenging). To rule out that the close correlation between the most common questions types and the most common justification types is merely due to statistical reasons, a follow up research could be conducted focusing exclusively on activity-targeted categorizations.

4A.4 Implications for Question Logic

If the link between question type and justification type is confirmed, it would be bad news for question logicians who want to look at inferences involving questions with a rather narrow scope on context information. Furthermore, it would be a stretch to call supporting the perlocutionary outcome a justification. Moreover, classifying a question by the kind of addressee activity it targets already requires a lot of interpretational effort and is prone to error. Classifying a justification type may be even more delicate. It seems, by applying these categories to questions and their contextual argumentative surroundings, a rather coarse grained semantic understanding – in terms of conversational strategies – is to be gained, whereas the question logicians cited by Hitchcock (Wiśniewski and Kubiński) are looking for fine grained devices to single out and validate inferences involving types of questions. Therefore, they set the interpretational bar a bit lower and primarily base their categorizations on grammatical understanding: "connections between question and direct answer should be structural and should not depend on content" claims Kubiński, putting emphasis on his interest in achieving an understanding of questions through grammatical-structural understanding. He also offers various ways to partition the considered class of questions: "Is it true that?" vs. "Who?", "What?", "Which?", "Where?" and so on; simple vs. compound; homogeneous vs. heterogeneous; possessing denumerably many direct answers vs. having exactly k direct answers (Kubiński 1980:45). Note that these categories require grammatically categorial, as well as grammatically compositional understanding of the questions and their direct answers but not necessarily anything Reinmuth would label semantic understanding. Similarly, Wiśniewski claims:

> "Moreover, in many cases it is the logical form of questions and declarative sentences that determines what questions arise from what sets of declarative sentences. In particular, this is true in the case of all our examples: it is easy to observe that if any expressions which occur in any of the above patterns were replaced (in a systematic manner) by expressions of the same syntactic categories, we could still legitimately say that the resultant question arises from the corresponding set of resultant declarative sentences." (Wiśniewski 1995:6)

Accordingly, Wiśniewski's apparatus heavily relies on grammatical-structural understanding to arrive at semantic rules governing erotetic implication and evocation.

Thus, what Hitchcock has done with his activity-based categorizations and what I have done with my interpretation of the data, does not only abstain from fostering the understanding the quoted logicians were after, it downright discourages their endeavors. The result, that parts of the question accompanying activity cannot be classified justificational at all suggests it hardly fruitful to search for inference rules. It seems very promising, though, to conduct a similar research, yet, exploring ways of categorization separately, especially regarding questions types: Solely distinguishing the questions by a certain kind of grammatical understanding (or solely by a kind of semantic understanding) may result in a different distribution than classifying them with respect to the activity their authors seem to demand from the addressees. Such a procedure, I suppose, would allow for a much more systematic inquiry of the relationship between questions and their surroundings.

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5 How to Arrive at Questions

Moritz Cordes

Abstract
The question of how to arrive at questions is ambiguous. I will concentrate on two readings: (i) How should one set up a formal syntax that accomodates questions? (ii) How does one, while working in a suitable formal language, arrive at a situation where one is allowed to or even must ask a certain question? In other words: How is the asking of questions regulated within a given formal language? I will propose an answer to question (i) and consider the field of possibilities of answering (ii).

5.1 How should one set up a Formal Syntax that Accomodates Questions?

The aim of this section is to provide a vocabulary and a syntax which accomodates questions or, in a different terminology, interrogatives. There have been many proposals of this kind, which are not satisfactory with regard to the following criteria:

1. Questions should not be *identified with expressions* which were not intended to represent questions. Thus, questions are neither simply disjunctions or existential formulas (Harrah 1963) nor are they imperative-epistemic formulas (Åqvist 1975) nor are they just open formulas (Carnap 1934, Hamblin 1958).
2. Questions should not involve new *syntactical categories*, which were introduced solely because of them. The erotetic constants of Inferential Erotetic Logic ('?{…}', '**S**', '**U**', etc., Wiśniewski 1995) do not satisfy this criterion; neither does Belnap and Steel's request expression (e.g. '$(^{?}_{3} - \neq)$', Belnap & Steel 1976).

Together the two criteria can, very informally, be read thus: YES to new expressions, NO to new categories! In a way, violating the first criterion makes question logic too dependent on other formalisms so that it cannot bloom its own

blossoms.[1] Violating the second criterion inflates the importance of questions risking the system's unattractivity or even incompatibility from the point of view of systems that do *not* center around questions and that have no reason to stipulate idiosyncratic categories.

Inquisitive Semantics (Ciardelli et al. 2018; for short: I.S.) presents systems that satisfy these two criteria. At first, it appears as if I.S. infringes on the first criterion because, in the relevant systems, the preexisting symbol '$\vee$' is used as an inquisitive operator. However, I.S.'s '$\vee$' is not the '$\vee$' of standard propositional logic – many tautologies of classical propositional logic involving '$\vee$' are not tautologies in I.S.. Hence, one can write the inquisitive operator as '$\vee_i$', thereby satisfying the first criterion.

However, there are other concerns with I.S.: '$p \vee_i q$' is a propositional formula which, according to I.S., expresses an *inquisitve proposition* (Ciardelli et al. 2018:23). Hence, its utterance is to be considered an act of interrogation, presumably. At the same time this formula (and the proposition it expresses) is evaluated as *true* or *false* within I.S. (ibid.:22). So there is no distinction between the expressions whose utterances pursue interrogative aims and the expressions whose utterance assert the truth of a proposition. In fact, asking whether p or q, one cannot avoid being evaluated by I.S. as expressing something which has a claim to truth, for, after all, an assertion can be performed by uttering the very same expression. Against this, asking whether p or q, even if the additional default answer '$\neg p \wedge \neg q$' is disallowed, does not necessary make a claim to the truth of the disjunction.[2] Is there a way which gets questions out of the alethic realm and draws a clearer distinction?

At this point it must appear as if I want to have something that makes questions a thing entirely different from what is available in propositional or first-order syntax but at the same time I do not want to do something that diverges from such standard frameworks. This is true, in a way, but a different wording might make the legitimacy of my aspirations plausible: For the formalization of questions, I am looking for a category of expressions, which is necessitated by something unrelated to the phenomenon of questions but which can be exploited once questions are included in order to give them a distinct character.

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1 If there is no *identification* of questions with preexisting expressions, the problem returns, of course, if and as soon as the further development of the system renders questions *equivalent* to preexisting expressions.

2 Usually, the category of a presupposition is used here. Whether this is justified is not discussed here, but it should go without saying that presupposing '$p \vee q$' and asserting '$p \vee q$' are two different things.

I believe, at this point I can introduce the category of *performators*: atomic unary object-language operators, which can be seen as *illocutionary* expressions.[3] They are applied to formulas and yield expressions that are not formulas; thus, they cannot be iterated. In deviation from general customs, but in accord with the performator tradition, the term 'sentence' is applied to the resultant expression (i.e. performator with (closed) formula). Here is a schematic display (misusing arithmetic symbols) with a simple example:

performator + (closed) formula = sentence
'I postulate:' + '0 has no predecessor' = 'I postulate: 0 has no predecessor'

So how are performators necessitated independently from questions? There is not enough room here to expand on this. So here is the elevator pitch: If a language comprises the five standard categories of (i) individual constants, (ii) variables, (iii) predicates, (iv) connectives and (v) quantifiers, then this vocabulary alone is not enough to set up a linear[4] calculus of natural deduction with the usual inference rules for introduction and elimination that allows for unique readability at the level of derivations (Reinmuth & Cordes 2017).[5] In contrast, performators indicating the performance of assumptions and inferences allow for a disambiguation of such derivations. If one takes 'Suppose' and 'Thus' to be such two performators, a simple derivation (with three assumptions and only one inference) looks like this:

1 Suppose p
2 Suppose q
3 Suppose $p \wedge q$
4 Thus $(p \wedge q) \wedge q$

Example 1: performators in practice

3 Carl Friedrich Gethmann coined the term 'performator' (Gethmann 1979:84–85). Peter Hinst was the one who implemented the category in an ND calculus, but he called these expressions 'modificators' (Hinst 1982). Geo Siegwart expanded Hinst's work and uniformly employed Gethmann's term (Siegwart 1997). Performator-style expressions have been used throughout modern logic, but, to my knowledge, always in a technically incomplete or deficient fashion (Cordes 2014).

4 The attribute 'linear' is intended to exclude tree calculi.

5 Still such calculi are frequently introduced in all kinds of logic textbooks. On closer observation it becomes clear that the calculi employ additional devices not found in the five standard categories, like dependency numerals or boxes around subproofs or sequent arrows or, indeed, something that very much looks like a performator. Kalish and Montague's '*Show*' is a case in point (Kalish et al. 1980), as is Jaśkowski's 'S' for suppositions (Jaskowski 1934). Cf. Cordes (2014).

Note: Without the performators it is not clear that line 3 is not a conjunction introduction. Furthermore it would be unclear whether it is correct to infer '$(p \wedge q) \longrightarrow (p \wedge q) \wedge q$' via conditional introduction in line 5, because this only works if line 3 is not an inference.[6]

Anyway, once one accepts performators on these technical, question-unrelated grounds,[7] one may wonder whether they help us with the question-related problems sketched at the beginning. Let us take 'WHETHER' to be a question performator. Then, in propositional question logic, 'WHETHER p' can be read as a yes/no-question.

One of the benefits of performators is that, by the exclusive use of object-language expressions, they make explicit the kind of utterance that is being made. One does not have to figure out through contextual evidence whether something is an inference or an assumption or a question: There are inference sentences, assumption sentences, and question sentences and in a calculus which deals with such sentences they can be treated differently just in virtue of their performator. This means, among other things, that each kind of sentences (inferences, assumptions, questions, etc.) can be associated with a separate set of rules: inferences with the well-known inference rules, assumptions with the liberal assumption rule[8], and questions with rules of asking (the topic of the next section).

Yes/no-questions are only a very frugal start. There are at least two more important kinds of questions, namely choice-questions (Is p the case or q or r?) and wh-questions (What x is such that $F(x)$?). In order to accomodate choice questions, one needs a choice-question performator, say 'WHICH'. It appears that this performator would require application to multiple closed formulas φ_1, φ_2, … . But this would diverge from all other performators, which are consistently unary. In order to keep 'WHICH' unary, the various options in a choice-question need to be joined to form *one* proposition, e. g. by '$\vee$'. Thus, the

6 There are other ways to disambiguate derivations, for example by calling them valid iff they *can* be complemented with rule commentary that determines the role of each line. But this potential-commentary approach causes other problems with the reading of a derivation.

7 There is not only a technical argument for performators relating to ND calculi, there are also considerations from philosophy of language in favor of performators. Beyond this, one could also ask: Why delete performators when moving from natural language to formal logic? After all 'thus', 'suppose', and similar words are used in natural language all the time – for good reason!

8 Informally: One may assume anything.

usual choice-questions are represented as ⌜WHICH $\varphi_1 \vee \ldots \vee \varphi_n$⌝ with $\varphi_1, \ldots, \varphi_n$ being closed formulas.[9]

In order to include wh-questions one may add another question performator, 'WHAT'. Similar to choice-questions, wh-questions are peculiar with respect to their ›content‹. This troubles the picture of a straightforward application of performators to closed formulas. Wh-questions seem to be inherently *open* in the sense underlying logical syntax: They include free variables. Can performators, consequently, be applied to open formulas, i. e. to expressions that do not communicate a ›whole‹ content? – Once again, question-unrelated first-order logic provides a hint toward a solution: In universal introduction, the premise includes (at the place where a bound variable will appear post-inferentially) either a free variable or an ›anonymous individual constant‹. The latter appear to involve an abuse of a category (individual constants) which is associated with referential duty; the former seems less critical. Sometimes such free variables in UI-contexts are referred to as *parameters*. I will keep things tidy by treating parameters as constituting their own category distinct from variables (and from individual constants) and I will write them non-italicized.[10] This lets us consider formulas *with* parameters but *without* free variables as *closed*[11] – an admittedly technical solution which, however, is somewhat justified by a certain technical conception of UI (and EE). So 'Who killed JFK?' can be formalized as 'WHAT Killed(x, jfk)' where 'x' is a parameter and not a (free) variable.

Apart from yes/no-questions (WHETHER), choice-questions (WHICH), and wh-questions (WHAT), one may accomodate other kinds of questions in the sketched framework. Except for a brief footnote, this must be done elsewhere.[12]

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9 In a way, this gives a special meaning to the symbol '∨', apparently like in Inquisitive Semantics. But the interpretation of ⌜$\varphi_1 \vee \ldots \vee \varphi_n$⌝ as either a yes/no- or a choice-question does not come from this connective, but from the performator, which needs to be applied. In fact, ⌜$\varphi_1 \vee \ldots \vee \varphi_n$⌝ on its own is neither assertion nor question. Compare ⌜WHETHER $\varphi \vee \psi$⌝ and ⌜WHICH $\varphi \vee \psi$⌝. The former calls for affirmation or confirmation of ⌜$\varphi \vee \psi$⌝, the latter for affirmation of either φ or ψ. On the other hand, ⌜WHETHER φ⌝ and ⌜WHICH $\varphi \vee \neg\varphi$⌝ can be said to be equivalent in some sense. – One problem is left open: Are questions of the form ⌜WHICH $\varphi_1 \vee \ldots \vee \varphi_n$⌝ ambiguous if some φ_i is itself a disjunction? In order to avoid an answer at this point, I presuppose that in a choice-question of this form no φ_i is itself a disjunction.

10 So variables are italic and from the end of the alphabet; parameters are upright and from the end of the alphabet; individual constants are upright and from the beginning of the alphabet.

11 This requires one to adjust some meta-logic formulations in order to exclude disruptive parameter occurrence. Definitions, e. g., should be required to be free of parameters.

12 Why-questions with performator 'WHY' could be determined to have not single closed formulas for answers, but sentence-sequences which form ›explanations‹. – How-questions with performator 'HOW' could be determined to be answered by ›instructions‹,

5.2 How is the Act of Asking to be Regulated within above Framework?

The arrival at questions in the sense of the establishment of their syntax alone gives only limited information about the way in which we can arrive at questions while being *in* a language with this kind of syntax. But it is already possible to give a first idea of what might be needed to arrive at a question in this sense. This can be done by the formulation of a first rule for asking wh-questions:

> Rule 1 (QR1). If one has gained the parameter-free closed formula ⌜$\exists\xi_1 \ldots \exists\xi_n\ \varphi$⌝ with pairwise distinct $\xi_1, \ldots, \xi_n$ and $\beta_1, \ldots, \beta_n$ are pairwise distinct parameters and ψ comes from substituting β_1 for $\xi_1, \ldots, \beta_n$ for ξ_n, in φ, then one may ask ⌜What ψ⌝.

If one takes ⌜$\exists\xi_1 \ldots \exists\xi_n\ \varphi$⌝ to be ›the‹[13] presupposition of ⌜What ψ⌝, then one could say QR1 manifests the requirement of arguing for a presupposition before asking a (wh-)question. – With the help of QR1 one can define a very simple consequence-style relation based on a concept of what one might call a question-derivation:

> A sequence $A_1, \ldots, A_n$ is a question-derivation of ⌜What φ⌝ from X iff $A_1, \ldots, A_{n-1}$ is a derivation and A_n = ⌜What φ⌝ is in accord with QR1 within $A_1, \ldots, A_n$.

Here is an example for a question-derivation:

1 Suppose $\forall x\,(F(x) \longrightarrow \exists y\,R(x, y))$
2 Suppose F(a)
3 Thus F(a) $\longrightarrow \exists y\,R$(a, y)
4 Thus $\exists y\,R$(a, y)
5 What R(a, x)

Example 2: a question derivation of ‘What R(a, x)’ from {‘$\forall x\,(F(x) \longrightarrow \exists y\,R(x, y))$’, ‘$F$(a)’}

Next, define the associated consequence relation of *question derivability*:

> $X \vdash_{Q1} Q$ iff there is a question-derivation of Q from X.[14]

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designed as another kind of sentence-sequences. – What-is-X-questions with performator ‘What-Is’ could be determined to be answered by definitional sentences, i. e. single sentences whose performator ‘Def’ indicates the definitional status.

13 The problematizing chevrons around the definite article indicate that this is a specialized sense of the concept of a question presupposition which guarantees uniqueness but which ignores all the other important kinds of presuppositions surrounding questions.

14 Note that the consequence relation defined here relates sets of closed formulas to something that is not a formula but a sentence.

This is a very simple way to set up a very simple erotetic consequence relation (an ›askability‹ relation or a ›question arrival relation‹, if you will).[15] It follows the idea that, before asking a question, its presupposition needs to be substantiated. But it is doubtful whether in practice presupposition-substantiation is really an expected precursor to a sound act of interrogation (cf. Hitchcock, this volume). Furthermore, this requirement is the first on the following list and thus only one among many that might be imposed on the asking of questions:

- (PRE1) One may ask only those questions whose presupposition is secured.[16]
- (PRE2) One may ask only those questions whose presupposition follows from preceding statements together with the presuppositions of preceding questions (cf. Loeser 1968:60).
- (OPEN) One may ask only those questions which have not yet been answered.[17]
- (HELP) One may ask only those questions whose answering helps with answering the set of possible answers to another question.[18]
- (ALGO) One may ask a (new) question only if no other question is currently unanswered (Loeser 1968:60).

15 Here is a more complicated one: Let me stick with a propositional language with 'WHICH' being the only question performator – so there are only choice-questions. Some terminology: I will refer to a conjunction as being a *basic conjunction* iff it is a conjunction of alphabetically ordered literals and no literal occurs twice and none is the negation of another. A propositional formula is in *disjunctive normal form* iff it is a disjunction of basic conjunctions and each literal in each of these basic conjunctions is the negation of or identical with some literal of any other of these basic conjunctions and none of these basic conjunctions occurs twice. A disjunctive normal form is *synthetic* iff the number of its conjunctions is smaller than 2 to the power of the length of each conjunction. Apart from the usual propositional inference rules and the assumption rule we adopt rule (QGR): If one has proven $\ulcorner \varphi_1 \vee \ldots \vee \varphi_n \urcorner$ and for each φ_i there is a synthetic disjunctive normal form ψ_i such that one has proven $\ulcorner \varphi_i \leftrightarrow \psi_i \urcorner$, then one may ask $\ulcorner$WHICH $\varphi_1 \vee \ldots \vee \varphi_n \urcorner$. The associated definitions for question-derivation and question-derivability yield the relation of *question evocation with empty premise set*. Question evocation is defined in Inferential Erotetic Logic (IEL; cf. Wiśniewski 1995:ch. 5); the limitation to an empty premise set is made for the sake of simplicity. The step to question evocation for finite premise sets (as in Wiśniewski 2016) is only a small one.

16 This requirement comes very close to the at-least-one-true-answer-condition required from question evocation and erotetic implication in Inferential Erotetic Logic (IEL).

17 This resembles paraphrases of the second requirement of IEL's question evocation (Wiśniewski 2013:ch. 6).

18 If 'helps with answering' is read as 'narrowing down the set of answers', this comes close to the usual paraphrases of the second requirement in IEL's erotetic implication (Wiśniewski 2013:ch. 7).

- (WIDE) One may ask only those questions a narrower question than which has been answered in the negative (Stahl 1962).
- (MEAN) One may ask only those what-is-X-questions where X is being referred to in the preceding sentences (cf. Loeser 1968:60).
- (FREE) One may ask anything.

Besides the obvious pluralism, there are two more problems with these requirements, if they are supposed to help with the establishment of formal rules of asking: (i) Each of these requirements is ambiguous and (ii) some of them yield (in some readings) rules which are not decidable. A specific result pertaining to the latter problem has been proven elsewhere (Cordes 2020). For now, I would like to illustrate the former problem. For this purpose take (HELP). This requirement of asking a question Q_2 relates to a previously asked question Q_1 and, implicitly, to a possibly empty set X of closed formulas representing some kind of background knowledge. Now there are at least three readings to (HELP):

- (HELP.1) One may ask Q_2, provided that to each[19] answer φ to Q_2 there is a *proper* subset of the set of answers to Q_1 such that φ together with X implies that a true answer to Q_1 is included in this proper subset.[20]
- (HELP.2) One may ask Q_2, provided that to each answer φ to Q_2 either there is a *proper* subset of the set of answers to Q_1 such that φ together with X implies that a true answer to Q_1 is included in this proper subset or φ together with X implies the negation of an answer to Q_1.[21]
- (HELP.3) One may ask Q_2, provided that to each answer φ to Q_2 there is a *proper* subset of the set of answers to Q_1 such that φ together with X and with the presupposition of Q_1 implies that a true answer to Q_1 is included in this proper subset.

Note that each of these requirements is non-equivalent to the others. Obviously, (HELP.1) is stronger than (HELP.2). Less obviously, under a straightforward understanding of 'the presupposition of Q_1', (HELP.2) is stronger than (HELP.3). Here are some examples with choice-questions, where to each choice-question $\ulcorner$WHICH $\varphi_1 \vee \ldots \vee \varphi_n\urcorner$ its only and all answers are φ_1, ..., φ_n and its presupposition is $\ulcorner\varphi_1 \vee \ldots \vee \varphi_n\urcorner$. Let the background knowledge be empty ($X = \emptyset$) in all examples.

19 To further broaden the spectrum of readings for (HELP), one could substitute 'some answers' for 'each answer' in (HELP.1) to (HELP.3).

20 This reading of (HELP) comes close to one requirement for IEL's erotetic implication (Wiśniewski 2013:ch. 7).

21 Wiśniewski discusses the relation between elimination (negating possible answers) and narrowing-down (affirming a proper subset of possible answers) in Wiśniewski (2013:sect. 7.1.1).

Example 3: Let 'WHICH $\neg\neg p \vee \neg\neg q$' be the initial question (Q_1). The question 'WHICH $p \vee q$' (Q_2) satisfies (HELP.1), (HELP.2), and (HELP.3).

Example 4: Let 'WHICH $p \vee q$' be the initial question. The question 'WHICH $p \vee \neg p$' satisfies (HELP.2) and (HELP.3) but not (HELP.1).

Example 5: Let 'WHICH $p \vee q$' be the initial question. The question 'WHICH $(p \rightarrow q) \vee (q \rightarrow p)$' satisfies (HELP.3) but neither (HELP.1) nor (HELP.2).

I will not try to decide between the various readings. But this showcase is intended to impose some justificational pressure on those studies in erotetics which focus on a total of only one or two readings of informal question requirements. Above list ((PRE1) to (FREE)) together with the indication of multiple readings in each case spans a space of options that is frequently neglected.

Furthermore, suppose that somebody *did* provide some kind of justification for specific readings. The job of finding formal rules of asking is not done at this point – at least if one wants to have rules upon which one can act. For example, it is not obvious that the conditions imposed on Q_2 in the readings (HELP.1) to (HELP.3) are decidable. That this can be a source of serious trouble and, in fact, *is* a source of serious trouble in the case of IEL's evocation is somewhat shown in Cordes (2020).

The big picture which emerges from these rough considerations is the following: There are many different ways to regulate the asking of questions in a formal framework, and they are inspired by many different ideas one can have about what authorizes one to ask a question at a certain point in a cognitive discourse. How can one deal with this pluralism?[22]

Within a framework that includes performators it is always possible to translate each separate intuition about how to regulate questioning into a separate performator. This would create a need for much more than three question performators, even if one accomodates only one syntactical kind of questions, say choice-questions. There would already be three performators associated with the three readings of (HELP). – Another approach could distinguish different kinds of sentence sequences, depending on the set of rules employed, similarly to how explanations and argumentations (i.e. proofs with empirical premises) might employ different sets of rules (with some overlap in

22 Needless to say that this kind of pluralism is different from the kind of pluralism indicated at the beginning of this paper, which consisted in the existence of several general approaches to questions in formal logic. The kind of pluralism which is at issue now occurs within single general approaches (e.g. the one sketched in the first section).

the inferential part). This would mean that there is a kind of sequences which is associated with the generation of questions that help in the answering of an initial question, which includes several subkinds associated with (HELP.1) to (HELP.3); then there is a kind of sequences which is associated with the widening of the scope of questions when negative answers accumulate (cf. (WIDE)); and so on…

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5A How to Arrive at Questions

Lani Watson

In the abstract to his paper, Cordes notes that his title is ambiguous across (at least) two readings, one regarding the correct formal syntax for questions, the other regarding the correct regulatory parameters for question-asking in a formal language. In adopting that same title for this response, I aim to offer an alternative and complementary reflection, from an explicitly informal perspective. In particular, I focus on the more salient second reading, and provide a sketch of what I take to be the correct regulatory parameters, or norms, for question-asking in informal language. In other words, I provide a sketch of the norms that guide question-asking in everyday life. I then offer some thoughts on what this means for good and virtuous questioning.

Before proceeding, it is important to note the contributions that others have made on this topic from a broadly informal perspective, including those interested in questioning and inquiry specifically, and in epistemic norms more generally (Hookway 1999, Friedman 2013, 2015, 2020, Kelp 2014, Whitcomb 2017, Archer 2018, Millson 2020, Thorstad 2021, Sapir and van Elswyk 2021, Falbo forthcoming). It is not possible to engage with these contributions substantively, in a short piece such as this. Nonetheless, the reflections I offer here can and should be read in light of the small but growing literature dedicated to the norms of inquiry (aka zetetic norms). This literature contains much of interest for formal theorists. My own ideas both intersect with and depart from the literature in various ways.

5A.1 A Norm for Question-asking

For me, it is important to ground any investigation of the norms that guide question-asking in the familiar and dynamic, real-world contexts in which it takes place. Question-asking is an integral part of everyday life, common across cultures, languages, and circumstances. We all learn how to do it as infants and continue to do it throughout our lives. I have argued elsewhere that question-asking is best characterised as a practice (Watson forthcoming).

More precisely, question-asking is part of an epistemic practice that we call questioning.

This characterisation of questioning as an epistemic practice is significant for two reasons. Firstly, it provides a distinct lens through which to examine questions themselves. Questions are embedded within a real-world practice that is governed by norms. They do not exist independently of that practice and are thereby also defined and constrained by it. The practice of questioning has a certain primacy in this regard. This practice-oriented lens was first sharpened by Wittgenstein in *Philosophical Investigations* (1953), where he argued for the primacy of practices in any rule-following system, contending that formal linguistic conventions arise out of rather than determine linguistic practices. As such, the regulatory parameters for question-asking in formal language provide only a limited (albeit valuable) insight into the norms that guide question-asking within a real-world community of questioners. The norms for question-asking, in this latter context, are those that govern the *practice* of questioning.

Secondly, practices are typically defined in terms of their distinctive goals, shared across a community of practitioners. Epistemic practices, then, are defined in terms of a distinctively epistemic goal. In the case of questioning, I contend that this is the goal of information-seeking. (I have argued elsewhere that a question is an information-seeking act (Watson 2021).) The information-seeking act, the question, is an essential constitutive feature of the practice of questioning. Questioning is, therefore, an epistemic practice because it is defined and structured by an epistemic goal. The norms that govern the practice of questioning are thus *epistemic* norms.

I propose, then, the following norm for question-asking: *Ask Q only when you are seeking to elicit the information that stands as an answer to Q.* I call this the Information-Seeking Norm. It is derived from the joint claims: 1) that the norms for question-asking are those that govern the *practice* of questioning; 2) that the norms that govern the practice of questioning are *epistemic* norms; 3) that questions are an essential constitutive feature of the practice of questioning, and 4) that a question is an information-seeking act. While there is much more to be said in order to elaborate and defend each of these claims, and the Information-Seeking Norm itself, I will limit myself to simply stating it here in the context of this short reflection. I believe it captures the correct

regulatory parameters that guide the practice of questioning within real-world communities of questioners, across cultures, languages, and circumstances.[1]

5A.2 Two Conditions for Good Questioning

One advantage of the Information-Seeking Norm, in contrast to alternatives such as the Ignorance Norm (proposed in different guises by Friedman (2015) and Whitcomb (2017)), is that the Information-Seeking Norm provides a rich basis for evaluating questioning. The Ignorance Norm says, in essence, that "one should ask a question only if one doesn't know its answer" (Whitcomb 2017:148). Such a norm provides a limited basis for evaluating questioning: Either one adheres to the norm because one is ignorant, or one violates the norm because one already knows the answer. There is little room for further normative analysis. The Information-Seeking Norm, by contrast, suggests a more nuanced framework for normative analysis because it centrally concerns an act (information-seeking), as opposed to a state (ignorance). There are many ways in which an act (as opposed to a state) can be evaluated along a spectrum, from 'doing it well' to 'doing it badly', and it is along this spectrum that one can evaluate questioning.

Significantly, this spectrum allows us to evaluate questioning beyond merely observing whether or not a question has resulted in a satisfactory answer. One can, of course, note whether asking *Q* has elicited the information that stands as an answer to *Q*. But, this is not all there is to good questioning, if one is interested in a rich normative analysis of the practice. There are two further questions one can ask, in order to arrive at this: 1) has the information been elicited competently, and 2) is the information worth having. As such, good questioning does not merely consist in successfully eliciting information. Rather, the good questioner *competently* elicits *worthwhile* information. These are the two basic conditions for good questioning.

Taking these in turn, firstly, one can ask what it means to competently elicit information. The notion of competency is, in many respects, a close cousin of success but they are, nonetheless, distinct. Competency is, at once, and in

1 It is worth noting briefly that the Information-Seeking Norm says nothing about the myriad reasons one might have for seeking to elicit information and, thereby, asking a question. One might do so with the express intent of, for instance, showing concern for a friend's wellbeing (e.g. how are you feeling today) or embarrassing an arrogant colleague (e.g. do you know what X actually means). Equally, one might do so exclusively to elicit information (e.g. what time is the next bus due). The Information-Seeking Norm does not limit the ways in which we use questions, rather it captures the normative principle that grounds the practice of questioning in all its myriad forms. I discuss this in more detail in (Watson 2021:288–294).

different lights, both a more restrictive and a more permissive notion than success. It is more restrictive because competency requires a degree of skill, while success can be the product of sheer luck: One can successfully elicit information by chance, even if one asks bad questions, but one cannot competently do so. It is more permissive because competency does not require success, while success, obviously, does: One can competently engage in questioning without actually eliciting information, but one has not, thereby, been successful. Good questioning requires competently eliciting information.

Secondly, one can ask what it means to elicit worthwhile information. Good questioning does not merely amount to eliciting any information, however competently. The aim is to elicit information that is worthwhile, relevant or significant in some sense (I use 'worthwhile' to represent these various related categories). As such, good questioning excludes cases of trivial information-elicitation. Examples of trivial information occur throughout contemporary epistemology. Counting blades of grass (Kvanvig 2014) or motes of dust (Sosa 2003), or memorising all the entries in the Kansas phonebook (Grimm 2009), are three examples given. That such cases represent trivial information is broadly agreed upon. Determining precisely why this is the case is more complex and contentious. Fortunately, one does not need to determine this in order to accept the ›worthwhileness‹ condition for good questioning, as long as one accepts that some information is indeed more worth having than other information, and that seeking to elicit worthwhile information is better than seeking to elicit trivial information. Good questioning requires eliciting worthwhile information.

These two basic conditions for good questioning make sense in the context of the familiar, real-world practice. Good questioners are those people who ask the ›right questions‹. These are the questions that get at the heart of an issue or probe a particularly important and overlooked dimension of a situation; they are the questions that uncover the worthwhile information that we really need or want. What is more, good questioners do not just ask the right questions, they ask them at the right time, in the right way, of the right sources or people. They uncover information sensitively and efficiently by competently judging not only what to ask, but also who, when, where, and how to ask. Good questioners competently elicit worthwhile information. These are the parameters that regulate not just questioning, but good questioning.

5A.3 A further Condition for Virtuous Inquisitiveness

Good questioning is a skill; it requires competency and judgement. As a skill, however, there is no guarantee that it will be exercised. One may possess any

number of skills but be disinclined or unmotivated to exercise them for various reasons, whether this be due to external barriers, internal anxiety, or a simple lack of interest. A person may, for example, be an excellent questioner but have no interest in acquiring information about anything much at all. In this case, there is no reason to think they would exercise the skill of good questioning. Something over and above the skill is required; would-be questioners must be sufficiently motivated to ask their questions. It is this motivation that leads us from good to virtuous questioning.

The transition from good to virtuous questioning is a matter, primarily, of motivation. While the good questioner may be disinclined to employ their skills, the virtuous questioner will necessarily be motivated to do so. Thus, as Aristotle says in his famous treatment of virtue in the *Nicomachean Ethics*, the virtuous person acts:

> "at the right times, with reference to the right objects, towards the right people, *with the right aim*, and in the right way" (1953:Book II, 1106b21-23, emphasis added)

The virtuous questioner, then, must ask "with the right aim" or motivation. Virtuous, as opposed to good questioning, is not merely a matter of what, who, when, where, and how one asks, but also why. Having the right aim ensures that a questioner's actions are not only a matter of skill, but of possessing the right motivation.

What, then, does virtuous questioning look like among real-world communities of questioners. The answer to this draws a wide selection of intellectual virtues into view. The open-minded or intellectually humble person might engage in virtuous questioning, for instance. So might the rigorous or intellectually courageous person. Indeed, one can easily imagine any of the intellectual virtues involving a degree of virtuous questioning. I have argued elsewhere, that, among these, inquisitiveness is *the* question-asking virtue; it is the only virtue defined by questioning (Watson 2015). In other words, it is the only virtue that involves good questioning as a necessary component. The inquisitive person is characteristically motivated and able to engage sincerely in good questioning. Virtuous inquisitiveness therefore involves the two conditions for good questioning – competency and worthwhileness – plus, virtuous motivation. It is this motivation that constitutes a further condition for virtuous inquisitiveness.

Again, this further condition makes sense in the context of the familiar, real-world exercise of the virtue. The virtuously inquisitive person is one who asks the right questions, in the right way, for the right reasons. They do not ask questions in order to, say, humiliate an arrogant colleague (however deserving!)

or to show concern for a friend's wellbeing. The virtuously *inquisitive* person asks question in order, first and foremost, to find things out. In doing so, they aim to achieve "cognitive contact with reality" (Zagzebski 1996) – the modus operandi of the intellectually virtuous agent. This is the further parameter that regulates not just good questioning, but virtuous inquisitiveness.

Of course, I have offered here only an outline of a response to the title chosen by Cordes, which is given a formal treatment in his paper. As noted, this has been an attempt to provide an alternative and complementary reflection on the title, from an explicitly informal perspective. I have proposed a norm for question-asking in everyday life and offered some thoughts on what this means for good and virtuous questioning. I truly welcome the invitation to take this approach, as I believe the formal and informal study of questions have much to offer to each other and hope that an engaged dialogue between these fields will continue to emerge over the coming years.

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6 The Method of Socratic Proofs: From the Logic of Questions to Proof Theory[1]

Dorota Leszczyńska-Jasion[2]

"If it is true that questions are valuable
because they lead to judgments,
it may also be true that judgments are valuable
because they lead to inquiries."

Felix S. Cohen (1929:351)

Abstract

I consider two cognitive phenomena: inquiring and justifying, as complementary processes running in opposite directions. I explain on an example that the former process is driven by questions and the latter is a codification of the results of the first one. Traditionally, proof theory focuses on the latter process, and thus describes the former, at best, as an example of a backward proof search.

I argue that this is not the best way to analyze cognitive processes driven by questions, and that proof-theoretical analysis of questions can bring mutual benefits for both proof theory and erotetic logic.

In the second part of my paper (sect. 6.3) I introduce the structural rules of weakening and contraction. Results concerning their admissibility are discussed. I also sketch an erotetic interpretation of the rule of weakening as reducing information noise, and that of contraction as securing information.

1 This material, as well as the presented talk, is a preview of my monograph under the same title to appear (2021).

2 This paper, as well as the presentation, was prepared thanks to financial support of National Science Centre, Poland, grant no 2017/26/E/HS1/00127.

6.1 Inquiring and Justifying

The topic of my presentation is the use of proof-theoretical concepts and tools in the analysis of questions. My interest is, specifically, in the analysis of transformations of questions: phenomena which can be interpreted as special cases of erotetic reasoning.

Inferential Erotetic Logic (IEL, for short) is a paradigm in the logic of questions created by Andrzej Wiśniewski and later developed by Wiśniewski and his associates.[3] I believe that the framework of IEL makes it possible to analyze both the cognitive process that leads from a question to a judgment and the one leading from judgments to further questions. Working within this paradigm I have realized that there are important analogies – as well as differences of at least the same importance – between proofs and transformations of questions (called Socratic transformations in the IEL paradigm).

To start with an example, suppose that we deal with the task of proving that the following mathematical formula holds ($x, a, b \in R_+$).

(1) $$\log_b x = \log_b a \cdot \log_a x$$

If we remember that by the very definition of logarithm ($\log_c y = d \iff c^d = y$) it holds that:

(2) $$c^{\log_c y} = y$$

We can try to reach (1) by obtaining the following one first:

(3) $$b^{\log_b x} = b^{\log_b a \cdot \log_a x}$$

Since (1) and (3) are equivalent (in a well-defined sense), it is better to go through (3), because by (2) we can reduce (3) to:

3 See Wiśniewski (1995, 2013). Other references can be found in the paper by Andrzej Wiśniewski published in this volume.

(4) $x = b^{\log_b a \cdot \log_a x}$

And by some further maths:

(5) $x = (b^{\log_b a})^{\log_a x}$

which, by (2) again, reduces to:

(6) $x = a^{\log_a x}$

Finally the latter, by the same argument, reduces to:

(7) $x = x$

As far as school assignments are concerned, the above reasoning is fine, but we have to realize that it is not a proof of (1); it is inquiring into the grounds for (1). In sequent-calculus presentation a proper proof could be displayed, for example, as follows:

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\Rightarrow x = x \qquad \Rightarrow (2)}{\Rightarrow x = a^{\log_a x}}\, def.\log, sub. \qquad \Rightarrow (2)}{\Rightarrow x = (b^{\log_b a})^{\log_a x}}\, def.\log, sub.}{\Rightarrow x = b^{\log_b a \cdot \log_a x}}\, def.\text{power of} \qquad \Rightarrow (2)}{\Rightarrow b^{\log_b x} = b^{\log_b a \cdot \log_a x}}\, def.\log, sub.}{\Rightarrow \log_b x = \log_b a \cdot \log_a x}\, exp.$$

The leftmost branch starts with premise '$\Rightarrow x = x$' which can be taken as an axiom. To this the definition of logarithm is applied, substituting (or replacing) one of the x's with '$a^{\log_a x}$'. This whole step is reconstructed as an application of a two-premise rule that acts on said axiom and sequent '$\Rightarrow (2)$', and allows to perform the substituting operation. The other steps are quite obvious. (One can argue whether this is a correct, sound, proper reconstruction, but this is quite irrelevant to the discussion presented here.)

On the other hand, the previously presented reasoning would be better represented as:

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\text{What is the ground for } \log_b x = \log_b a \cdot \log_a x\,?}{\text{What is the ground for } b^{\log_b x} = b^{\log_b a \cdot \log_a x}?}}{\text{What is the ground for } x = b^{\log_b a \cdot \log_a x}?}}{\text{What is the ground for } x = (b^{\log_b a})^{\log_a x}?}}{\text{What is the ground for } x = a^{\log_a x}?}}{\text{What is the ground for } x = x?}$$

The consecutive steps lead from a question to a question showing that one problem can be reduced to another. We stop asking when we arrive at something that seems fairly obvious – obvious enough to state that the question is, in a sense, rhetorical.

Traditionally, for a proof-theoretician the above reasoning is an example of *backward proof-search*. We all know this type of reasoning: When searching for proofs in a sequent calculus we would not start with axioms but with the formula to be proved, and applying some sequent-calculus rules upwards – deducing the form of premises from that of conclusion – we would try to reach axioms.

From the perspective of proof theory, backward proof-search is just another way to find proofs – I see the need to stress that we fail to see questions from this perspective. Questions are triggers for proofs, just as formulating a problem is always the first step to its solution; questions initiate the search for solutions, *int. al.*, the search for proofs.[4] For this reasons questions can be, and should be, treated seriously as proof-theoretical objects which are not reducible to other objects.

Hence my point is that we can gain mutual benefits by joining the two perspectives: the proof-theoretical one and that of the logic of questions. IEL makes it possible by developing *erotetic calculi* which are calculi of questions that allow to model some special kinds of erotetic reasoning and to analyze its proof-theoretical aspects. The rules of erotetic calculi allow to transform questions in the search of a solution of the problem expressed by an initial question.

To illustrate the mentioned benefits I present a sketch of a structural analysis of erotetic calculi. This paper is not meant to be technical, hence I introduce a minimum of the technical backbone. Below, I provide a sketchy description

4 During the conference, I did not develop the thought 'questions as triggers for proofs', here I develop this idea more than I did during the conference.

of erotetic calculus $\mathbb{E}^{Q}$, designed for classical first-order logic; I introduce the structural rules of contraction and weakening and provide the justification of the definition of semi-admissibility of the rules in $\mathbb{E}^{Q}$. I also sketch an interpretation of these rules in the erotetic setting.

6.2 Erotetic Calculus $\mathbb{E}^{Q}$

Erotetic calculi were designed by Wiśniewski as means to *calculate* the answer to a problem whether B can be derived from $\{A_1, ..., A_n\}$ in an underlying logic. Problems of this kind are represented by expressions of the following form:

(8) $?(A_1, ..., A_n \vdash B)$

In the case of calculus $\mathbb{E}^{Q}$ the underlying logic is the classical first-order logic (FOL, for short). Each Socratic transformation constructed in $\mathbb{E}^{Q}$ begins with such a question which is further transformed by, *int. al.*, rules presented in Table 1 which we shall discuss in a moment.

The erotetic calculi are worded in languages that allow to construct, among its wellformed expressions, *sequents*. These are, roughly, expressions of the form:

(9) $A_1, ..., A_n \vdash B$

Questions of language $\mathrm{L}^{?}_{\vdash \mathrm{FOL}}$ (the language in which $\mathbb{E}^{Q}$ is expressed) are expressions of the form:

(10) $?(\varphi_1, ..., \varphi_n)$

where φ_i is a sequent. A question of the form:

(8) $?(A_1, ..., A_n \vdash B)$

asks whether the situation/fact described by '$A_1, ..., A_n \vdash B$' holds. Question (10), possibly containing more than one sequent, asks if the fact described by φ_1 holds, and ..., and the fact described by φ_n holds. Hence the reading of the comma between sequents is conjunctive.[5]

5 Which shows that we are not working with hypersequents here, cf. Avron (1993, 1996).

To keep things as simple as possible, only some of the rules of $\mathbb{E}^{Q}$ are displayed in Table 1. (The reader can consult (Leszczyńska-Jasion 2021) for more details.)[6]

In Table 1 the Greek letter 'Φ' represents the context in which the displayed sequent occurs. So Φ is a sequence of sequents with a particular occurrence of the displayed sequent (called a *constituent* of the question) under consideration. Our sequents have only one formula in the succedent, but the antecedent can contain an arbitrary finite number of elements (formulas of the underlying language of FOL). The Latin letter 'S' indicates the context in which a formula (formulas) occurs. In sequent calculus terminology the formula displayed in the premise of the rule is its *active* formula, whereas the remaining formulas in S are the side formulas of the rule.

$$\frac{?(\Phi(S(A\wedge B)\vdash C))}{?(\Phi(S(A,B)\vdash C))}\,L_{\wedge} \qquad \frac{?(\Phi(S\vdash A\wedge B))}{?(\Phi(S\vdash A;S\vdash B))}\,R_{\wedge}$$

$$\frac{?(\Phi(S(A\to B)\vdash C))}{?(\Phi(S(-A)\vdash C;S(B)\vdash C))}\,L_{\to}$$

$$\frac{?(\Phi(S(\_)\vdash A\to B))}{?(\Phi(S(--A)\vdash B))}\,R_{\to}$$

$$\frac{?(\Phi(S(\forall xA(x))\vdash C))}{?(\Phi(S(\forall xA(x),A(t))\vdash C))}\,L_{\forall} \qquad \frac{?(\Phi(S\vdash \forall xA(x)))}{?(\Phi(S\vdash A(a)))}\,R_{\forall}$$

t is any closed term

a is a constant which does not occur in the premise

Tab. 1: Rules of $\mathbb{E}^{Q}$

Here is a bunch of definitions introducing the notion of Socratic proof. A *Socratic transformation* of a question Q in calculus $\mathbb{E}^{Q}$ is a sequence of questions starting with Q and regulated by the rules: Each consecutive question results from the previous one by one of the rules. A Socratic transformation is called *successful*, provided that it is finite and each constituent of its last question is of one of the forms:

6 Calculus $\mathbb{E}^{Q}$ is another variant of erotetic calculus for classical first-order logic, next to the original $\mathbf{E}^{PQ}$ introduced in (Wiśniewski & Shangin 2006) and some others considered later in (Chlebowski 2018, Leszczyńska-Jasion 2018, Wiśniewski 2006). The rules of $\mathbb{E}^{Q}$ are expressed in a modified variant of the uniform notation introduced by Smullyan, where the modification consists in using complement '$-A$' instead of negation '$\neg A$'.

(11) (a) $T(B) \vdash B$, or

(b) $T(B)(-B) \vdash C$.

The two forms clearly correspond to axioms of sequent calculi; due to the reversed direction of reasoning (mentioned at the start) the erotetic calculi do not have axioms. In turn, successful Socratic transformations reach axiomatic sequents at the end.

A sequent '$S \vdash A$' of language $\mathrm{L}^{?}_{\vdash \mathrm{FOL}}$ is called *closed* if it contains no sentential functions. Finally, the notion of *Socratic proof* is introduced for closed sequents; a Socratic proof of sequent '$S \vdash A$' is a successful Socratic transformation of question '$?(S \vdash A)$'. If there exists a Socratic proof of a sequent in $\mathbb{E}^{\mathrm{Q}}$, then we say simply that the sequent is *provable in* $\mathbb{E}^{\mathrm{Q}}$.

Here is a Socratic proof of sequent '$\forall x \forall y\,(P(x, y) \longrightarrow \neg P(y, x)) \vdash \forall x\, \neg P(x, x)$' in $\mathbb{E}^{\mathrm{Q}}$; we can read this example as showing that from asymmetry of a binary relation its irreflexivity follows.

Example 1. Below A stands for the formula '$\forall x \forall y\,(P(x, y) \longrightarrow \neg P(y, x))$', and B is for '$\forall y\,(P(a, y) \longrightarrow \neg P(y, a))$'.

$$\dfrac{\dfrac{\dfrac{\dfrac{?\,(\forall x \forall y(P(x,y) \longrightarrow \neg P(y,x)) \vdash \forall x \neg P(x,x)\,)}{?\,(\,\forall x \forall y(P(x,y) \longrightarrow \neg P(y,x)) \vdash \neg P(a,a)\,)}\,R_{\forall}}{?\,(\,A\,,\forall y(P(a,y) \longrightarrow \neg P(y,a)) \vdash \neg P(a,a)\,)}\,L_{\forall}}{?\,(\,A\,,\forall y(P(a,y) \longrightarrow \neg P(y,a))\,,P(a,a) \longrightarrow \neg P(a,a) \vdash \neg P(a,a)\,)}\,L_{\forall}}{?\,(\,A\,,B\,,\neg P(a,a) \vdash \neg P(a,a) \quad ; \quad A\,,B\,,\neg P(a,a) \vdash \neg P(a,a)\,)}\,L_{\longrightarrow}$$

6.3 Structural Analysis

In my presentation I reflected on what we can gain with the structural analysis of question processing. Here is a summary of some technical results described in Section 2.5 of (Leszczyńska-Jasion 2021).

6.3.1 Admissibility and Derivability of the Erotetic Rules

Traditionally, once the structural rules are introduced into a sequent calculus, the issue of their admissibility arises. In our setting the question to be answered at the start is how should the notion of admissibility of an erotetic rule be understood. In (Wiśniewski & Shangin 2007) some rules admissible in the erotetic calculus $\mathbf{E}^{\mathrm{PQ}}$ (the original version of the erotetic system for FOL) are introduced and analyzed. Some of them, but not all, are derivable in the calculus. The authors introduce also a set of admissible structural rules; however, the very

notions of derivability and admissibility in the erotetic context are not analyzed in (Wiśniewski & Shangin 2007).

Sara Negri and Jan von Plato define the notion of admissibility as follows (Negri & von Plato 2001:20):

> "Given a system of rules **G**, we say that a rule with premisses S_1, ..., S_n and conclusion S is *admissible* in **G** if, whenever an instance of S_1, ..., S_n is derivable in **G**, the corresponding instance of S is derivable in **G**."

where derivability of a sequent S_i in **G** is defined as the existence of the relevant derivation. It follows that if a rule is admissible, then its addition to a proof system does not influence the derivability relation generated by the system. Any conclusion derivable from a set of premises after the addition must have been derivable before the addition. It means, *int. al.*, that adding an admissible rule to a sound calculus must result in a sound calculus.

In the simplest case, admissibility is met in the form of derivability of a rule.[7] Referring to the above quotation, we would say that a rule with premises S_1, ..., S_n and conclusion S is *derivable* in **G** if every instance of S is derivable in **G** from the respective instances of S_1, ..., S_n. Usually it means that we are able to develop a schema of derivation leading from premises S_1, ..., S_n to conclusion S, where only the rules of **G** are applied; therefore a derived rule is considered a tool to make useful shortcuts in a proof. Adjusting the notion of derivability to the erotetic rules seems fairly simple (this is how I introduce this notion in (2018) and (2021)):

> Definition 1 (derivability in $\mathbb{E}^{Q}$). Let $\mathbf{r} = Q/Q^*$ be an erotetic rule. We will say that **r** is *derivable in* erotetic calculus $\mathbb{E}^{Q}$ iff there exists a finite Socratic transformation **s** of question Q in $\mathbb{E}^{Q}$ such that Q^* is its last term.

Indeed, this is how the notion is understood also in (Wiśniewski & Shangin 2007).

The notion of admissibility is more problematic. The direction of *proving* as defined by the rules of a sequent calculus is converse to the direction set by the erotetic rules, hence we do expect trouble. I propose the following solution (again, see also (Leszczyńska-Jasion 2018, 2021)).

> Definition 2 (admissibility in $\mathbb{E}^{Q}$). Let $\mathbf{r} = Q/Q^*$ be an erotetic rule. We will say that **r** is *semi-admissible in* erotetic calculus $\mathbb{E}^{Q}$ iff the following condition holds:
> 1. if there exists a successful Socratic transformation of question Q^* in $\mathbb{E}^{Q}$, then there exists a successful Socratic transformation of question Q in $\mathbb{E}^{Q}$.

7 See also the account of admissibility and derivability by A. Indrzejczak in (2010:22).

If, except for clause 1., **r** satisfies also clause 2.:
2. if there exists a successful Socratic transformation of question Q in $\mathbb{E}^{?}$, then there exists a successful Socratic transformation of question Q^* in $\mathbb{E}^{?}$,
then we say that **r** is *admissible in* erotetic calculus $\mathbb{E}^{?}$.

On the face of it, it may seem that the very clause 2 of Definition 2 captures the basic intuition behind admissibility which is expressed in the quotation cited on page 190. However, the point is that the ›final conclusion‹ of a successful Socratic transformation is expressed by its *first* element, not the last one – as it is in the case of standard proofs. For example, suppose that we are able to prove the following dependency:

(d) if there is a successful Socratic transformation of question '$?(A \vdash B; -A \vdash B)$' in $\mathbb{E}^{?}$, then there is a successful Socratic transformation of question '$?(\vdash B)$' in $\mathbb{E}^{?}$.

Taking dependency (d) for granted, when investigating provability of sequent '$\vdash B$', one can pass from question '$?(\vdash B)$' to question '$?(A \vdash B; -A \vdash B)$', since finishing a Socratic transformation of the later question with a success yields that there exists a successful Socratic transformation of the former question. In other words, proving dependency (d) shows the admissibility of the following rule in calculus $\mathbb{E}^{?}$:

$$\frac{?(\vdash B)}{?(A \vdash B\,; -A \vdash B)}$$

Let us stress that the dependency expressed by (d) *does not* yield that there is a Socratic transformation *leading* from question '$?(\vdash B)$' to question '$?(A \vdash B; -A \vdash B)$'; in fact, there is no such Socratic transformation, as the rule is not derivable in $\mathbb{E}^{?}$.

The primary aim of going from question Q to Q^* by an erotetic rule is to simplify the process of resolving question Q. Therefore an admissible rule Q/Q^* should be introduced with the purpose of using the fact that resolving Q^* is easier than resolving Q. In other words, the existence of a solution to Q^* must guarantee the existence of a solution to Q, just as we have seen in the above example. In the case of standard sequent calculi it is the existence of a *resolution* of the premises S_1, ..., S_n, i.e. their derivation from axioms, that warrants the existence of a *resolution* (derivation) of the conclusion S.

All the above leads us to the conclusion that it is condition 1 in Definition 2 that expresses the idea of admissibility known from other proof systems. We can ask now what is the purpose of calling the property *semi-admissibility* and

involving condition 2. The point is that condition 1 alone does not warrant correctness of a rule. Let us consider, for example, the following:

$$\frac{?(\vdash B)}{?(\vdash A \wedge \neg A)}$$

where A, B are sentences of L_{FOL}. Unfortunately, the rule satisfies condition 1 of Definition 2, as there is no successful Socratic transformation of question '?($\vdash A \wedge -A$)' in $\mathbb{E}^{?}$. But the rule is clearly incorrect; hence we need condition 2 in Definition 2 to warrant correctness.

Let $c(\mathbf{r})$ stand for a restriction of erotetic rule $\mathbf{r} \in \mathbb{E}^{?}$ to instances that do not contain sentential functions. The following is proved in (Leszczyńska-Jasion 2021):

Corollary 1. If $\mathbf{r}$ is a rule derivable in $\mathbb{E}^{?}$, then:
1. $\mathbf{r}$ is semi-admissible in $\mathbb{E}^{?}$,
2. $c(\mathbf{r})$ is admissible in $\mathbb{E}^{?}$.

6.3.2 *Structural Rules: Weakening as Reducing Information Noise, Contraction as Securing Information*

Erotetic calculi do not need structural rules to be sound and complete, but the rules occur extremely useful in metatheory – just as they do in the case of more standard calculi of sequents.[8]

The rule of weakening can be presented as follows.

$$\frac{?(\Phi(B_1, B_2, \ldots, B_n \vdash A))}{?(\Phi(B_2, \ldots, B_n \vdash A))}\, L_{weak}$$

In the erotetic setting, the rules of weakening add formulas to what is a premise of the rule. When read top-down they *remove* information. Here come some particular instances of the rule.

$$\frac{?(r, p \wedge q \vdash p)}{?(p \wedge q \vdash p)}\, L_{weak} \qquad \frac{?(p, q \vdash p)}{?(q \vdash p)}\, L_{weak}$$

In the example on the left the information which is removed is clearly irrelevant. The example to the right shows that the rule is not admissible in $\mathbb{E}^{?}$. As a matter of fact, the example to the left is quite typical for applications of the

8 Negri & von Plato (2011, 2011), von Plato (2016), Troelstra & Schwichtenberg (2000).

rule of weakening, which in a standard sequent calculus would be used when the axiomatic basis of the calculus is restricted to axiomatic sequents of, more or less, the form '$P \vdash P$'. Weakening is then necessary to add context to the skeleton axioms. To be clear: The aim of adding L_{weak} to $\mathbb{E}^{Q}$ is to use it as in the example displayed on the left, that is, to *remove irrelevant information*, to *reduce the information noise* which needs to be deleted in order to focus on what is relevant for the conducted inquiry.

The following lemma is an analogue of height-preserving admissibility of weakening[9] which I prove in (2021):

> Lemma 1 (semi-admissibility of L_{weak} in $\mathbb{E}^{Q}$). If there exists, in $\mathbb{E}^{Q}$, a successful Socratic transformation **s** of the question-conclusion of L_{weak}, and **s** is of length n, then there exists a successful Socratic transformation in $\mathbb{E}^{Q}$ of the question-premise of the rule which is of length not exceeding n.

The following is a straightforward corollary from the above lemma.

> Corollary 2 (eliminability of weakening in $\mathbb{E}^{Q}$). If there is a successful Socratic transformation of question Q in $\mathbb{E}^{Q} \cup \{L_{weak}\}$, then there is also one in $\mathbb{E}^{Q}$.

Here is the rule of contraction:

$$\frac{?\,(\,\Phi\,(\,B_1, \ldots, B_n \vdash A\,)\,)}{?\,(\,\Phi\,(B_1, B_1, \ldots, B_n \vdash A\,)\,)}\ L_{contr}$$

Applying the contraction rule amounts to adding another occurrence of a formula that already occurs in the antecedent of the sequent-premise. Again, when compared to the usual contraction rules of sequent calculi the above rule is ›inverted‹. The rule is necessary to *secure information*. For example, in the case of the so-called *additive* rules of sequent calculi, like the following:

$$\frac{A, \Gamma \vdash C \quad B, \Delta \vdash C}{A \vee B, \Gamma, \Delta \vdash C}$$ where Γ, Δ are finite multisets of formulas

it can happen that repeating some part of Γ or Δ in the premises is necessary to finish the proof. This aspect is somehow invisible in erotetic calculi as all the erotetic rules are designed to share contexts, exactly for the reason of securing all the information contained in the question-premise. But we can think of other

9 Cf. Negri & von Plato (2001:sect. 3.2).

reasons for securing the information which is the description of a problem that is being decomposed when we try to solve it.[10]

For example:

$$\dfrac{\dfrac{?\,(\,\Phi\,(\,B \wedge C, B_2, \ldots, B_n \vdash A\,)\,)}{?\,(\,\Phi\,(\,B \wedge C, B \wedge C, B_2, \ldots, B_n \vdash A\,)\,)}\,L_{contr}}{?\,(\,\Phi\,(\,B, C, B \wedge C, B_2, \ldots, B_n \vdash A\,)\,)}\,L_{\wedge}$$

In the above Socratic transformation the formula $B \wedge C$ is copied so the information about the initial structure of the problem is secured. To sum up, the rules of contraction in the erotetic setting are interpreted as *rules for securing information*.

The following lemma is an analogue of admissibility of contraction, but without the height-preserving property.[11] It is worth noticing that not every variant of sequent calculus for classical logic admits this property. The proof of the following lemma can be found in (Leszczyńska-Jasion 2021).

> Lemma 2 (semi-admissibility of $\mathrm{L}_{\mathrm{contr}}$ in $\mathbb{E}^{\mathrm{Q}}$). If there is a successful Socratic transformation of the question-conclusion of $\mathrm{L}_{\mathrm{contr}}$ in $\mathbb{E}^{\mathrm{Q}}$, then there is a successful Socratic transformation of the question-premise of the rule in $\mathbb{E}^{\mathrm{Q}}$.

From the above lemma the following conclusion follows.

> Corollary 3 (eliminability of $\mathrm{L}_{\mathrm{contr}}$ in $\mathbb{E}^{\mathrm{Q}}$). If there is a successful Socratic transformation of question Q in $\mathbb{E}^{\mathrm{Q}} \cup \{\mathrm{L}_{\mathrm{contr}}\}$, then there is also one in $\mathbb{E}^{\mathrm{Q}}$.

A similar structural analysis can be performed for (some) propositional modal logics and propositional intuitionistic logic, as shown in (Leszczyńska-Jasion 2021).

In the discussion during the conference there was a question about other proof-theoretic developments in the logic of questions, so I add some information and some items to the references section.

Interrogative tableaux were proposed, *int. al.*, in (Hintikka 1992, Hintikka & Harris 1988), developed in (Harris 1994) in terms of game-theoretical semantics, then proposed in a more expanded form in (Hintikka et al. 1999). The gametheoretical interpretations have been further developed, e. g., in (Genot 2009, Genot & Jacot 2010).

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10 The example that follows was not discussed during the conference, I added it afterwards.

11 Compare Negri & von Plato (2001:sect. 3.2).

Natural deduction systems for inquisitive propositional logic InqB and certain fragments of the first-order system InqBQ were presented by Ivano Ciardelli in Chapters 3 and 4 of (2016).

The method of Socratic proofs: First introduced in (Wiśniewski 2004), the first-order level captured in (Chlebowski 2018, Leszczyńska-Jasion 2021, Wiśniewski 2006, Wiśniewski & Shangin 2006), see also (Wiśniewski 2013); propositional paraconsistent logics, mainly CLuN and CLuNs in (Wiśniewski et al. 2005), then also the minimal LFI (Logic of Formal Inconsistency), mbC, ›erotetized‹ in (Chlebowski & Leszczyńska-Jasion 2015). Erotetic calculi for propositional modal logics were discussed in (Leszczyńska 2004, 2007, Leszczyńska-Jasion 2008, 2009, 2021); propositional intuitionistic logic in (Leszczyńska-Jasion 2021, Skura 2005), and FDE (First Degree Entailment) in (Szczepiński 2018).

The relation of *erotetic implication* and/or *evocation* was captured proof-theoretically in (Cordes 2020, Millson 2019, 2021). In (Skura & Wiśniewski 2015) the authors develop an axiomatic account of proper multiple-conclusion entailment; later in (2016) Wiśniewski extends the ideas of (Skura & Wiśniewski 2015) into an axiomatic account of classical propositional evocation in a sequent calculus style.

Dynamics is not really present in the framework of erotetic calculi, but erotetic search scenarios can serve for this purpose. The idea of e-scenarios was introduced in (Wiśniewski 2003), and examined and/or applied in (Leszczyńska-Jasion & Łupkowski 2016, Łupkowski 2016, 2017, Łupkowski & Leszczyńska-Jasion 2016, Urbanski 2001, Urbanski & Łupkowski 2010); see also (Wiśniewski 2013:Part III).

Finally, connections between the various paradigms in the logic of questions are examined in: (Hamami 2015, Łupkowski 2015, Wiśniewski 2017, Wiśniewski & Leszczyńska-Jasion 2015).

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6A Comments on Dorota Leszczyńska-Jasion's *The Method of Socratic Proofs*

Jared Millson

Over the past 50 years, the logical study of questions has matured into a robust field of research, with a number of frameworks and paradigms taking root. Among these, the program of Inferential Erotetic Logic (IEL) has been especially fruitful. This program strives, as its architect, Andrzej Wiśniewski, puts it, "to analyze inferences which have questions as conclusions and [to] give an account of the validity of these inferences" (Wiśniewski 2013:1). IEL is distinctive in its focus on inferences to and from questions. While other approaches may specify entailment relations among erotetic relata, few are devoted to understanding the erotetic reasoning patterns that we find intuitively valid, and none attempt to capture the range of such patterns as IEL does.

As the appearance of the term 'validity' in Wiśniewski's description suggests, IEL is primarily occupied with the semantic characterization of these erotetic inferences. In this respect, IEL resembles many other paradigms in the field. Indeed, compared to the extensive semantic treatments on offer, relatively little work has been devoted to proof theory in erotetic logic. This relative dearth of scholarship is especially acute in the case of IEL, since proof theory aims, *inter alia*, to formalize our actual practices of inference-making, practices that IEL contends often include questions. There is thus a compelling need for proof-theoretic accounts of the inferential relationships studied by IEL. It is here that Dorota Leszczyńska-Jasion's contribution to the field and her study of Socratic Proofs is invaluable.

In what follows, I provide a brief introduction to IEL in order to establish the context of Leszczyńska-Jasion's work. I will then proceed to describe key features of her chapter, reflecting on its significance for the study of Socratic Proofs and erotetic logic more generally. My aim is to make this material as accessible as possible to those working outside the field.

6A.1 Why Inferential Erotetic Logic?

Inferential Erotetic Logic (IEL) emerged in the mid-1990's as a rejection of the then-popular view that there are no legitimate patterns of inference that involve questions, either as premises or conclusions. Nuel Belnap embodied this view when, in a piece that enjoins philosophers and logicians to abandon their preoccupation with declarative sentences and truth-conditional content – what he calls the "Declarative Fallacy" – he states that "it is *only* declaratives that can figure in inference" (Belnap 1990; emphasis in original). Against this "received view", Wiśniewski (1995) argues that there are intuitively recognizable inferences in which questions figure as conclusions – a. k. a. erotetic inferences – and that it is possible to define the validity of such inferences without assigning questions a truth-value. At the core of this proposal are two distinct families of erotetic inference – *erotetic evocation*, in which questions "arise" from a set of statements, and *erotetic implication*, in which questions are inferred from other questions together with a (possibly empty) set of auxiliary statements.

Wiśniewski's claims were not without precedent. In the two decades preceding the latter's monograph, Tadeusz Kubiński (1980) analyzed questions as syntactic categories of first-order languages. This approach enabled Kubiński not only to represent a wide range of question types but also to identify various logical relationships among questions and their answers that intimate what Wiśniewski would come to call erotetic inferences. Around the same time, Jakko Hintikka was developing his semantics for interrogatives into the Interrogative Model of Inquiry (IMI) – which promised to be both a general theory of argumentation and a logic of scientific discovery (Hintikka 1981, Hintikka & Harris 1988). Built with the tools of epistemic logic, IMI formulates rules of question-and-answer procedures in the style of tableaux systems and has subsequently been given a game-theoretic semantics (Harris 1994, Hintikka 1992). Unlike IEL, however, IMI does not analyze inferences among questions themselves.

Among the distinctive features of Wiśniewski's approach is its capacious treatment of the relationship between questions and answers. Other analyses of this relationship, both prior and subsequent, cleave to interpretations of natural language expressions and strive to formalize the meaning and, on occasion, the use of interrogative sentences in a first-order language. In some cases, this effort results in expressions that make the representation of inferences among formal analogues to natural language interrogatives quite difficult, if not impossible – though for Belnap and Steel (1976), this is no doubt considered a feature rather than a bug. In other cases, questions are reduced to more familiar abstract entities – e. g. functions on sets of possible worlds – which makes

the relationship between questions and answers both perspicuous and readily applicable to natural language analysis, but which restricts the scope of its relata. Groenendijk and Stokhof's (1984, 1997) popular treatment of questions as partitions of logical space, for instance, identifies questions with sets of their complete possible answers and treats the latter as both mutually exclusive and jointly exhaustive. Whatever advantages such representation schemes may have for capturing the meaning of *certain* classes of natural language expressions, those advantages are purchased at the cost of rather severe constraints on what can qualify as a question and what relations they can stand in.

In contrast, Wiśniewski's approach to the representation of questions and answers, drawing as it does upon Kubiński's, is remarkably liberal, and, in this respect, IEL enjoys a flexibility that almost none of its rivals possess. First, it treats questions as distinct syntactic expressions in a formal language, i. e. erotetic formulas, rather than as semantic objects or abstract entities, ensuring that virtually any logical language can be "enriched" with questions. Second, it identifies questions with sets of their direct answers and places few constraints on the latter. Informally, direct answers are just possible answers to a question that are "optimal" in the sense that they provide information of the required kind and, at the same time, provide neither more nor less information than is requested. Formally, direct answers may be formulas of any standard logical language. The sets that constitute questions need only contain two or more (syntactically distinct) members. In this respect, IEL remains largely agnostic about the interpretation of natural language interrogatives – contrasting quite dramatically with Groenendijk and Stokhof's questions-as-partitions view. Finally, IEL requires only a bare bones, "minimal semantics" for a language to exhibit the relations of erotetic evocation and implication – permitting the study of such inferences in both classical and non-classical contexts (Wisniewski 2013:ch. 3). These characteristics stand in stark contrast with, e. g., inquisitive semantics, where questions are defined semantically and are given their own, nonclassical, logic (Ciardelli & Roelofsen 2011). Taken together, these three features give IEL a flexibility that fosters exploration of its inferences in different logical environments – something that anyone sympathetic to logical pluralism should find appealing (Beall 2005). In turn, this flexibility makes IEL an ideal playground for proof theorists.

6A.2 The Method of Socratic Proofs

As mentioned above, proof theory is of special import for IEL insofar as the former aims to model actual patterns of argumentation as formal objects and the latter claims to study actual patterns of erotetic argumentation. It is reasonable

to expect any logic that claims to analyze extant reasoning-phenomena to be equipped with a proof theory that characterizes the construction of proofs within it. But the significance between proof theory and erotetic logic may well run in the other direction – i. e. an analysis of erotetic argumentation might yield insights for the formal study of proofs.

One such insight concerns the (higher-order) process of determining whether a proof exists. A reasoner who attempts to find the proof of a claim (or set of claims), X, in a system, C, may be construed as seeking an answer to the question 'Is there a proof of X in C?'. The process of obtaining a proof thus reduces to that of finding an answer to this question. For instance, a reasoner might proceed to transform X via the rules of C, such that she eventually arrives at a question of the form 'Is there a proof of X^* in C?' where a proof of X^* is self-evident.

Indeed, this pattern appears to describe the familiar procedure of backward proof search. When we want to determine whether some sequent, $X \vdash A$ is derivable in a sequent calculus, *SC*, we typically construct a tree from the bottom up. That is, we begin with the (end) sequent in question and consider what premises would be needed to obtain that sequent via *SC*'s rules, and then what premises would be needed to obtain those, and so on until we arrive at a sequent that follows directly from *SC*'s axioms. This backward procedure may be construed in terms of a transition from the question 'Is $X \vdash A$ provable in *SC*?' to the self-evident question of whether certain instances of *SC*'s axioms are provable in *SC*. Here, we see that a familiar and ubiquitous feature of our practices of locating proofs is perspicaciously characterized in terms of erotetic reasoning – reasoning in which questions serve as as both premises and conclusions.

As Leszczyńska-Jasion notes, it is precisely this insight that the method of Socratic Proofs – the first proof theoretic method to be developed for relations studied by IEL – aims to provide. More specifically, the method intends to capture patterns of reasoning whereby we decompose complex or ›opaque‹ questions about the derivability of certain sequents in some base logic into simpler, more ›transparent‹ questions whose answers are intuitively obvious.

In its original presentation (Wiśniewski 2004), the base logic was the classical propositional calculus (CPL), and the relevant questions concerned the provability of classical sequents containing (finite) sequences of CPL formulas in their antecedent and single formulas in their succedent, i. e. $S \vdash A$. The derivability relation captured by the turnstile, '$\vdash$', however forms part of the Socratic Proof system's object-language, and thus such sequents are in fact formulas, atomic declarative formulas (atomic d-wffs) to be precise, in the the overarching system.

The latter's erotetic formulas are formed by appending '?' to a non-empty finite sequence of atomic d-wffs, yielding expressions of the form ?Φ, where $\Phi = \langle S_1 \vdash A_1; \ldots; S_n \vdash A_n \rangle$, which may be read as: 'Is it the case that: A_1 is derivable from S_1 in CPL and … and A_n is derivable from S_n in CPL?'[1] So, the method of Socratic Proof characterizes a process of transitioning from one yes-no question about the derivability of certain sequents to another.

Socratic Proofs belong to the broader class of *Socratic transformations*, i. e. (finite) transformations of a question, ?Φ into another, ?Ψ, according to the system's erotetic rules. These rules apply to a particular constituent of ?Φ, i. e. an atomic d-wff, and replace its occurrence with that of one or two d-wffs, yielding ?Ψ. *Successful* Socratic transformations (SSTs) terminate in questions whose constituent, d-wffs are, in essence, instances of *reflexivity* and/or *ex falso quodlibet*, with side-formulas or ›context‹ – i. e. $S, A \vdash A$ and $S, A, \neg A \vdash B$, respectively.[2] Notice that these are not axioms in the erotetic calculus – indeed, the system has no axioms *per se* – nor are they the axioms of most sequent systems for CPL since they permit non-atomic formulas to be principal (i.e. A above need not be an atom). In the propositional case, Socratic Proofs are simply SSTs – the only difference between the two occurs in the case of base logics with quantifiers, where 'proof' is reserved for successful transformations of questions whose constituent d-wffs are devoid of individual parameters (i.e. proof-theoretic analogues to names or constants).

Socratic transformations preserve an important relationship in IEL. As Wiśniewski (2004) has shown, when there is a Socratic transformation of one question, ?Φ into another ?Ψ, then ?Φ *purely erotetically implies* ?Ψ. Pure erotetic implication is a special class of erotetic implication in which the auxiliary set of statements (i.e. declarative premises) is empty. It is intended to characterize the validity of an inference from one question, Q to another, Q' that satisfies the following conditions:[3]

C_1 if at least one direct answer to Q is true (i.e. Q is sound), then at least one direct answer to Q' \$ is true (i.e. Q' is sound), and

C_2 if each direct answer to Q' is true, then at least one member of a nonempty proper subset, Y, of direct answers to Q is true.

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1 The full erotetic language also contains recursive operators for conjoining (**&**), negating (**ng**) and affirming (**af**) d-wffs. Notice that while erotetic formulas in the system resemble hypersequents, their concatenation is treated ›conjunctively‹ rather than ›disjunctively‹.

2 I am using '¬' for what appears in Leszczyńska-Jasion's presentation as '–'.

3 See (Wiśniewski 2013).

The first of these conditions ensures that erotetic implication preserves question-soundness, just as classical logical consequence preserves truth, such that one cannot be lead from a question that has at least one true answer (i.e. is sound) to one that has none (i.e. is unsound). The second condition establishes that the implied question is cognitively useful for obtaining a direct answer to the implying question by narrowing down the set of its possible (true) direct answers. Since there are no erotetic rules in the Socratic Proof system that apply to statements outside of their role as direct answers to questions, it is clear that the type of erotetic implication that obtains in Socratic transformations is of the pure variety.

In fact, the relationship among questions in a Socratic transformation is even stronger; not only does a Socratic transformation of ?Φ into ?Ψ entail pure erotetic implication between ?Φ and ?Ψ, it also ensures that ?Ψ purely erotetically implies ?Φ. In other words, each question in a Socratic transformation is equivalent, in the sense that an affirmative (resp. negative) direct answer to one is equivalent to an affirmative (resp. negative) direct answer to the another (Wiśniewski 2004). Kubiński calls this relationship one of *p-equipollence* between questions.

The equivalence of questions in a Socratic transformation arises, in part, because the erotetic rules are semantically invertible. In general, invertibility is the semantic complement to semantic adequacy (or soundness) of a rule. Where a rule is semantically adequate just in case one cannot use it to go from true premises to a false conclusion, a semantically invertible rule never leads from false premises to a true conclusion. As articulated by C_1, rules corresponding to pure erotetic implication are semantically adequate when they transmit the soundness (i.e. the property of having at least one true answer) of a question from premises to conclusion. Erotetic rules are invertible when they ensure that sound questions can only be derived from sound questions.

The semantic invertibility of erotetic rules in Socratic Proof systems is closely related to the fact that they codify backwards proof search procedures. Working ›downward‹ in a Socratic transformation from more complex to less complex questions is analogous to working ›upward‹ in a proof search from an end-sequent to its premises. Whereas in sequent calculi proof construction proceeds in the opposite direction of proof search, in Socratic Proof systems the two operate in the same direction. Consequently, SSTs are ›proof confluent‹ in the sense that applying rules to a provable formula always yields a proof, i. e. there are no ›bad moves‹ that might lead a derivation into a ›dead end‹ where no proof is found (Hähnle 2001:119).

6A.3 Erotetic Rules and Their Properties

The fact that Socratic transformations proceed in the opposite direction of proof construction in sequent systems means that certain familiar and desirable properties of proof systems will not apply to the former in the way they typically do to the latter. As we have already observed, the semantic adequacy (i.e. soundness) of a sequent calculus depends upon the adequacy of its rules, while the semantic adequacy of Socratic Proof systems rests on their rules' invertibility. Another example concerns a rule's admissibility.

Traditionally, a rule is thought to be admissible just in case its conclusion is derivable in a system if its premises are. Consequently, admissible rules tend to be formulated as derivation schemata (a. k. a. ›derived rules‹) that serve as ›shortcuts‹, reducing the length of proofs, but having no effect on the semantic adequacy of the system itself. As Leszczyńska-Jasion's contribution nicely demonstrates, admissibility of erotetic rules is complicated by the direction of Socratic transformations. A straightforward application of the definition of admissibility to Socratic Proofs would yield the following property: If there is an SST of an erotetic rule's premises then there is also one of its conclusion (clause 2 in Leszczyńska-Jasion's Definition 2). But since the premises of erotetic rules align with the conclusions of rules in sequent calculi, this property is analogous to the invertibility of sequent rules – a property that not all sequent calculi share.

Given the difference in direction of proof construction between Socratic Proof and sequent systems, it is tempting to treat as admissible those rules that have the converse property – i. e. if the conclusion of an erotetic rule has an SST, then so do its premises (clause 1 in Leszczyńska-Jasion's Definition 2). Leszczyńska-Jasion warns us not to follow this path either, since it would treat as admissible rules that trivially satisfy this condition by having conclusions for which there is no SST.[4]

In the final analysis, Leszczyńska-Jasion rightly notes that, taken individually, neither the straightforward nor the converse reading of traditional admissibility will be appropriate in Socratic Proof systems – only their conjunction can do the trick. From my perspective, the core justification for this interpretation of admis-

4 It is not clear how much weight this consideration should carry, since the traditional definition of admissibility also admits of such cases. For instance, a rule that permitted the inference of $\vdash B$ from the premise $\vdash A \wedge \neg A$ in a classical sequent calculus would trivially satisfy the traditional definition of 'admissible', since there is no proof possible of its premise. Despite being intuitively unwarranted, the rule respects both the letter and the spirit of admissibility – i. e. that adding an admissible rule has no effect on a system's soundness, neither enlarging nor diminishing the class of sequents that can be proven within it.

sibility is that Socratic transformations preserve equivalency (p-equipollence, to be precise) among questions. Indeed, due to this feature, preserving the semantic adequacy of Socratic transformations requires the mutual or co-derivability of premises and conclusions.

Perhaps the most interesting element in Leszczyńska-Jasion's contribution is her reflection on the potential for formulating familiar structural rules, in particular that of Weakening, in Socratic Proof systems. In sequent calculi, left-weakening is not only an expedient in proof construction, especially in those systems whose axioms are restricted to instances of atomic reflexivity (i.e. $p \vdash p$), but also an embodiment of *monotonicity* (i.e. $A \vdash C \Rightarrow A, B \vdash C$). But monotonicity captures an inherently *directional* property of classical logical consequence.

The converse of monotonicity, treated as a proof-theoretic property, is not something we would expect our proof systems to have. Such a principle would tell us that if $A, B \vdash C$ has a derivation then so do $A \vdash C$ and $B \vdash C$. In some cases, one of the latter sequents will be derivable when the former is, e. g. $p \vdash p$ has a derivation whenever $p, q \vdash p$ does. But even here, $q \nvdash p$, and thus converse montonicity fails, as expected. In other instances, neither of the relevant sequents obtain – e. g. even though $p, q \vdash p \wedge q$ is provable neither $p \vdash p \wedge q$ nor $q \vdash p \wedge q$ are. From a semantic perspective, this outcome is precisely what we would expect. While $A, B \vdash C$ may preserve truth from antecedent to succedent, there is no guarantee that either $A \vdash C$ or $B \vdash C$ will, let alone both.

The failure of monotonicity's converse to obtain in the classical base logic is one reason why Leszczyńska-Jasion's weakening rule (L_{weak}) is not admissible in her erotetic calculus.

$$\frac{?(\,\Phi\,(\,B_1, B_2, \ldots, B_n \vdash A\,)\,)}{?(\,\Phi\,(B_2 \ldots, B_n \vdash A\,)\,)}\, L_{weak}$$

Perhaps, however, there is a rationale for such a rule when viewed from the perspective of erotetic reasoning. After all, if we want to know whether there is a proof of $A, B \vdash C$ then asking whether $A \vdash C$ or $B \vdash C$ is provable may well advance our inquiry. In monotonic base logics, affirmative answers to either of the latter questions, i. e. $\mathbf{af}(A \vdash C)$ or $\mathbf{af}(B \vdash C)$, will entail an affirmative answer to our initial question, i. e. $\mathbf{af}(A, B \vdash C)$. Moreover, a negative answer to our initial question, i. e. $\mathbf{ng}(A, B \vdash C)$ entails negative answers to $?(A \vdash C)$ and $?(B \vdash C)$. But notice that negative answers to those questions will *not* entail an answer to the initial question, i. e.$?(A, B \vdash C)$, nor will an affirmative answer to the latter entail answers to either of the former. Thus, adding a (left) weakening rule to the Socratic Proof system would not only compromise p-equipollence

among questions, it would also undermine the pure erotetic implication between premises and conclusion (and, of course, vice versa).

What then is the point of discussing a rule such as L_{weak}? Leszczyńska-Jasion tells us that, when read top-down, such a rule may be conceived as licensing the removal of information. In some cases, the information removed is irrelevant – as in the transition from $?(p, q \vdash p)$ to $?(p \vdash p)$. But in other cases, relevant information is lost – e. g. from $?(p, q \vdash p)$ to $?(q \vdash p)$ – and our inquiry is led astray.

There can be no doubt that the identification of irrelevant information and its removal is a vital facet of our practices of erotetic reasoning. If I am wondering who broke the vase and I have two sets of information, one consisting of the location of certain individuals at the time of its destruction, and another consisting of complex arithmetic truths, the latter is, at least *prima facie*, irreverent. My inquiry will proceed much faster, more efficiently, and more successfully if I ignore the latter set of information and focus on the first. The tricky part, however, is determining what counts as relevant information. In this hypothetical case, the distinction is obvious, but in many others it will not be. Jettisoning relevant information, such as that concerning the suspects' locations, frustrates and even inhibits inquiry.[5]

The difficulty, then, with L_{weak} is that it permits the indiscriminate removal of information, whether irrelevant or not. In this respect, the rule retains the close relationship between backwards proof search and Socratic transformation. When constructing derivation trees, bottom-up, according to the rules of a calculus, we will invariably produce some that fail to constitute proofs – e. g. we will find premises from which our end-sequent follows but which are not, in turn, (ultimately) derivable from its axioms. A fruitless application of L_{weak} is similar insofar as it leads us to pursue a question for which there is no SST. The similarity with backward proof search may be sufficient to warrant a consideration of L_{weak}. But the rule not only fails to preserve the soundness of the erotetic system to which it is added, it also jeopardizes the system's *confluence* – it constitutes, in some instances, a ›bad move‹ that leads to ›dead ends‹.

In my view, the upshot of Leszczyńska-Jasion's discussion of L_{weak} is that it highlights what is at once the strength and limits of Socratic Proofs. By preserving equivalence among questions, the downward construction of a successful Socratic transformation eventually yields an answer to our initial question. And when regarded upwards, the transformation reveals how simple

5 It is interesting to note that the very notion of relevant information has been subject to analysis in terms of answers to questions (Floridi 2011, Allo 2014).

questions can be manipulated and concatenated to produce much more complex ones. These are unequivocal insights, especially for our understanding of mathematics and other formal sciences. But this type of erotetic reasoning is the patina of a deeper and richer phenomenon. The erotetic reasoning we find in the empirical sciences and in everyday inquiries traverses relationships among questions that are, like L_{weak}, far looser, more prone to error, and more *heuristic* in nature than those captured in Socratic Proofs. IEL has resources to aid our understanding of these relationships and the flexible framework in which to explore them. I have begun to do so already in (Millson 2021), but much more work is needed. In pursuing such endeavors, we should take to heart the lessons imparted by the study of Socratic Proofs.

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7 Accepting & Rejecting Questions: First Steps toward a Bilateralism for Erotetic Logic

Jared Millson

Abstract
It's commonly thought that, in conversation, speakers accept and reject propositions that have been asserted by others. Do speakers accept and reject questions as well? Intuitively, it seems that they do. But what does it mean to accept or reject a question? What is the relationship between these acts and those of asking and answering questions? Are there clear and distinct classes of reasons that speakers have for acceptance and rejection of questions? This chapter seeks to address these issues. Beyond their intrinsic interest to those working on the nature of questions, solutions to these problems may aid the extension of inferentialist approaches to logic and language. Inferentialists who think that inferences should be conceived in terms of the norms we are subject to in virtue of both the sentences we accept or assert as well as those we reject or deny are known as *bilateralists*. A coherent account of accepting and rejecting questions raises the prospects for a bilateralism that interprets question-involving or erotetic inferences according to these additional primitives. While a full-blown bilateralism for erotetic inferences and ultimately for question-forming operators themselves far exceeds this chapter's scope, the work presented here does sketch the first steps in that direction.

7.1 Introduction

When philosophers of language, logicians, and formal semanticists talk about *questions* they typically have in mind the semantic objects associated with interrogative clauses, as well as the contents of certain speech acts and mental states. In these contexts, the paradigmatic speech act is that of *asking a question*. While the attention paid to this type of speech act still pales in comparison to the ink spilled on its cousin, *assertion*, there has been at least some concerted effort to understand

what it is to ask a question (Searle 1969, Bach & Harnish 1979). Until recently there was little interest in question-directed attitudes other than *knowledge-wh*. Fortunately, thanks to the recent work of epistemologists on attitudes like *inquiring* and *wondering* (Friedman 2013, 2017a, 2017b), this is changing.

Despite these noble attempts to break free from what Nuel Belnap (1990) called the declarative fallacy – i. e. the privileging of declarative sentences and their contents in semantics and pragmatics – there remains plenty to be done. Those of us working in the intertheoretic sub-field devoted to the nature of questions should, *inter alia*, strive to analyze the various things that we *do* with questions. This means investigating speech acts other than those of asking and answering questions as well as the interrogative attitudes these hitherto neglected speech acts might express. Among the inhabitants of this inquisitive realm that deserve our attention are the acts and attitudes of accepting and rejecting questions, or so I contend.

The call to appreciate the ways we accept and reject questions is unlikely to meet resistance from the sub-field's rank and file – what researcher ever opposed the investigation (especially by others) of phenomena in her domain? But I will not motivate this call simply by appealing to the intrinsic value of understanding these phenomena. Rather, I would like to point up the role such understanding might play in a more ambitious project in the philosophy of language and logic, namely, inferentialism.

Inferentialism is the program that seeks to explain the meaning of linguistic expressions in terms of the role they play in our inferential practices – what Brandom (1994) calls "the game of giving and asking for reasons". The inferentialist program has been pursued by a motley of theorists operating with what are often divergent research interests. In the hands of some, most notably Brandom (1994, 2008) and Peregrin (2014), the program is a grand philosophical affair intent on nothing less than a systematic treatment of vocabularies – semantic, intentional, representational, and modal – as different ways of making explicit speakers' commitments in a primitive, denuded inferential practice. In others' hands, the program is a far more technical endeavor, aiming to show that the meaning of specific expression-types and operators is captured by their introduction or elimination rules in a natural deduction system grounded on a proper account of *proof* (Francez & Dyckhoff 2010, Piecha & Schroeder-Heister 2016, Prawitz 1965, Schroeder-Heister 2006, Wansing 2000).

It must be acknowledged that inferentialism in all its forms has struggled to achieve its goals – with some taking a dim view of its prospects altogether (Williamson 2010). There are two interrelated challenges that the program faces, which, in turn, shape how its practitioners operate. The first is the lack of

consensus regarding what constitutes *inference* or *proof*. The second is the need to expand the range of linguistic phenomena explained by inferentialist means.[1] Given these challenges, most contributions to inferentialism attempt to show that a preferred interpretation of *inference* is able to fund theories that can save more phenomena than their competitors. So it is with my suggestion here.

The conception of inference with which I am concerned comes from those inferentialists who espouse *bilateralism*. According to bilateralism, inferences should be conceived in terms of the norms we are subject to in virtue of not only the sentences we accept or assert, but also those we reject or deny (Francez 2014, Restall 2005, Rumfitt 2000). Here, then, is where the acceptance and rejection of questions has the potential to make progress on both challenges confronting inferentialism.

If it can be shown that the bilateralist's notions of acceptance and rejection apply to questions as well as to propositions, then it may be possible to give bilateralist interpretations of inferences containing interrogative vocabulary, or at least their formal, logical counterparts. The latter have been studied in model-theoretic frameworks under the title of *erotetic inferences* for more than 30 years by those working in the program of Inferential Erotetic Logic (IEL) (Wiśniewski 1995, 2013).[2] If these inference-types can be given plausible bilateralist interpretations, the stage would be set to regiment those inferences in ways that capture the semantics of questions. The resultant bilateralism for interrogative vocabulary would make progress on both challenges confronting inferentialism – i.e. it would inch the program closer to conceptual consensus by showing that bilateralism's notion of inference can explain a new range of phenomena.

The prospects for this bilateralist program will depend upon our ability to expand the notions of *acceptance* and *rejection* beyond the speech acts of assertion and denial to those whose contents are questions. My central claim here is that such expansion is coherent and plausible. I will attempt to show that acceptance and rejection, as the bilateralist conceives them, are determinable attitude or speech act types whose determinates can take on

1 As Greg Restall (2016) has recently observed, if logical inferentialism is to be taken seriously as a genuine theory of meaning, its champions must do "more work on the range of applications in the theory of meaning for speech acts beyond assertion and concepts beyond the core logical constants".

2 Ostensibly, the idea would be to replace the model-theoretic account of erotetic inferences offered by IEL with a proof-theoretic one. My recent attempts to develop a proof theory – in the form of nonmonotonic sequent calculi – for some of the inferences studied by IEL have hinted in this direction, but I have yet to offer a full-throated defense of this inferentialist strategy (2019, 2021). The reader will not find such a defense here either; rather, I aim to address one of the issues confronting such a defense.

different content-types, namely, propositions and questions. I will motivate this effort by looking at claims in the literature that appear to anticipate this expansion and suggest ways in which we might understand accepting and rejecting questions. Of course, even if *acceptance* and *rejection* can be coherently applied to questions, the success of a bilateralist approach to erotetic inferences requires the adequate treatment of many additional technical and conceptual issues. My aim here is simply to clear the ground for such an approach.

To flesh out my proposal, I will sketch the ways that accepting and rejecting questions can be achieved both explicitly and implicitly by more familiar speech acts, e. g. those of asking and answering questions. The upshot here is that there are no one-to-one mappings among the acts of asking/answering and accepting/rejecting a question. Rather, askings and answerings can serve to accept or reject questions, depending on their context and content.

I will also follow previous bilateralist attempts to distinguish stronger and weaker forms of assertion and denial within a framework for conversational dynamics that roughly coheres with what Stalnaker (2002) has developed. Incurvati and Schlöder (2017, 2019) have pursued this approach by arguing that strength-variants of assertion and denial can be distinguished in terms of the reasons or grounds that speakers have for asserting or denying a proposition. While I do not think that question acceptance and rejection come in forms that are intuitively *strong* or *weak*, I will argue that they may be productively sub-divided according to speakers' reasons. I summarize the speech acts that realize the acceptance/rejection of questions, both explicitly and implicitly, as well as the various reasons a speaker might have for doing so in Table 2.

7.2 Bilateralism and Questions

Bilateralism in logic is often cast as a response to Frege's (1919) claim that it is unnecessary to distinguish the speech act of assertion from that of denial since the latter can be reduced to assertions of negated propositions. Bilateralists, in contrast, insist that denials ought to be awarded the status of primitives alongside assertions (Smiley 1996, Rumfitt 2000). Doing so, they contend, not only does justice to a fundamental discursive phenomenon, but also supplies a pragmatically-grounded conception of *inference*, e. g. as norms governing constellations of asserted and denied propositions. This conception, in turn, provides a framework within which logicians may assess the merits of different inference rules and formal systems. As Restall (2013) has argued, friends of truth-gaps can be construed as advocating the coherence of denying A without asserting $\neg A$ while friends of truth-gluts can be seen as championing the coherence of asserting $\neg A$ without denying A. Perhaps most notable of all, bilateralists offer

an inferentialist defense of classical logic, thus marking a substantial intervention in the long-running debate about which logic, classical or intuitionistic, is to be preferred on pragmatic or "anti-realist" grounds (Restall 2005).

Once again, my distal aim is to see whether there are tools in the bilateralist toolshed that might fund a coherent, pragmatically-informed notion of erotetic inference. At first blush, this might seem a hopeless endeavor. The primitives of bilateralism are, after all, the speech acts of assertion and denial, and regardless of your attitude toward their coeval status, we can all agree that neither concern questions. Curiously, though, an appeal to questions figures in one of the earliest defenses of bilateralism. Smiley (1996) proposes that both assertion and denial be conceived as question-answer pairs. Asserting *A* is construed as answering *Yes* to the self-addressed question *Is it the case that A?* while denying *A* is answering *No*. In a sense, Smiley intimates that assertions and denials are analyzable into yet more primitive components, namely, questions and answers. While I will not explore that suggestion here, Smiley's interpretive strategy does suggest a deep connection between acceptance and rejection, on one hand, and questions and answers, on the other.

The claim I wish to explore here is that assertion and denial express just one kind of acceptance and rejection – namely acceptance and rejection of a claim, of a proposition, or, following Smiley's lead, of an answer to a question. In other words, acceptance and rejection might be general *determinable* types of which the attitudes expressed by assertion and denial are *determinates*.[3] While bilateralists have focused on assertion and denial as the building blocks of inference, their approach might in fact offer the resources for understanding other speech acts and attitudes as instances of these determinable attitude- or speech act-types – what I will be calling *acceptance* and *rejection* – and for establishing an expanded notion of inference.

Since the terms 'acceptance' and 'rejection' have been used with various senses by different bilateralists, it behooves us to take a moment to regiment our terminology. In what follows, I will use these terms to refer to the determinables whose determinates are types of attitudes as well as types of speech acts. When needed, I will distinguish propositional acceptance/rejection from question acceptance/rejection, where these modifiers denote the content-types of the respective attitudes and speech acts. The most familiar determinate speech act of propositional acceptance is assertion, and its counterpart is denial, which is a determinate of propositional rejection. The attitude typically expressed by

3 My claim here does not appeal to any particular account of the determinable-determinate distinction, but for a nice gloss on the topic see Funkhouser (2006).

assertion is what I will call 'assent', and I will call the attitude associated with denial 'dissent'. So assent and dissent are determinate attitudes of acceptance and rejection, respectively.

Strictly speaking, then, I am proposing two pairs of determinables: There is the pair consisting of the determinable *attitudes* of acceptance and rejection (whose determinates are assent and dissent) and the pair of determinable *speech acts*, which I am also calling acceptance and rejection (whose determinates are the speech acts of assertion and denial). I will assume that in ordinary circumstances, a speaker expresses her assent to a proposition when she asserts it, and her dissent from a proposition when she denies it.[4]

	Attitude	Speech act
Propositional acceptance	Assent	Assertion
Propositional rejection	Dissent	Denial

Tab. 1: Terminology for propositional acceptance & rejection

I will use the term 'question' to refer to the semantic objects associated with interrogative sentences, and to the contents of certain speech acts (e.g. askings) and mental states (e.g. inquiring). For brevity, I will refer to acts of asking a question as 'queries' and to acts of answering questions as 'answerings'. I will assume that speakers express interrogative attitudes when they felicitously ask a question (Friedman 2013, 2017a). Given the tight connection between interrogative attitudes and the speech acts that express them, and for sake of concision, I will be focusing most of my attention on the speech acts of querying and answering.

As mentioned, my aim is to show that questions form the semantic contents of speech acts other than queries, namely those of accepting and rejecting. While some of the accounts of these acts that I will examine operate with particular conceptions of questions – e.g. one that treats questions as partitions of logical space – I am

4 I am intentionally loose with my talk of determinable ›speech acts‹ and will not insist upon their determinates validating speech act reports that employ some special speech act verbs in natural language. Even though it is perfectly intelligible to say someone accepted or rejected a question, we rarely make such ›reports‹, and our intuitions regarding them do not provide the best guide to inquiry. It may be safer to say that acceptance and rejection are sorts of ›moves‹ one makes in discourse, which are often but not always realized by distinct speech acts. Indeed, as my discussion of the literature indicates, the acceptance and rejection of questions has a complicated relationship to the more canonical speech acts of asking and answering questions.

not presuming any particular account of questions. Still, what I have to say is most conducive to the family of accounts that represent the *set-of-answers methodology*, according to which questions are sets of those propositions that provide its possible direct answers (Peliš 2017). The account of question acceptance and rejection that I land on appeals to Stalnaker's (1999, 2014) view of conversational dynamics in terms of what he calls the *common ground*. I have found this framework to be quite helpful, but I suspect that the picture I sketch could be spelled out against different background theories of pragmatics.

7.3 Acceptance and Rejection as Determinables

There is precedent for the view of acceptance and rejection I am suggesting. I will begin by outlining the account of propositional acceptance and rejection as determinables. The *locus classicus* for this view is Stalnaker.

> "Acceptance, as I shall use the term, is a broader concept than belief; it is a generic propositional attitude concept with such notions as presupposing, presuming, postulating, positing, assuming and supposing as well as believing falling under it. Acceptance is a technical term: claims I make about acceptance are not intended as part of an analysis of a term from common usage. But I do want to claim that this technical term picks out a natural class of propositional attitudes about which one can usefully generalize. Belief is obviously the most fundamental acceptance concept, but various methodological postures that one may take toward a proposition in the course of an inquiry or conversation are sufficiently like belief in some respects to justify treating them together with it.
>
> To accept a proposition is to treat it as a true proposition in one way or another – to ignore, for the moment at least, the possibility that it is false. One may do this for different reasons, more or less tentatively, more or less selfconsciously, with more or less justification, and with more or less feeling of commitment." (Stalnaker 1984:79–80)

I think we can plausibly attribute to Stalnaker the view that acceptance is a determinable attitude-type of ›treating-a-proposition-as-true‹ whose determinates are distinguished from one another by, *inter alia*, the reasons or grounds for this treatment.[5] Indeed, he insists that unlike belief, agents do not accept things *simpliciter*, but always "for some purpose or other" (Stalnaker 2014:39).

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5 There is some ambiguity in Stalnaker's use of the term 'acceptance'. He uses it both for this determinable attitude-type and for its determinate instances that are simply not belief (assent). To avoid confusion we might refer to the latter as *non-doxastic acceptance*. So we have a general attitude-type of acceptance whose determinates are belief and non-doxastic acceptance – the latter being something like the relative complement of acceptance (in the determinable sense) and belief.

What is the relation between this generic attitude of acceptance and the speech act of assertion? On Stalnaker's account, an assertion is a proposal to update the common ground. Roughly put, the common ground is the set of propositions which conversational participants take for granted for the purposes of that conversation – i. e. those propositions they *accept*. In a possible worlds framework where we think of a proposition as a set of possible worlds, each proposition in the common ground may be conceived as making a distinction between sets of possible worlds, ruling out the worlds in which the proposition is false. The intersection of the common ground is the context set, i. e. the set of worlds which participants collectively consider to be possible for the purposes of conversation. In order for an assertion to successfully update the common ground, it must be accepted by all parties to the conversation.

Since others' acceptance of a proposition is required for its successful assertion, acceptance might initially sound like a purely reactive move – one that can be realized only after a proposition has been asserted in discourse. But if accepting an assertion is a matter of permitting the common ground to be updated by the addition of its propositional content, then, by asserting *A*, a speaker signals, rather trivially, that they accept *A*. This seems to hold for proposals more generally – e. g. if I am proposing that we take the highway to our destination, then it goes without saying that I am permitting us to do so.[6] So it is perfectly consistent with Stalnaker's approach to treat acceptance as a generic, determinable attitude or act that is not purely reactive.

In a similar vein, and as part of a broader contribution to bilateralist inferentialism, Incurvati and Schlöder (2017) defend the idea that rejecting a proposition is a matter of refusing to update the common ground. Furthermore, they claim that there are stronger and weaker ways of doing so depending on the speaker's reasons. A speaker who *strongly* rejects a proposition prevents it from updating the common ground *because it is false*, while one who *weakly* rejects a proposition does so for some other reason. More recently, Incurvati and Schlöder (2019) have extended their account to include a weak version of assertion. Both weak rejection and weak assertion are distinguished from their stronger forms by the fact that they make *unspecific* demands for evidence – e. g. a weak rejection of *A* may be correct because there is evidence against *A*, but may also be correct because of the (mere) absence of evidence for *A*. Weak

6 The more interesting and subtle cases of acceptance are those in which interlocutors accept one proposition by asserting another or simply by not contesting someone else's assertion. These are the cases that Stalnaker (2014, 1999) looks at in developing his account of presupposition accommodation.

rejection and weak assertion are in this sense a motley, or as Dickie (2010) puts it, they are "messy".[7]

Both Stalnaker's notion of acceptance and Incurvati and Schlöder's conception of rejection are plausibly interpreted as delineating general, determinable attitude-types or speech act-types whose determinates are distinguished from one another by the grounds a speaker has for accepting or rejecting a proposition. What I am suggesting is that a speaker's grounds for acceptance/rejection is not the only parameter by which to specify their determinates. One may do so by differentiating between what content-types are accepted or rejected – i. e. their *objects*. I want to argue that the possible objects of acceptance and rejection include not only propositions, but also questions.

7.4 Accepting and Rejecting Questions

Having established the plausibility that propositional acceptance and rejection are determinable act and attitude types, I turn now to those who have discussed the phenomena of question acceptance and rejection. Lascarides and Asher (2009) treat acceptance and rejection as speech acts that "don't just happen with assertions" but also "with questions as well", and claim that "an agent can choose to address the issues raised by the questioner; he can also choose to reject them" (Lascarides & Asher 2009:1). So, on this account, acceptance and rejection are again determinable speech acts whose determinates can take different content-types.

On their view, a speaker may explicitly accept a question by uttering something to the effect of *Good question!* as well as by "providing a direct answer or by an explicit admittance that one doesn't know an answer" (Lascarides & Asher 2009:1–2). Explicit rejections can be realized by saying things like *That's not a good question!* or *I won't answer that question!*. In both cases, a *good* question is one that is worthy of being addressed. Lascarides and Asher (2009) also contend that speakers may *implicitly* accept and reject questions. We will look at some of the ways speakers may achieve this in section 7.4.1 below.

Another precedent for the idea that acceptance and rejection can take questions as their objects is Roberts (2012). Augmenting Stalnaker's picture of conversation as a practice of collaborative inquiry, Roberts adds *questions under discussion* (QUD) to the conversational *scoreboard*. Just as we can think of a proposition as a set of possible worlds, we can think of a question as a set of sets of possible worlds whose members (i.e. sets of worlds) correspond

7 The "messiness" of Incurvati and Schlöder's (2019) weak assertion thus hearkens back to (what I have called) Stalnaker's non-doxastic acceptance.

to the propositions that give possible answers to that question. Following Groenendijk and Stokhof's (1997) semantics for interrogatives, Roberts takes this answer-set as a set of exhaustive propositions – i.e. the sets of worlds are mutually incompatible and a question is a partition over logical space.

Roberts envisions the QUD as an ordered set or *stack* of accepted but yet-to-be answered questions. When a question is accepted, it is added to the top of the QUD stack. This represents the fact that participants are now committed to answering it. An accepted question's "relationship to any question previously on top will be guaranteed by a combination of relevance, entailing a commitment to answering prior questions, and logical constraints on the way that the stack is composed" (Roberts 2012:6:15–16). More specifically, the position of questions on the QUD may reflect a *strategy of inquiry*, whereby certain questions lower on the stack are answered by answering subquestions at the top. Q_1 is a (contextual) sub-question of Q_2 (i.e. the superquestion) if every complete answer to Q_1, together with propositions (accepted) in the common ground, entails a partial answer to Q_2. For instance, in a conversation in which it is common ground that the only egg-laying mammals are the platypus and echidna, participants can adopt the strategy of answering the superquestion *Is this animal an egg-laying mammal?* by accepting and attempting to answer the subquestions *Is this animal a platypus?* and *Is this animal an echidna?*. The subquestion-superquestion relation is quite close to the relation of erotetic-implication studied by IEL (Wiśniewski 1995, 2013), and so I shall often refer to it as an *inferential* relationship among questions.[8]

Paralleling Stalnaker's account of assertion, Roberts treats queries as proposals to add a question to the QUD stack. As with assertions, this proposal must be accepted by all participants in order to take effect. If the proposal is accepted, a new partition is added to the common ground, generating a new set of alternatives to distinguish between, and the participants commit to answering the corresponding question. So Roberts' account agrees with that of Lascarides and Asher insofar as a speaker who accepts a question indicates that she regards it as, in some sense, worthy of being addressed. For Roberts, accepting a question means undertaking a commitment to determine what its answer is.

8 The difference between erotetic implication and the superquestion-subquestion relationship (as conceived by Roberts) is that the latter is formulated according to the questions-as-partitions view where questions are sets of their exhaustive and mutually exclusive answers. Erotetic implication, on the other hand, is formulated according to the view that questions are (just) sets of their direct answers, which need not be exhaustive or mutually exclusive. Thus, erotetic implication is a broader and more liberal relation than Roberts' superquestion-subquestion relationship.

To my knowledge, Roberts does not explicitly consider what it means to reject a question. According to her model, however, a question is *removed* from the QUD just in case either its answer is entailed by common ground (e.g. after the latter is updated by an assertion that a participant makes in response to the question) or it is determined to be unanswerable. Of course, being removed from the QUD may not be the same as being rejected, since rejection, it would seem, is a matter of refusing to allow the question to be added to the QUD in the first place. (I will return to this issue in section 7.4.4.)

So there is precedent for considering acceptance and rejection to be determinable speech acts, and, ostensibly, attitudes too, whose content may be questions as well as propositions. To accept a question is to deem it worthy of address, to undertake a commitment to finding its answer, and to permit its addition to the conversation's QUD. Rejecting a question is a refusal to allow such addition. In this sense, acceptance (rejection) is seen a matter of allowing (preventing) changes to the conversational context. When a proposition is accepted (rejected), participants allow (refuse to allow) the common ground to be updated by its content. Similarly, when a question is accepted (rejected), the participants allow (refuse to allow) it to be added to the QUD.

7.4.1 Accepting Questions Explicitly and Implicitly

We have already seen some of the ways in which speakers explicitly accept and reject questions. Roberts' account helps to flesh out this picture by offering some insights into the relationship between question acceptance and the paradigmatic speech acts of querying and answering. Following Stalnaker, Roberts treats acceptance as something speakers do in response to others' proposals to update the common ground. However, we need not assume that acceptance is a purely reactive performance. Indeed, we are free to use the strategy we used with Stalnaker to treat assertion as a manner of (trivial) acceptance. *Mutatis mutandis*, in asking a question a speaker permits the QUD to be updated accordingly and thus trivially accepts that question. If, following Lascarides and Asher, directly answering a question is an explicit way of accepting a question, then it would seem that asking a question is as well. So we now have three ways of explicitly accepting a question Q: by directly answering Q, by pleading ignorance with respect to Q's answer, and by asking Q oneself.

How do we implicitly accept a question? Here, I think that Roberts' model of conversational dynamics provides an important insight. One may implicitly treat a question as worthy of address by asking a subquestion to the accepted (super)question. Returning to the previous example, I can accept my interlocutor's question *Is this animal an egg-laying mammal?* by asking the subquestion

Is this animal a platypus?. One might also signal one's acceptance implicitly by referring the querier to a source of information that one thinks will answer the question. For instance, one might defer to anothers' judgment – e. g. *Let's consult Kia; she'll know whether this is an egg-laying mammal.*. This seems like yet another way to accept a question, at least implicitly.

7.4.2 Rejecting Questions Explicitly and Implicitly

We have seen that there are overt and explicit ways to reject a question – e. g. by saying *I won't answer that!*. Let us now turn to the ways in which speakers might do so implicitly. Lascarides and Asher (2009) examine an interview with a politician who responds to a reporter's query by providing information that answers a different question than the one she asks. This is a familiar tactic deployed by speakers who wish to avoid undertaking certain discursive commitments. By answering a question that superficially relates to the question asked, but one that, crucially, does not imply even a partial answer to it (and hence is not one of its subquestions), speakers *evade* that question and *implicitly reject* it. Of course, by evading one question, speakers signal their acceptance of another – i. e. the question whose answer they are providing in lieu of the one asked.

Asking rhetorical questions may also be a way of signalling one's rejection of a question. The point of rhetorical questions is often to ask a question which one thinks should *not* be investigated. Asking rhetorical questions typically succeeds in adding one of its answers to the common ground. So, this is yet another way, besides question evasion, in which querying can serve to reject questions.

So we have now seen some ways to implicitly accept and implicitly reject questions. Before moving on, however, I would like to challenge the suggestion made by Lascarides and Asher (2009) that speakers explicitly accept questions by directly answering them. It seems to me that not all answerings work this way. For instance, if my adult interlocutor, with whom we may suppose I have a long-term and intimate relationship, asks me for the solution to a simple problem of arithmetic, e. g. *Does 2+2=4?*, my affirmative response, likely accompanied by a gesture of surprise and confusion, does not signal my acceptance of the question. I most certainly do not take his question to be worthy of address – indeed, I take it to flout the maxim of relevance, since I assume its answer is already common ground between me and my interlocutor. Irrespective of whether I am able to decipher the communicative intention behind this flouting, my answering will convey, at least implicitly, my *rejection* rather than my acceptance of his question. So, not all direct answerings are ways of accepting a question; some will count as implicit rejections. As the example here suggests, an answering

will tend to implicitly reject a question when its answer is already common ground. I develop this suggestion in section 7.4.4 below.

7.4.3 Reasons for Accepting a Question

We saw that Incurvati and Schlöder (2017, 2019), distinguish between stronger and weaker forms of assertion/denial by citing the reasons or grounds a speaker has for asserting/denying a proposition. Does question acceptance/rejection also admit of sub-divisions according to speakers' reasons? I think they do, though not in ways that suggest the markers 'strong' and 'weak' in any obvious way.

The reasons for which we accept and reject questions are as varied as those for which we accept and reject propositions.[9] Many of the distinctions we could impose upon this motley, even those appearing to ›carve nature at its joints‹, will not serve my purpose. Given my intention to articulate question acceptance/rejection in a manner that might inform a bilateralism for erotetic inferences, the most salient distinction will be that between reasons that are rooted in the nature of conversation as a collaborative inquiry and those that are not. I take it that there are instances in which we accept a question because it *furthers* or reject a question because it *frustrates* the collaborative inquiry with which we are engaged. I will refer to these as *intra-conversational* reasons or goals, and will contrast them with *extra-conversational* ones. The former are reasons agents have for undertaking performances and adopting attitudes that concern the coherent as opposed to incoherent ways in which collaborative inquiry might proceed, i. e. the permissible and impermissible directions such inquiry could take, given how it has been conducted thus far. In this sense, such reasons only arise from within the context of a particular conversation. In contrast, extra-conversational reasons are antecedent to, independent of, or otherwise external to the particular conversational context in question. This distinction is by no means clear cut, but it serves as a helpful starting point – enabling me to home in on those sorts of reasons that may play a role in articulating erotetic inferences.

Among the intra-conversational reasons for accepting a question, one appears to be especially salient. According to Roberts' model, speakers will often accept a question because answering it furthers some inquiry that is already been agreed to – i. e. because it forms a sub-question to some other question on the QUD. In such cases, we accept a question because it realizes a *strategy*

9 Not even Stalnaker sought to provide a taxonomy of reasons for propositional acceptance. Incurvati and Schlöder (2017), moreover, are exceedingly conservative in their approach to reasons for rejection – only distinguishing between rejections grounded in the falsity of a proposition and those that are not.

of inquiry.[10] Oftentimes in conversation we find ourselves addressing questions that promote inquiry on some *bigger* (super)question that lies, often implicitly, on the QUD stack. Indeed, according to Roberts, all conversations have the Big Question of *What is the way things are?* on their QUD stack, since complete answers to *any* question will provide partial answers to this one (Roberts 2012:6:6). If that's the case, then it follows, rather trivially, that speakers can always accept a question on the grounds that it furthers collaborative inquiry into the Big Question.

However, even if such reasons are available to speakers, they need not always be operative in the conversational context. Rather, speakers may have what I am calling extra-conversational reasons for accepting a question – reasons, that is, that speakers have prior to or independently of the particular conversational context in which the question arises. For instance, one might accept a question because doing so follows from certain responsibilities one has as part of one's particular social role – what, following Hart (1968), we may call *role-responsibilities*. By 'social role', I mean the position that one occupies in a profession, organization, or institution in virtue of which others are entitled to treat her as having certain rights and responsibilities. Examples of social roles include: doctor, lawyer, employee, parent, student, colleague, friend, and pet-owner. Social roles and their accompanying responsibilities may, however, be much more fine-grained than this list suggests. For instance, your auto mechanic (not just any auto mechanic) must accept and address, and conversely may not reject, questions about the diagnosis of your car's problems (and not someone else's) before she bills you for repairs. In this scenario, *What's wrong with this car?* is not necessarily a sub-question to any question already on the conversation's QUD – save for the Big Question. Nonetheless, your auto-mechanic has a role-responsibility to accept it.[11]

In addition to role-responsibilities, individuals' desires and interests can also motivate question acceptance in an extra-conversational sense. I might ask a passerby for the time, thereby trivially accepting this question, because I have a desire for punctuality. The passerby may directly answer and hence accept my request for the time simply out of a desire to be polite or helpful. As

10 This may be a *strong* way of accepting a question, since it implies inferential commitments – namely, those that correspond to the subquestion-superquestion relationship – but again, I see no obvious way of maintaining a distinction between strength-variants of question acceptance.

11 Khalifa and Millson (2020) argue that obligations to accept why-questions stem from role-responsibilities and individuals' interests.

with role-responsibilities, individuals' interests can motivate the acceptance of questions that bear no inferential relation to other questions on the QUD.[12]

So we have seen that speakers may accept questions for intra-conversational as well as extra-conversational reasons. The former is exemplified when a question is accepted because it forms a sub-question to one already on the QUD. The latter includes instances when the question's acceptance fulfills a speaker's role-responsibility or satisfies a particular desire. What about reasons for question rejection?

7.4.4 Reasons for Rejecting a Question

I see reasons for question rejection falling into the same two categories. Just as speakers' role-responsibilities or interests may motivate their acceptance of questions, so too may these extra-conversational goals lead them to reject questions. For instance, the politician who evades the reporter's pointed inquiry does so because they fear that providing an answer, whether truthfully or not, will frustrate the interests or goals they have independently of those that stem from this particular conversation. In some cases, a speaker's role-responsibilities and adherence to certain social norms provides grounds for question rejection – such as when the addressee is not permitted to disclose the information sought by the querier. These then are some of the extra-conversational reasons for which speakers reject questions.

On the other hand, I see three sub-classes of intra-conversational reasons for rejecting a question. The first of these captures instances in which questions are rejected because all of their possible answers are ruled out by the common ground. Such cases are most visible when a question's presupposition is excluded from the common ground. Following Wiśniewski (2013:39), I will refer to any statement entailed by all of a question's possible direct answers as its *presupposition*. While this is a semantic presupposition, we may naturally assume it to be a pragmatic one as well – i. e. something that speakers presuppose. If it is mutually accepted, i. e. presupposed, that you never smoked cigarettes, then it would be incoherent for us to accept the question *Have you stopped smoking?* since both of its possible answers (i.e. *that you stopped smoking* and *that you did not stop smoking*) entail that you used to smoke, and this presupposition is incompatible with the common ground. So, one reason to reject a question is that a conversation does not coherently permit the addition of *any* of its possible answers to the common ground. This reason is properly

12 It is not clear whether these reasons correspond to a *weaker* sense of question acceptance than those that stem from presumed inferential relations among questions, but they are certainly distinct from the latter.

intra-conversational because it concerns the permissible and impermissible directions that collaborative inquiry can take.[13]

Notice that this sense of question rejection builds upon the notion of proposition rejection. When one rejects a question because its possible answers are uniformly inconsistent with the conversation's common ground, one does so because one (propositionally) rejects all of its answers. (If these propositional rejections are *strong* – i. e. they are rejected because they are false – then it is tempting to call the resultant question rejection *strong* as well. I think such terminology is harmless in this circumstance, however, it is still not intuitively clear that there are stronger and weaker forms of question acceptance.)

A second class of intra-conversational reasons is to be found in those instances when speakers reject a question because its set of possible answers does not exhaust the relevant alternatives or ›live options‹. In their account of weak rejection, Incurvati and Schlöder (2017) use a dialogue fragment first given by Grice (1989).

Alice: X or Y will win the election.

Bob: No, X or Y *or Z* will win.

For Incurvati and Schlöder, Bob's response is a canonical example of a *weak* propositional rejection, since his utterance cannot be felicitously understand as asserting that neither X nor Y will win. He must have some grounds for rejecting Alice's claim other than its falsity. His reason, it would seem, is that Alice's assertion does not exhaust the range of relevant alternatives. Now, suppose that rather than making the disjunctive assertion, Alice were to ask the following question and Bob were to respond in a similar manner as before.

Alice: Who will win the election: X or Y?

Bob: Don't forget about Z! X or Y *or Z* will win.

Bob's response seems to be felicitous in this context too. So, it would seem that this is a distinct (intra-conversational) reason for rejecting a question – distinct, that is, from rejecting a question because its possible answers have been ruled

13 Rejecting questions on these grounds (i.e that none of its possible answers is compatible with the common ground) is quite close to the relation Harrah (2002:46) calls "suppressing a question". For him, a set of statements X suppresses a question Q just in case $X \models \neg A$ for each direct answer, A, to Q.

out by the common ground. It too can be construed in terms of a question's presupposition; in this case the relevant presupposition is what Wiśniewski (2013:40) calls "prospective" – i. e. a statement that is not only entailed by each direct answer to a question but that also entails that at least one of those answers is true. In his response, Bob is challenging the prospective presupposition of Alice's question – i. e. *that either X or Y will win*. But unlike the case in which a question is rejected on the basis of its answers' incompatibility with the common ground, this type of rejection contests the common ground itself. For, Alice appears to accept that either X or Y will win and assumes that Bob does so as well, while Bob in fact does not accept this statement.

I believe there is one more class of intra-conversational reasons for rejecting a question. Above I argued that answering trivial questions, namely those whose answers are already entailed by the context set, may serve to implicitly reject rather than to accept a question. I think these sorts of rejecting-by-answering responses speak to a distinct class of reasons one may have for rejecting a question. If the answer to a question is already common ground, then, at best, asking that question makes explicit what was already implicit. If conversations are cases of collaborative inquiry, then we are permitted, if not obliged, to reject questions whose address would fail to further the goals of that inquiry. Indeed, as I mentioned above, asking such questions will likely run afoul of the maxim of relevance. If it is common ground that you never smoked, then, *ceteris paribus*, the question of whether you have (ever) smoked does not do anything to further our conversational goals. In such a case, only one possible answer to the question – namely, *that you have smoked* – is ruled out by the common ground and hence is worthy of propositional rejection. But the fact that the common ground also *entails* a direct answer seems to provide a (different) reason for rejecting the question of whether you smoked.

Of course, just because it is sometimes coherent to reject a question on the grounds that one of its answers is already entailed by the common ground, it in no way follows (absurdly) that all answerings are question rejections. If the answer to a question is not entailed by the common ground and the question is on the QUD, then a proposal to update the common ground with its answer is perfectly felicitous. In doing so, one both answers the question and removes the question from the QUD. If a participant subsequently asks that same question, however, it can, and arguably, should be rejected, since the common ground now entails its answer.

Thus far, I have suggested three intra-conversational grounds for rejecting questions: (1) the common ground excludes all of its possible answers, (2) the question's possible answers do not exhaust the range of relevant alternatives,

and (3) the common ground already contains or entails the question's answer. The first and the third of these seem to map on to reasons that Roberts gives for a question being removed from the QUD, so long as rejecting all the answers to a question is roughly the same as deeming a question unanswerable.[14]

One might worry that (1) and (3) conflate the removal of a question from the QUD with its rejection and that to do so elides an important distinction. While it is well placed, this worry would be more troubling if my aim were to give an analysis of conversational dynamics in terms of acceptance and rejection, but that is not what I am trying to do. Rather, I have sought to determine whether that analysis employs concepts of accepting and rejecting a question that might fund a bilateralist approach to erotetic inferences.

On that point, it is relevant to note that removing a question from the QUD and explicitly rejecting a question, say, by uttering 'I won't answer that!' both have the effect of removing a question from further consideration. So, perhaps what I am calling *rejection* of a question is best glossed as *placing a question out of (conversational) bounds*. This gloss seems to align with the story about propositional acceptance and rejection given above, where stronger and weaker versions are specified according to the kinds of reasons a speaker has for doing so. In other words, removing a question from the QUD and explicitly refusing to respond to it are both ways of placing a question out of bounds that are distinguished from one another by the reason one has for doing so.

7.5 Next Steps

Having established the coherence and plausibility of accepting and rejecting questions as genuine phenomena, the path is open for a bilateralist interpretation of inferences pertaining to questions, i. e. erotetic inferences. There is a variety of ways to pursue this project. My preference is for bilateralist readings of sequent systems, such as that proposed by Restall (2005), which treat sequents as demarcating combinations of (propositional) acceptance and rejection that are incoherent or *out of bounds*. This approach lends itself to the Stalnakrian framework insofar as sequents may be read as incoherent conversational states.

As I have shown in other work (Millson 2019, 2021), it is possible to define a sequent calculus that is sound and complete for two IEL relations, namely evocation and (regular) erotetic implication. The sequent rules for these inferences can be formulated as introduction and elimination rules for erotetic formulas. Since these two erotetic-inferential relations are defined

14 Naturally, there may be other reasons why a question is *practically* unanswerable – for instance, when its answering would involve inquiry that far outstrips the resources available in a given conversational context.

in terms of multiple-conclusion entailment, it is advantageous that my proof systems utilize multiple-conclusion sequents. The fact that Restall's bilateralist approach to sequents yields an intuitive pragmatically-grounded defense of multiple-conclusion sequents, and hence, of classical logic, is thus a welcome complement to these systems. It is my hope that in future work, I may be able to supply a bilateralist interpretation of my sequent calculi for erotetic inferences.

	Achieved by	**Reasons**
Accepting Q	Overt acceptance, e. g. "That's a good question!" Querying Q or Q's subquestion Directly answering Q (when Q's answer is not CG) Pleading ignorance w.r.t. Q Suggesting an information source for Q's answer	<u>Intra-conversational Reasons</u> Q is a subquestion of a question on the QUD <u>Extra-conversational Reasons</u> Answering Q is part of one's role-responsibility; Answering Q furthers one's interests
Rejecting Q	Overt rejection, e. g. "I won't answer that!" Querying Q (when Q is rhetorical) Answering a question that does not address Q (Evading Q) Directly Answering (when Q's answer is CG)	<u>Intra-conversational Reasons</u> Q's possible answers are ruled out by CG Q's possible answers do not exhaust the relevant alternatives Q's answer is (already) CG <u>Extra-conversational Reasons</u> Answering Q frustrates interests or violates norms

Tab. 2: Ways to accept & reject a question and the reasons to do so

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7A Comments on Jared Millson's *Accepting & Rejecting Questions*

Joshua Habgood-Coote

In *Accepting & Rejecting Questions: First Steps Toward a Bilateralism for Erotetic Logic*, Jared Millson explores accepting and rejecting *questions*. He offers two ways to distinguish acceptance and rejection for questions, considering the *different speech acts* we employ to accept and reject questions, and the different *reasons* why we accept and reject questions. His purpose in this taxonomic work is to lay the groundwork for a inferentialist account of interrogative expressions, which understands the meaning of sentences like 'where are your keys?' in terms of their inferential role.[1] Specifically, he is interested in developing a *bilateralist* version of inferentialism in which the acceptance and rejection of questions are treated as distinct. He suggests that the inferences involved in accepting and rejecting questions can be captured by an inferential erotetic logic which can handle the relations between questions, and between questions and propositions.

For the most part, I will focus on tweaking and elaborating Millson's taxonomy but I will close by considering a couple of open questions.

7A.1 How to Accept and Reject Questions

Following Lascarides and Asher (2009), Millson distinguishes between *explicit* and *implicit* ways in which we can accept or reject a question (for example, the question 'where can we get good coffee?'). This gives us a four-way typology:

Explicit acceptance:

1. Offering a direct answer that is not already in the common ground of the conversation ('Two Day serves good coffee');

1 There would be a similarly interesting project investigating the prospects for an inferentialist account of imperatival language.

2. Expressing ignorance about that question ('I don't know where to get good coffee round here');
3. Repeating the question ('where can we get good coffee?').[2]

Implicit acceptance:

4. Asking a subquestion of the question posed ('where sells good coffee in the old town?');
5. Referring to a source of information ('Dara has lived here for ages, she'll know').

Explicit rejection:

6. Flat out rejection ('I can't tell you that, it's a local secret!').

Implicit rejection:

7. Evading the question ('what time does the conference start?');
8. Asking rhetorical questions ('where can we get good coffee in Bristol?' [sarcastic tone]);
9. Asserting a proposition that is in the common ground ('Dara just told us to go to Two Day coffee').

I would like to offer a couple of friendly amendments to this typology.

First, I think we ought to acknowledge the importance of backchannel communication to the acceptance and rejection of questions. The linguist John Heritage suggests that when it is a response to an assertion, the phatic expression 'oh!' functions as a device to mark a change of informational state (1984:299). Jennifer Nagel interprets this as the claim that 'oh!' can be a marker of the acceptance of a proposition (see Nagel forthcoming). Similarly in the case of querying, there are various phatic expressions which mark the acceptance and rejection of questions. In my (British English) idiolect, an isolated 'ooh!' (as in 'ooh, good question!') can mark the acceptance of a question, and an isolated 'huh?' (as in 'huh, she just told us that!') can mark the rejection of a question. Natural languages have a number of different devices for different kinds of acceptance and rejection. For example, Danish and Swedish have adverbs 'jo' (Danish) and 'ju' (Swedish) which can be added into an answer to indicate that it was already common ground (Heinemann et al. 2011). In English, a prefatory 'oh' in a response can indicate that the question was

2 Millson does not discuss this, but I suspect that acceptance by repeating the question will often involve a shift of focus as in 'where <u>can</u> we get good coffee?'.

irrelevant, has false presuppositions, gets into trouble with the context, or that the speaker is reluctant to answer (Heritage 1998), and 'of course, …' can function to challenge the presuppositions of a question (Stivers 2011). The linguistic study of epistemics offers us a rich resource for thinking about the different ways in which we accept and reject questions

Secondly, I suspect that besides asking subquestions there are several other ways to implicitly accept a question by asking further questions. In at least some contexts, we can accept a question by asking one of its superquestions. For example, I might implicitly accept the question 'where can we get good coffee?' by asking 'well, where sells coffee round here?'. We can also accept a question by asking other questions which are neither subquestions nor superquestions, but which stand to provide relevant evidence about the question (for example 'which shops are in the good coffee guide?').[3]

Thirdly, referring to potential sources of information is really an example of a broader class of implicit responses that do not directly relate to the question posed, but rather to the *methodological* question of how to answer that question. For example, we might implicitly accept a question by laying out a plan for how to answer it, or implicitly reject it by talking about how difficult that question would be to answer. The process of answering a question often involves a parallel methodological discussion, so we should expect that methodological comments open up ways to accept and reject questions.

7A.2 Why to Accept or Reject Questions

Incurvati and Schlöder (2017, 2019) distinguish between strong and weak forms of assertion and denial in the propositional case. They understand these functional roles as follows (2019:754–55):

- By strongly asserting *p*, one proposes to add *p* to the common ground (or accepts a previous proposal to this effect).
- By strongly rejecting *p*, one proposes to add *not p* to the common ground (or accepts a previous proposal to this effect).
- By weakly asserting *p*, one prevents *not p* from being added to the common ground.
- By weakly rejecting *p*, one prevents *p* from being added to the common ground.

Strong assertion and strong rejection involve proposals to add propositions to the common ground, whereas weak assertion and weak rejection involve

3 In other work, I have called these *casual subquestions* (Habgood-Coote 2020).

attempts to *block* changes to the common ground, effectively maintaining the status quo. Incurvati and Schlöder (2017) point out that strong and weak assertion involve different kinds of normative considerations: strong acceptance and rejection of a proposition appeal to reasons relating to the proposition's truth, whereas weak acceptance and rejection appeal to a ›motley‹ of reasons.

Millson suggests that the reasons we have to accept and reject questions will similarly divide into intra-conversational and extra-conversational reasons. He suggests that intra-conversational reasons will relate to the goal of collaborative inquiry, and will concern the coherence of inquiry, whereas extra-conversational reasons will be a similar motley. With this distinction in place, he suggests a number of examples of intra- and extra-conversational reasons for acceptance and rejection of questions

Intra-conversational reason for accepting a question:

1. The question is a subquestion of another question which is already on the QUD-stack.

Extra-conversational reasons for accepting a question:

2. Answering the question is part of one or both of the conversationalists' role responsibilities;
3. Answering the question would further one or both of the conversationalists' desires or intentions.

Intra-Conversational reasons for rejecting a question:

4. The presuppositions of the question are ruled out by the common ground;
5. The options presented by the question do not exhaust the *live* options;
6. The answer to the question is already entailed by the context set.

Extra-Conversational reasons for rejecting a question:

7. Answering the question is forbidden by one or both conversationalists' role responsibilities;
8. Answering the question frustrates one or both of the conversationalists' desires or intentions.

Again, I think that there are a couple of missing categories of reasons.

Firstly, I wonder how to think about reasons to reject questions because they are irrelevant. Roberts (2012) points out that the questions on the scoreboard of a conversation will act as a filter that determines which propositions are relevant to that conversation. If we are talking about where to get coffee, your trivia about Lithuanian religious history (the last pagan country in Europe!) will be

unwelcome. The same holds true of questions. There are two kinds of irrelevant questions to consider: superquestions of the question being investigated, and disjoint questions which are neither subquestion nor superquestion of the question being investigated. If we are chatting about how eels reproduce (a genuine mystery[4]), it would be unhelpful to raise the question 'how do all vertebrates reproduce?' (superquestion) or the question of why ice is slippery (disjoint question).

It is important to say that superquestions and disjoint questions can *sometimes* be helpful for progress in inquiry. Answering a superquestion might help to understand how to answer its subquestions, and disjoint questions can sometimes provide relevant evidence (see footnote 3). I think this suggests two ways that Millson might want to think about irrelevant questions. First option: We have intra-conversational reasons to *reject* superquestions and disjoint questions because they are not part of the questions that we are answering. But, in certain cases there might be extra-conversational reasons to accept these questions onto the QUD-stack, because answering them will provide us with the means to answer the questions we are interested in. Second option: Intra-conversational norms allow us to accept superquestions and disjoint questions, although they do not provide positive reasons. Positive reasons to accept or reject these kinds of questions come from our extra-conversational interests in resolving the questions we are interested in. I can imagine reasons to take either option, and we might offer different treatments of superquestions and disjoint questions.[5]

A second gap is *zetetic* reasons to accept or reject questions (Friedman 2020) that go beyond the question-subquestion relation. Our general practical interests can give us reasons to accept or reject questions, and our interests in answering the questions which we have collectively accepted onto the QUD-stack can do the same. Our zetetic interests can generate a number of different kinds of reasons: Certain strategies of inquiry might get us to an answer more quickly, by asking fewer intermediate questions, or by expending less resources, and some questions may be unanswerable given our current resources (a point which Millson notes in footnote 13). I think that it should be uncontroversial that there are zetetic reasons to accept and reject questions, but what is a little less obvious is whether we will want to count these as intra-

4 https://www.newyorker.com/magazine/2020/05/25/where-do-eels-come-from (2021-09-02)

5 For example, we might think that we can have intra conversational reasons to move up to superquestions, but only extra-conversational reasons to move across to disjoint questions.

or extra-conversational reasons. Millson's initial gloss on intra-conversational reasons ("there are instances in which we accept a question because it *furthers* or reject a question because it *frustrates* the collaborative inquiry with which we are engaged") suggests that zetetic reasons will count as intra-conversational, but I suspect that he might have had in mind a slightly different notion of intra-conversational reasons, corresponding to the way in which the unfolding of a conversation is constrained by logic (rather than practical issues about how to best answer questions), which would make zetetic reasons (modulo the question-subquestion relation) into extra-conversational reasons.

7A.3 Open Questions

There are two issues that I remain unsure about: Millson uses the analogy with weak and strong assertion and rejection to help us understand the different kinds of reasons which can bear on accepting and rejecting questions. It would be interesting to think about whether there are analogous distinctions between strong and weak asking and rejection of questions which can help us to understand the behaviour of inquisitive speech acts. It is a little difficult to see how we might add the negation of a question to the QUD, but if we think about a commitment to answering a question as a task on the shared to-do list, we can think of strong and weak asking as follows:

- By strongly asking *Q*, one proposes to add *answering Q* to the to-do list (or accepts a previous proposal to this effect).
- By strongly rejecting *Q*, one proposes to add *not answering Q* to the to-do list (or accepts a previous proposal to this effect).
- By weakly asking *Q*, one prevents *not answering Q* from being added to the to-do list.
- By weakly rejecting *Q*, one prevents *answering Q* from being added to the to-do list.

Millson's paper lays the groundwork for an inferentialist account of interrogative sentences in inferential erotetic logic. It is not too hard to see how to model the intra-conversational reasons for accepting and rejecting questions (especially if we construe intra-conversational reasons as focused on the coherence of questions). I was much less sure how the inferentialist account is supposed to formalize extra-conversational reasons, especially if these reasons include zetetic considerations. I take it that this is not a specific problem

for the inferentialist account of interrogatives, but rather a general issue for inferentialism.[6]

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8 Questions and Indeterminate Reference

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Abstract

This short paper describes a perspective on questions which does not view wh-words as existential quantifiers or as expressions introducing a quantificational domain, but rather as indeterminate referential expressions (Dotlačil and Roelofsen 2019). The proposal is programmatic in nature, and several aspects of it remain to be worked out in greater detail. I argue, however, that it has several potential benefits, including a principled account of weak and strong question interpretations, a uniform analysis of single-wh and multiple-wh questions, and an account of the typologically widespread similarity between interrogative and indefinite pronouns which, unlike previous approaches, can explain the observation that if a language contains interrogative and indefinite pronouns which are similar in form but non-identical (e.g., *where* and *somewhere*), the indefinite pronouns are always morphologically more complex than the interrogative pronouns, and never the other way around (Haspelmath 1997). The tentative proposal is that an interrogative pronoun involves *complete indeterminacy* in the sense that it does not only leave open what its referential value is but also whether it has a referential value at all. For instance, *where* is completely indeterminate, permitting lack of a referential value. The 'some' in *somewhere* eliminates this possibility and thereby exerts existential force.

1 The ideas presented here originate to a large extent in joint work with Jakub Dotlačil. I gratefully acknowledge financial support from the Netherlands Organisation for Scientific Research (NWO) and the European Research Council (ERC, grant number 680220).

8.1 The Indefinite-interrogative Affinity

A core semantic property of questions, which sets them apart from assertions, is that they determine a number of ways in which the conversation may proceed – for short, a number of *alternatives*. An assertion like *Susan called* simply proposes to add the information that Susan called to the common ground, the body of information that the conversational participants have jointly established so far. By contrast, a question like (1) does not propose to add a specific piece of information to the common ground, but asks the addressee to pick one from various possible alternatives.

(1) Who called?

Resolution alternatives: {Susan called, Mary called, ...}

Thus, it is important to ask how the alternatives that a question introduces are constructed in the interpretation process, and in particular, what the semantic contribution of wh-words, interrogative complementizers, intonation, and possibly other grammatical elements is.

We approach this issue here from a particular perspective. Namely, we will investigate how questions relate to *indefinites*, which are also often taken to generate alternatives. An indefinite description like *a woman* in (2) does not pick out a particular individual. Rather, its semantic contribution involves a *set* of individuals, i. e., a set of individual alternatives.

(2) A woman called.

Individual alternatives: {Susan, Mary, ...}

While theories generally agree on the fact that the semantic contribution involves a set of individuals in some way, they differ rather fundamentally w.r.t. further aspects of the semantics of indefinites. The oldest theory is that indefinites express *existential quantification* over this set of individuals (Russell 1919). Another prominent proposal is that indefinites just contribute a *domain of individuals* (or a logical variable associated with such a domain of individuals) and that in sentences like (2) existential quantification is contributed by a separate "existential closure" operator (Heim 1982:ch. 2, Kratzer & Shimoyama 2002). A third view is that sentences like (2) do not involve existential quantification at all, but rather that indefinites function as *indeterminate referential expressions*,

and that the set of individuals they introduce should be regarded as the set of possible referential values (Kamp 1981, Heim 1982:ch. 3).

Typological research has revealed intriguing evidence that questions and indefinites are intimately connected. However, the nature of this connection remains poorly understood. More specifically, there are two major typological findings that need to be accounted for.

First, it has been found that in many languages indefinite pronouns and wh-words are identical or very similar in form (Ultan 1978, Haspelmath 1997, Bhat 2000). This finding is referred to as the *indefinite-interrogative affinity*. Three major cross-linguistic paradigms have been distinguished.

Composite wh-indefinites: In many languages, indefinite pronouns are constructed out of interrogative pronouns by adding some additional morphology. We will refer to such indefinite pronouns as *composite wh-indefinites*. For instance, in English the indefinite pronouns *somewhere* and *somehow* are based on the interrogative pronouns *where* and *how*, respectively. While the pattern is not fully productive in English (for instance, *someone* and *something* are not based on interrogative pronouns), it is in Latin, Greek, Romanian, Bulgarian, Russian, Chechen, Icelandic, and many other languages (Haspelmath 1997).

Bare wh-indefinites: It is also often the case that a single lexical item can be used either as a wh-word or as an indefinite. For instance, as illustrated in (3) and (4), the Dutch word *wat* can be used either as a wh-word meaning 'what' or as an indefinite meaning 'something' (Postma 1994, Hengeveld et al. 2019).

(3) Wat heeft ze hem gegeven?
What has she him given
'What did she give him?'

(4) Ze heeft hem wat gegeven.
She has him something given
'She gave him something.'

On their indefinite use, such items are referred to as *bare wh-indefinites*. Besides Dutch, other languages with bare wh-indefinites include Mandarin (Huang 1982), Russian (Yanovich 2005), German (Postma 1994), Passamaquoddy (Bruening 2007), and Korean (Yun 2019).

Indeterminate pronouns: In some languages both interrogatives and indefinites are built out of two pieces: so-called *indeterminate pronouns* and *Q-particles*. For instance, in Japanese 'who' is expressed by means of the indeterminate

pronoun *dare* in combination with the Q-particle *ka*, and the same two items are used together to express 'someone' (Kuroda 1965). The position of *ka* determines which interpretation obtains. If the particle appears at the clause boundary, an interrogative interpretation arises. If it appears at the edge of nominal phrase containing *dare*, an indefinite interpretation arises (Hagstrom 1998, Kratzer & Shimoyama 2002, Uegaki 2018). Similar constructions exist in Malayalam (Jayaseelan 2001), Tlingit (Cable 2010), Sinhala (Slade 2011) and Hungarian (Szabolcsi 2015).

The existence of such morphological similarities between interrogative and indefinite pronouns across many spoken languages strongly suggests that they must be closely related in terms of their semantics as well. This means that the following question needs to be addressed:

(Q1) What explains the observed indefinite-interrogative affinity? In particular, what is the common semantic core of wh-words and indefinites?

A second important cross-linguistic pattern, identified most forcefully by Haspelmath (1997), is that whenever an indefinite and an interrogative pronoun are similar in form but not completely identical, the indefinite is always morphologically more complex than the interrogative pronoun. That is, the indefinite always consists of the interrogative pronoun with some additional morphology – it is never the other way around. I will refer to this as *Haspelmath's generalization*. What this finding suggests is that the semantic contribution of indefinites is more complex than that of interrogative pronouns.

(Q2) What explains Haspelmath's generalization? In what way are indefinites semantically more complex than interrogative pronouns?

8.2 The Indeterminate Reference Hypothesis

One prominent existing approach to capture the indefinite-interrogative affinity, first proposed by Hamblin (1973) for questions and later extended to indefinites by Kratzer & Shimoyama (2002) (hereafter, K&S), treats both indefinites and wh-phrases as expressions that do not denote particular entities, but rather *sets of entities*. For instance, if the domain of discourse consists of Susan, Bill, and Chris, then *who* and *someone* are both assumed to denote the set {Susan, Bill, Chris}. In this framework, it is further assumed that semantic values are composed in a pointwise manner. This means that if *who* or *someone* is combined with a predicate, say *called*, we get a set of propositions: {'Susan called', 'Bill called', 'Chris called'}. The difference between the question *Who called?* and the assertion *Someone called* is that the former asks which of the

propositions in this set is true, while the latter conveys that at least one of these propositions holds without asking which one. K&S derive this difference by assuming that *someone* associates with an "existential closure" operator while *who* associates with a question operator.

A second prominent approach, due to Karttunen (1978), treats both indefinites and wh-phrases as *existential quantifiers*. The difference in meaning between *Who called?* and *Someone called* is then derived by assuming that wh-phrases interact in a particular way with interrogative complementizers.

Details aside, a crucial shortcoming of both these approaches is that they do not provide an account of Haspelmath's generalization. That is, by treating indefinites and wh-words as making *exactly the same* semantic contribution – be it existential quantification or introducing sets of entities – they cannot explain that indefinites are built out of wh-words in many languages, but the reverse pattern never occurs. In the rich literature on the semantics of questions that has emerged since the pioneering work of Hamblin and Karttunen (see Dayal 2016 and Roelofsen 2019 for recent surveys) this important issue has always remained open. To resolve it, a new view on the relation between wh-phrases and indefinites seems necessary.

But what are the options? I propose that a natural path forward suggests itself if we take a step back from the semantics of questions for a moment and take a broader perspective on the history of ideas in the field. Of particular relevance is the ›dynamic turn‹ that took place in semantics in the 1980s. While traditionally the meaning of a sentence was conceived of in terms of its *truth conditions*, in dynamic semantics it is viewed as its *context change potential*, i. e., the way in which it changes the context in which it is uttered (Kamp 1981, Heim 1982, Groenendijk & Stokhof 1991). This conceptual shift is relevant for us here because of the empirical considerations that motivated it. Namely, proponents of dynamic semantics were chiefly driven by long-standing problems concerning, precisely, the treatment of indefinites as existential quantifiers. They argued, instead, that indefinites should be treated as a kind of referential expressions. In dynamic semantics indefinites change the context of utterance by introducing a so-called *discourse referent*. The precise value of this discourse referent, however, can be left unspecified. In this sense, indefinites are *indeterminate* referential expressions.

The dynamic turn has been hugely influential. However, most dynamic semantic theories only deal with declarative sentences. Semantic theories of *questions* (with a few exceptions, see below) are generally formulated in a static framework, following the pre-dynamic lead of Hamblin (1973) and Karttunen (1978). In ongoing work with Jakub Dotlačil (see, e. g., Dotlačil & Roelofsen 2019,

2020), I am developing a dynamic semantics of questions based on the hypothesis that indeterminate reference is the common core of indefinites and wh-phrases. I will refer to this as the *Indeterminate Reference Hypothesis*.

8.3 A Dynamic Semantics for Questions

8.3.1 The Basic Idea

In the framework we are developing, a declarative sentence like (5a) is taken to result in three consecutive updates of the context, just like in standard dynamic semantics. First, a discourse referent x is introduced. Then the context is updated with the information that x is a woman and with the information that x called. This sequence of updates can be represented as in (5b).

(5) a. A woman called.

b. [x]; *woman*{x}; *called*{x}

(6) a. Which woman called?

b. [x]; *woman*{x}; *called*{x}; ?x

The novelty of the framework is that it allows for a very similar treatment of interrogative sentences like (6a). Namely, (6a) is taken to first introduce a discourse referent x and update the context with the information that x is a woman who called. This part is shared with (5a). In the case of (6a), however, the interrogative complementizer contributes a further update, ?x, which raises the issue who x is.

There is one existing approach to questions which is very close in spirit to the one sketched here, namely that of Haida (2007).[2] However, the scope of Haida's proposal is limited in various ways. One important reason for this is that it is based on the *partition theory* of questions (Groenendijk & Stokhof 1984). There are several types of questions that the partition theory cannot deal with, in particular ones that do not have a *unique* true resolution (e.g., *What is a typical French name?*). Our framework, which is based on inquisitive semantics (Ciardelli et al. 2018) rather than partition semantics, overcomes such limitations. This is crucial for the further refinements and applications of the theory sketched below.

2 Other existing dynamic approaches to questions (e.g., Groenendijk 1998, van Rooy 1998, & Alonivan Rooy 2002) adopt a rather different perspective and do not lend themselves to the crucial refinements and applications sketched below.

8.3.2 A New Connection between Indefinites and Interrogatives: Weak and Strong Readings

One empirical puzzle that provided particularly strong motivation for the dynamic turn in semantics concerned so-called *donkey anaphora*, exemplified in (7) and (8). These examples are problematic for traditional ›static‹ semantic theories, because the indefinites *a donkey* and *a dime*, when treated as existential quantifiers, cannot bind the anaphoric pronoun *it*, which lies outside of their scope.

(7) If Mary sees a donkey, she pats it on the back.

(8) If I have a dime in my pocket, I'll put it into the meter.

There is a striking difference between (7) and (8). Namely, (7) says on its most prominent reading that whenever Mary sees one or more donkeys, she pats *all* of them on their back, while (8) clearly does not commit the speaker to putting *all* the dimes she has in her pocket into the meter, but just *one*. This strong/weak ambiguity of donkey anaphora has been a central topic in the dynamic semantics literature (see, e. g., Heim 1990, Kanazawa 1994, Brasoveanu 2008, Champollion et al. 2019).

Our dynamic view on the indefinite-interrogative affinity suggests a connection between this ambiguity in donkey anaphora and a well-known ambiguity in the interpretation of wh-questions, namely that between *mention-all* and *mention-some* readings. For instance, to resolve the question in (9) one has to specify *all* people who were invited to the workshop, while (10) can be resolved by specifying just *one* good speaker, even if there are in principle multiple good candidates.

(9) Who has been invited to the workshop?

(10) Who would be a good speaker to invite for the workshop?

In (Dotlačil & Roelofsen 2020), we develop a unified analysis of these two phenomena, building on Brasoveanu's (2008) account of strong and weak readings of donkey anaphora. This requires extending the basic dynamic inquisitive framework sketched above with plural discourse reference, which plays a crucial role in Brasoveanu's approach to donkey anaphora. We are currently investigating a further extension with modal operators, which are known to affect the availability of mention-some readings (George 2011, Fox

2013, Xiang 2016). We are also pursuing a pragmatic theory of how the two types of ambiguity are resolved, unifying the pragmatic analysis of questions in (van Rooy 2003) with that of donkey anaphora in (Champollion et al. 2019).

8.3.3 A Uniform Dynamic Account of Single and Multiple Wh-questions

A long-standing puzzle in the semantic literature on questions concerns a contrast in presuppositions between questions with a single wh-phrase like (11) and ones with multiple wh-phrases like (12).

(11) Which girl danced with Peter?

(12) Which girl danced with which boy?

The puzzle is that, while (11) carries a *uniqueness presupposition* to the effect that a single girl danced with Peter, (12) does not presuppose that there was a single girl-boy pair who danced. Rather, it leaves open the possibility that several girls and boys danced, and asks the addressee to specify the dancing pairs.

Existing accounts of multiple wh-questions (e.g., Dayal 1996, 2016, Xiang 2016) stipulate that such questions involve a special complementizer or type-shifting operations which are not present in single wh-questions. That is, they do not offer a *uniform* account of single and multiple wh-questions.

In (Dotlačil and Roelofsen 2020), we propose that a dynamic analysis of wh-phrases does make it possible to formulate such a uniform account. The basic idea is that the question operator $?x$ in (6b) is a particular instance of a general n-place question operator, where n is the number of wh-phrases that the question contains. For instance, in (12), the two wh-phrases introduce two discourse referents, x and y, and the interrogative complementizer contributes a two-place question operator $?xy$. We provide a general definition of the n-place question operator, which yields correct interpretations both for $n = 1$ and for $n = 2$. The empirical properties of questions with three wh-phrases remain to be investigated in more depth.

8.3.4 An Account of Haspelmath's Generalization

According to the Indeterminate Reference Hypothesis, what indefinites and wh-phrases have in common is that they both involve indeterminate reference. This provides a possible account of the indefinite-interrogative affinity. But Haspelmath's generalization suggests that, besides this semantic commonality, there must also be a particular *difference* between indefinites and wh-phrases, which makes the former derivable from the latter but not vice versa.

What could this difference be? The idea that we want to pursue is that a wh-word involves *complete indeterminacy* in the sense that it does not only leave open what its referential value is but also whether it has a referential value at all. One way to model this would be to assume that the set of possible values associated with a discourse referent introduced by a wh-word contains a ›null‹ value (see (Bylinina & Nouwen 2018) for a highly congenial proposal outside the domain of questions). What composite wh-indefinites do, then, is to eliminate this ›null‹ value. This amounts to exerting existential force. For instance, *where* is completely indeterminate, permitting a null value, while 'some' in *somewhere* eliminates the null value and thereby exerts existential force. The null value may also be eliminated by other elements. For instance, in *which girl* it is the singular number feature of 'girl' that trims down the possible values associated with the discourse referent to atomic ones, dismissing both the null value and plural values.

Fully developing this *Two-level Indeterminacy Hypothesis* requires, among other things, working out a general account of how ›null‹ referential values affect the compositional interpretation process in the dynamic inquisitive framework sketched above. This will be a non-trivial enterprise, but doing so may finally lead to an analysis of indefinite and interrogative phrases which captures Haspelmath's generalization.

8.4 Conclusion

I have described a new perspective on questions, which does not view wh-words as existential quantifiers or as expressions introducing a quantificational domain, but rather as indeterminate referential expressions. While this approach to questions remains to be worked out in greater detail, I have argued that it sheds promising new light on (i) the weak/strong ambiguity, (ii) multiple wh-questions, and (iii) the indefinite-interrogative affinity.[3]

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8A Comments on Floris Roelofsen's *Questions and Indeterminate Reference*

David Hitchcock

In this comment, I contrast dynamic approaches to semantics like Floris Roelofsen's to mental-understanding, representational, and inferentialist approaches – each of which has its distinctive problems. I characterize as promising Roelofsen's proposal within his dynamic approach that indefinite pronouns like 'somewhere' share with wh-words like 'where' an indeterminate reference (e.g. to a place) but add exclusion of the null value (e.g. the value nowhere).

8A.1 Theories of Meaning

Dynamic approaches to semantics propose to explain the meaning of words, phrases, clauses, sentences and paragraphs by their potential contribution to ongoing "conversations" of which their utterance or inscription might be a part. Such approaches often use the concept of a "common ground" of a conversation, "the field on which a language game is played" (Stalnaker 2002:720). Stalnaker's expression 'language game' evokes Wittgenstein's introduction of this term in his *Philosophical Investigations* and his central statement in that work: "For a *large* class of cases of the employment of the word 'meaning' – though not for all – this word can be explained in this way: the meaning of a word is its use in the language" (Wittgenstein 1953, §43). Since people use the words of a language primarily to communicate to other people, who in turn respond using words, meaning can often be explained by the role of language units in interactive communication (i.e. "conversation") – a view articulated, for example, by Charles Hamblin:

> "The thesis that I shall adopt is that all properties of linguistic entities are 'dialectical', in the sense of being determinable from the broad pattern of their use. We might call this the Dialectical Theory of Logical Form or, perhaps, the Dialectical Theory of Meaning." (Hamblin 1970:285–286)

Hamblin's dialectical theory of meaning is implicit in his earlier discussion of what questions (i.e. interrogative sentences) are:

> "If pressed to define a question, I should do so by saying that it is a sentence which requires an answer; or (I should hastily add) a refusal to answer, or the raising of a point of order." (Hamblin 1958:161)

Rather than elaborate on this definition, Hamblin proposes his widely cited (and often criticized) three postulates about questions:

> "Postulate 1. An answer to a question is a statement.
> […]
> Postulate 2. Knowing what counts as an answer is equivalent to knowing the question.
> […]
> Postulate 3. The possible answers to a question are an exhaustive set of mutually exclusive possibilities." (Hamblin 1958:162–163)

Careful attention to the realities of linguistic usage across languages, exemplified in Floris Roelofen's *Questions and Indeterminate Reference*, has superseded Hamblin's definition and his three postulates in important respects. But the fundamental approach is the same: to pay attention to what people actually do when they use a language and in particular to how a contribution to interpersonal communication changes the context and thus affects what should follow it.

Explanations of meaning by conversational contribution can be contrasted to explanations of meaning by mental understanding or by representation or by inferential patterns.

A mental-understanding account takes the meaning of a linguistic unit to be what someone thinks of when they understand it; language is taken to be a vehicle for the expression of thoughts. This type of account goes back at least to Aristotle, who writes: "Now spoken sounds are symbols of affections in the soul, and written marks are symbols of spoken sounds." (1963:De Interpretatione 16a3–4) More recently, phenomenologists have appealed to the intuitive content of a concept as the meaning of a term (Tarski 1933/2006:153). Mental-understanding accounts face the difficulty of characterizing the thoughts that language units express in a way that is independent of the language that expresses them. Something is going on mentally when a speaker of English understands what a person means who says, 'Why are you looking at me in that strange way?', but it is difficult if not impossible to characterize that mental state without reference to what the person says.

Representational accounts take as paradigmatic the relation of a proper name to its bearer. Plausibly, the meaning of the English word 'Europe' is the continent that bears that name. Similarly, one might suppose, the noun 'tree' signifies a kind of plant, the adjective 'sepia' signifies a shade of brown, the verb 'walk' signifies a way of moving, the adverb 'politely' signifies a way of addressing someone else, and so on. Representative accounts of meaning have difficulty with what medieval philosophers called "syncategorematic terms", terms like 'at' or 'the' or 'if' that do not represent anything but go along with representational "categorematic terms" to form larger linguistic units, which are taken to have representative meaning. An indicative sentence, for example, may be taken to represent a truth-value (on a Fregean account) or a proposition (an abstract structure that can be given a compositional account and/or taken to be a set of possible worlds). An interrogative sentence whose utterance can be used in standard contexts to elicit a 'yes' or 'no' answer can be regarded as expressing the proposition expressed by a 'yes' answer, with its interrogative dimension attributed to the ›force‹ of the illocutionary act of asking. Representational accounts have difficulty with more complex interrogative sentences, such as open-ended wh-questions whose possible direct answers are not specified by the context of their utterance. They can be taken to express a propositional function. For example, the question 'how do the cells of a breathing animal convert oxygen into energy?' can be taken to express the propositional function *that the cells of a breathing animal convert oxygen into energy by process X*, where the variable 'X' ranges over processes by which oxygen could be converted into energy. A request to specify a value for X could be attributed to the force of the illocutionary act performed in saying or writing the interrogative sentence in standard contexts.

Brandom (1994, 1997, 2009) proposes his inferentialist account of meaning as an alternative to representational accounts. Language use, on his account, is rooted in social practices with internal norms that confer statuses of commitment and entitlement. Propositional contents, in particular, are what can serve as premises and conclusions of inferences. Their representational properties are a consequence of the social character of inferential practice. Brandom thus inverts (for example) the model-theoretic account of inference as legitimated by the absence of a counter-interpretation (i.e. an interpretation on which the inference's premises are true but its conclusion untrue). For example, whereas on a model-theoretic account a modus ponendo ponens inference from a conditional and its antecedent to the conditional's consequent is legitimated by a truth-functional interpretation of the word 'if', on Brandom's inferentialist account the truth-functional interpretation of the word 'if' is legitimated by the

entitlement given by a conditional to infer its consequent from its antecedent. The meaning of a singular indicative conditional is not that it does not have a true antecedent and a false consequent, but that from its antecedent one is entitled to infer its consequent; correspondingly, the assertion of a conditional is not justified by its lacking a true antecedent and untrue consequent, but by the derivation of its consequent from its antecedent. Brandom's account is challenging; habits of thinking about meaning in terms of representation die hard. If he is correct, however, representation is a derivative property of the semantic contents created by humanity's social inferential practice. A key objection to Brandom's approach is that he offers only a circular explanation of how social practices get their normative force. Catta et al. (2020) illustrate one way of explaining the meaning of questions within an inferentialist semantics: In a dialogue between teacher and student in which the teacher is guiding the student to justify an assertion (as in mathematics education), each question by the teacher is enabled by a previous assertion of the student and in turn prompts a defence of the aspect of the previous assertion singled out for attack. In the first-order language set up by the authors, for example, the student's assertion of a conjunction enables the teacher's questioning of either conjunct, which in turn requires the student's assertion of that conjunct. One can envision a massive project of explaining within an inferentialist framework the meaning of other sorts of questions, such as information-seeking questions, examination questions and confrontational questions. Such a project would try to explain the meaning of such questions not only by what can legitimately follow them but also what they can follow (i.e. what sorts of conversational and non-conversational context can legitimate the asking of an information-seeking question or an examination question or a confrontational question).

8A.2 Interrogative Pronoun and Null Value

Floris Roelofsen's chapter, *Questions and Indeterminate Reference*, assumes from the beginning a dynamic "conversational" account of meaning: Interrogative sentences, he writes, differ in meaning from assertions in that they determine a number of ways in which a conversation may proceed. In this respect, he notes, wh-words like 'where' resemble indefinite pronouns like somewhere, in that both open up alternatives – a shared semantic content. Typological research confirms the common semantic content by its discovery that in many languages wh-words and indefinite pronouns are similar in form, if not identical. Existing theories of their meaning account for this common semantic content either by taking both to denote a set of entities or by treating both as existential quantifiers. On the set-denotation account, indefinite pronouns are

distinguished semantically from wh-words in that sentences with a wh-word as subject ask for identification of the entity or entities in the set that have the specified property, whereas with an indefinite pronoun as subject they convey that at least one of the entities in the set has the specified property without asking which one. On the existential quantifier account, the difference is that wh-words interact in a distinctive way with the "interrogative complementizer" indicated by the question mark.

The drawback of these existing theories, and the inspiration for Roelofsen's novel proposal, is that they do not account for "Haspelmath's generalization": "that whenever an indefinite and an interrogative pronoun are similar in form but not completely identical, the indefinite is always morphologically more complex than the interrogative pronoun." (Roelofsen's chapter:sect. 8.1) This typological universal requires an account that takes the meaning of the indefinite to be a composite of the meaning of the corresponding interrogative pronoun and an additional component. Neither the set-denotation account nor the existential quantifier account fulfill this requirement.

Roelofsen's alternative starts by noting a parallel in dynamic semantics between a sentence like 'a woman called' and the corresponding sentence 'which woman called?'. Each sentence starts by introducing a discourse referent *x*, updates the conversational context by identifying the referent as a woman, and then updates it further with the information that she called. A wh-word and an indefinite pronoun have in common, then, that they introduce a referent without specifying which one it is. The difference, he proposes, is that the wh-word leaves open the possibility of a null value while the indefinite pronoun eliminates this possibility. For example, the question 'where did he go?' leaves open the possibility that he went nowhere, while the statement 'he went somewhere' closes off this possibility. This proposed semantic analysis accounts both for the common semantic content of wh-words and indefinites and for the fact that indefinites are always morphologically more complex than corresponding wh-words in languages where they are similar but not identical. The English pair 'somewhere' and 'where' illustrates the pattern. Indeed, this pair in itself makes plausible the idea that the morphological addition has the semantic content of closing off the possibility of a null value; the prefix 'some-' appears to have the force of an existential quantifier.

As well as explaining the indefinite-interrogative affinity and accounting for Haspelmath's generalization, Roelofsen's proposal (he reports) suggests an affinity between the strong/weak ambiguity of "donkey anaphora" and the ambiguity between *mention-all* and *mention-some* readings of wh-questions. It also provides, he reports, a uniform account of single and multiple wh-questions that

accounts for the difference in presuppositions of single and double wh-questions. In a closing footnote, he mentions two other linguistic phenomena that motivate his proposal: anaphora with wh-antecedents and intervention effects. Thus there are good reasons to pursue the proposal in depth.

But it is just that – a proposal. It needs to be worked out in detail, to account for the variety of linguistic phenomena involving wh-words and indefinite pronouns. In particular, Roelofsen points out, developing it requires working out in detail how the postulated null value permitted by a wh-word affects the compositional interpretation process as understood in a dynamic approach to semantics. We can look forward to learning these details in future work by Roelofsen and his collaborator Jakub Dotlačil. In the meantime, the proposal seems very promising.

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Questions are everywhere and the ubiquitous activities of asking and answering, as most human activities, are susceptible to failure – at least from time to time. This volume offers several current approaches to the systematic study of questions and the surrounding activities and works toward supporting and improving these activities. The contributors formulate general problems for a formal treatment of questions, investigate specific kinds of questions, compare different frameworks with regard to how they regulate the activities of asking and answering of questions, and situate these activities in a wider framework of cognitive/epistemic discourse. From the perspectives of logic, linguistics, epistemology, and philosophy of language emerges a report on the state of the art of the theory of questions.

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