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Predicting universal phonological contrasts

Abstract: FUL (*Featurally Underspecified Lexicon*) assumes that a handful of features will account for the phonological systems in the world's languages. Such an assumption would not be unusual. However, FUL makes several other assumptions including the following: (i) consonants and vowels share place features which are not represented on separate tiers; (ii) features are monovalent; (iii) there are no feature dependencies; (iv) CORONAL and PLOSIVE are always underspecified in representation but present on the surface, which in turn presupposes that both these features must occur in all languages; (v) phonological activity is not the only way to determine feature contrast. These assumptions are based on synchronic, diachronic, and experimental evidence. Detailed case studies examine whether these hypotheses hold in instances where the opposite claims have been made.

1 Introducing FUL

In a landmark work, Jakobson, Fant, & Halle (1952, henceforth JFH) proposed a set of 21 distinctive features for describing phonological systems. Well defined acoustic and articulatory correlates were identified for their features, and the same features were employed to classify place of articulation for vowels and consonants. An example would be the feature ACUTE: front vowels (such as [i y e ø æ]) and fronted consonants (e.g., alveolars and palatals) were classified as ACUTE and characterised as having high frequency energy. First proposed in 1999, the FUL system (short for *Featurally Underspecified Lexicon*) endorsed these two fundamental assumptions of JFH's. The following considerations, some differing from JHF, are especially highlighted in FUL: (i) phonological features form a hierarchical system; (ii) all features are monovalent; (iii) the contrasts established by this set of features should account for phonological alternations across the languages of the world; (iv) a small set of features are universally underspecified, and these features should therefore always be part of the inventory; (v) there are no feature dependencies; (vi) underlying phonological representations, as part of the mental lexicon, govern production and comprehension, with underspecification, thus, implying asymmetries in processing; (vii) feature specification and building the feature tree during acquisition initially follow a universal pattern; (viii) feature specification and underspecification should also play a part in language change.

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Notions from the JHF tradition such as “markedness”, “specificity”, “redundancy”, and “activity” have in one way or another been widely used by phonologists. No one has ever assumed that all features have the same “weight”, and most phonologists do not specify non-contrastive features. Chomsky & Halle (1968) engaged in detailed discussions about markedness combined with redundancy to obtain the right phonological alternations. In the early eighties, underspecification was hotly debated (cf. Archangeli 1988), particularly with respect to coronality (Paradis & Prunet 1991), and the concept was indeed frowned upon (McCarthy 1988). Halle et al. (2000) emphasise that full specification for contrastive features should be the norm. Despite the unease, there is no doubt that asymmetries and markedness differences exist across feature distributions and directions of the output of phonological rules, and various methods have been employed to handle them. Calabrese (1995) distinguished different types of feature representations such as contrastive, marked, and full, which in turn were interspersed in the ordering of rules. Mohanan (1993) favoured what he called “fields of attraction” and “dominance”, which allowed him to express degrees of markedness. Clements (2001) proposed a complex model combining both specification and underspecification, which allowed non-contrastive features to be specified if they were “active” in phonology. He distinguished between “active” features (which may form natural classes) and “prominent” features (which, for instance, play a role in spreading).

Against this historical backdrop, this chapter sets out the FUL view of underspecification and asymmetry, and specifically addresses two questions:

(i) How do FUL’s features and their hierarchical organisation account for the phonological contrasts of the languages of the world?
(ii) To what extent are (UNDER)SPECIFICATION and (IN)ACTIVITY correlated?

Through examining several test cases bearing on these issue in especially challenging ways, we seek to further strengthen the case for the FUL approach. Particular emphasis will be on the feature CORONAL, the focus of a lot of attention in past decades. In the course of a brief historical overview, Section 2 compares several approaches to coronals. Section 3 highlights the specifics of FUL in relation to other models, in particular the Contrastive Hierarchy proposed by Dresher and colleagues and Clements’ system of underspecification. Finally, Section 4 returns to monovalent features, in particular to account for complex vowel alternations like those of Kàlɔ̀ŋ analysed in Hyman (2003). The typological moral is that coronal contrasts and alternations involving coronal triggering on the face of it show a great deal of variation, but analysis – along lines dictated by a particular theoretical model, FUL – reveals fundamental unity of phonological grammar behind crosslinguistic diversity.

2 Towards FUL: [coronal] vs. [–back]

A decade after JFH, articulatorily oriented features were in the ascendancy in *The sound pattern of English* (Chomsky & Halle 1968, SPE), being supposedly better suited to describe phonological patterns of the world's languages. A major change was the establishment of separate place features for vowels and consonants. Vowels, for example, were all [–anterior], while consonants could be both [+anterior] and [–anterior]; vowels were characterised by [±back] and were always [–coronal]. Thus, there was no way to pair [coronal] consonants like dentals and palatoalveolars with [–back] vowels. A subset of features considered by SPE (1968: 407, adapted from Table 3) for various main places of articulation (and not including secondary articulations such as palatalised labials), is given in (1):[1]

(1) SPE feature composition for place of articulation

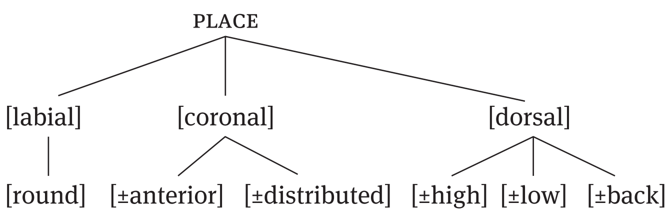
	anterior	coronal	high	low	back
CONSONANTS					
labials	+	–	–	–	–
dentals	+	+	–	–	–
palato-alveolars	–	+	+	–	–
does not exist	–	–	–	–	–
palatals	–	–	+	–	–
velars	–	–	+	–	+
uvulars	–	–	–	–	+
pharyngeals	–	–	–	+	+
VOWELS & GLIDES					
high front	–	–	+	–	–
high back	–	–	+	–	+
mid front	–	–	–	–	–
mid back	–	–	–	–	+
low front	–	–	–	+	–
low back	–	–	–	+	+

The eighties led the way to grouping features into natural classes rather than listing them arbitrarily (e.g., Clements 1985, 1989; Sagey 1986; Clements & Hume

1 Notwithstanding the move towards articulatorily oriented features in phonology, the acoustics of features continued to be investigated by Stevens, Blumstein and colleagues (cf. Stevens & Blumstein 1978; Blumstein & Stevens 1980; Lahiri, Gewirth, & Blumstein 1984), the goal being to locate invariant acoustic cues for distinctive features rather than for segments, which had proved to be impossible (cf. Lahiri et al. 1984 for cues to distinguish CORONAL and LABIAL diffuse stops).

1995; McCarthy 1988). Although controversies raged over the precise grouping, one assumption remained unchanged: vowels and consonants did not share all place features. The DORSAL node dominated vowels which were largely distinguished by [±back]. This had the unwanted consequence of segregating front vowels ([–back], [–coronal] [–anterior]) from dentals, alveolars, and palatoalveolars, which were grouped under [coronal]. Additionally, the height features [±high], [±low] were dominated by [dorsal]. The feature tree in (2) gives the general idea (see further Lahiri & Reetz 2010):[2]

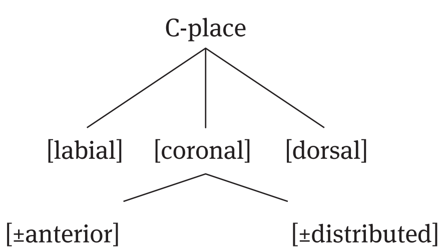
(2) Established class nodes (after Clements 1985; McCarthy 1988)



Consonants: [labial], [coronal], [dorsal]
All vowels: [dorsal], except for [round]

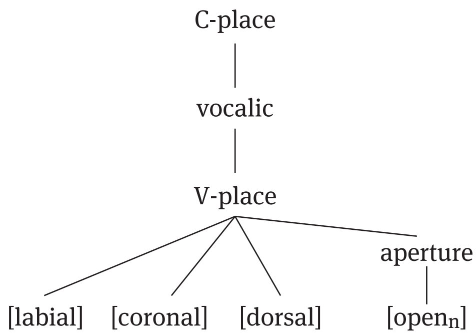
In a novel proposal, Clements (1989) argued that, similar to JFH, vowels and consonants ought to be brought together if the notion of constriction of the vocal tract with the parameters of degree and location was to be taken seriously. However, although the place features were accordingly the same, the place nodes for vowels and consonants would be on separate tiers.

(3) Feature tree following Clements & Hume (1995)
(a) CONSONANTS – PLACE only



2 The tier structures in the feature trees (1)–(4) are not relevant for the present discussion.

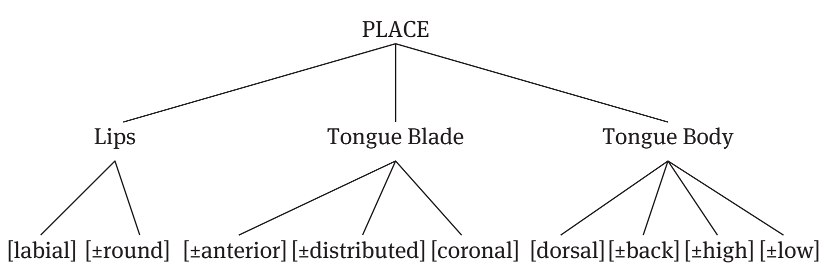
(b) VOCOIDS – PLACE only



[labial]: labial consonants, rounded vowels
[coronal]: coronal consonants, front vowels
[dorsal]: dorsal consonants, back vowels

A fundamental difference from earlier models is that [coronal] here entirely replaced [±back]. In response to Clements' unified theory, Halle et al. (2000) proposed to dispense with dependencies, such that [back] [high] [low] were no longer dependents of DORSAL.[3] Thus, any fronting that would spread [dorsal] would not necessarily spread [–back]. Nevertheless, vowels and consonants remained distinct in terms of place features. The PLACE node proposed by Halle et al. (2000) is as in (4):

(4) Feature organisation as in Halle et al. (2000)

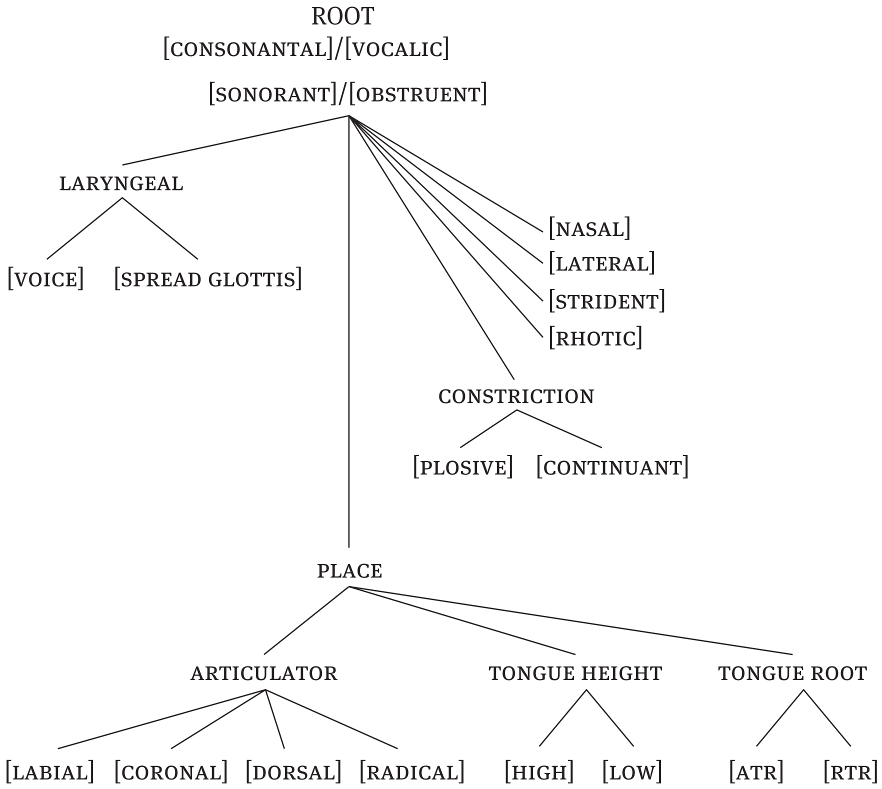


Taking JFH's view of combining all consonantal and vocalic features seriously, Lahiri & Evers (1991) and Lahiri & Reetz (2002) (cf. also Lahiri 2000; Ghini 2001a)

3 The feature tree given in Halle et al. (2000: 389) does not indicate +/– values. However, from their discussion of Irish assimilation it is obvious that as before the features HIGH, LOW, DISTRIBUTED, ROUND, ANTERIOR, BACK are binary.

pointed out that there was no necessity to duplicate the V-place node for vowels and secondary articulations, and that the aperture node was not only relevant for vowels but also for consonants. Thus, the constriction relevant on the horizontal dimension along the vocal tract was determined by the ARTICULATORS, and on the vertical dimension was characterised by the height of the tongue. Consequently, as seen in (5), the PLACE node dominated separate nodes ARTICULATOR and TONGUE HEIGHT, as well as the TONGUE ROOT features, with the PLACE features thus identical for vowels and consonants. Although, to honour tradition, we have kept the basic articulatory names, each feature has well defined acoustic cues as well. The features and feature organisation we will defend are based on universal principles of phonological alternations as well as production and perceptual mechanisms. The features are the same for production and perception (cf. Lahiri & Reetz 2010; Lahiri 2010; Plank & Lahiri 2015). Furthermore, the FUL processing model has clear-cut processes of matching from the signal to the representation and the other way around.

(5) Feature tree for FUL



A subset of the phonemes grouped under each feature (vowels and consonants) are given in (6).

(6) Features and segments

[LABIAL]	labial consonants, rounded vowels
[CORONAL]	front vowels, dental, palatal, palatoalveolar, retroflex consonants
[DORSAL]	back vowels, velar, uvular consonants
[RADICAL]	pharyngealised vowels, glottal, pharyngeal consonants
[HIGH]	high vowels, palatalised consonants, retroflex, velar, palatal, pharyngeal consonants
[LOW]	low vowels, dental, uvular consonants
[ATR]	palatoalveolar consonants, tense vowels
[RTR]	retroflex consonants, lax vowels

Two pairs of opposing features – CONSONANTAL/VOCALIC and SONORANT/OBSTRUENT – are the major class features available in all languages. All phonemes must be either CONSONANTAL or VOCALIC and SONORANT or OBSTRUENT. The members of each pair are conflicting – i.e., CONSONANTAL implies not VOCALIC and vice versa. The nodes LARYNGEAL, CONSTRICTION, PLACE, TONGUE HEIGHT, TONGUE ROOT, RADICAL are always present, although they may be empty if there are no contrastive phonemes in the language concerned, as discussed below. All features are monovalent; therefore, they are either present or absent, and unlike in Halle et al. (2000) and Clements (2001), there is no mixture of some binary (e.g., [±back]) and some monovalent features (e.g., [dorsal]). Further, in contrast to earlier approaches – for instance, in Clements (2001: 114, 47) [±posterior] is dominated by [coronal] – no features dominate other features in FUL.

A number of assumptions fall out from the feature tree and we take them in turn.

First, the features under each node are mutually exclusive. An exception is the LARYNGEAL node, where [VOICE] and [SPREAD GLOTTIS] can co-occur, as attested in only a few languages (among them Bengali and Hindi).[4] Thus, [NASAL/LATERAL/RHOTIC/STRIDENT], [CONTINUANT/PLOSIVE], [LABIAL/CORONAL/DORSAL/GLOTTAL], [HIGH/LOW], [ATR/RTR] are mutually exclusive for consonants. For vowels, [LABIAL] may combine with [CORONAL] and [DORSAL].

Second, the only dependencies we assume are universal implications such as [NASAL] ⇒ [SONORANT] or [STRIDENT] ⇒ [OBSTRUENT].

4 It is possible that the features under the LARYNGEAL node should be independent and not be subsumed under a single node.

Third, underspecification is fundamental to FUL. However, there are only two features which are universally underspecified: [CORONAL] and [PLOSIVE]. The reasons are based on contrast sensitivity and typological prominence.

Fourth, only those features that are necessary to maintain contrasts between the phonemes of a language are used. This is similar to Dresher's (2009) contrastivity, with the exception that there is no "activity" requirement in FUL. Feature specifications are independent of whether or not the features play an "active" role in phonological processes – as to be discussed in the context of a case study in the next section.

Fifth, feature trees are built in language acquisition based on the universal principle of PLACE-first (Ghini 2001b), where ARTICULATOR contrasts precede TONGUE HEIGHT contrasts. For the ARTICULATOR contrasts, [CORONAL] is the universal default: all languages must have this feature. Since [CORONAL] is underspecified, the assumption is that when during acquisition, a non-coronal phoneme is enountered, it becomes specified. For instance, Levelt (1995) and Fikkert & Levelt (2008) observed that a contrastive feature like [LABIAL] becomes specified first. For TONGUE HEIGHT, we believe that the feature [LOW] will be assigned first.

These assumptions are fairly restrictive and we are aware that they are in conflict with many assumptions made in the literature. Three issues are especially critical and will be addressed presently:

(i) How can languages be accounted for where [CORONAL] is supposed to be active?
(ii) If no dependent features such as [±anterior] and [±distributed] are permitted, how can various sets of sounds be accounted for which were classified by these features?
(iii) Does [CORONAL] always exist?

3 Underspecification of [CORONAL] and "activity"

3.1 Coronal activities

It has variously been proposed that it is essential that [CORONAL] is "active" and therefore needs to be specified. We will discuss two relevant case studies in some depth: palatalisation in Inuit dialects as analysed in Compton & Dresher (2001, henceforth C&D), and Tahltan vowel harmony as analysed in Clements (2001). In both instances, the presence of [CORONAL] is indispensible.

3.2 Development of Proto-Eskimo vowels and palatalisation

Proto-Eskimo had four vowels */i u a ə/ and in most Inuit dialects /ə/ merged with reflexes of */i/. Traditional descriptions distinguish between "strong *i*" from original */i/, which triggers palatalisation, and "weak *i*" from original */ə/, which fails to trigger palatalisation. In C&D's story, features are ordered according to a Contrastive Hierarchy as established by the Sucessive Division Algorithm. Only features which are "active" are on the top of the hierarchy. Based on various processes, it can be shown that [LOW], [LABIAL], and [CORONAL] are active in Proto-Eskimo and are treated as the marked values and the opposites are unmarked. The hierarchy for Proto-Eskimo is given in (7).

(7) Proto-Eskimo contrastive hierarchy for vowels: [LOW] > [LABIAL] > [CORONAL]

(a) Contrastive hierarchy

[LOW] (non-low)
/a/
[LABIAL] (non-labial)
/u/
[CORONAL] (non-coronal)
/i/ /ə/

(b) Feature contrast table of the 4-vowel system

/i/	/u/	/a/	/ə/
[CORONAL]	[LABIAL]	[LOW]	[–]

The hierarchy begins with [LOW], this being the first division by Jakobson & Halle (1956) on the grounds of highest sonority. The next cut follows the common pattern of place-next. The most important aspect is that /i/ is [CORONAL] and this is the feature that is required to trigger palatalisation. All four-vowel systems of this family have the strong *i* as coronal. The three-vowel systems /i u a/, however, do not have /ə/, neither is palatalisation being triggered. Thus, these vowel systems (again beginning with [LOW]) are organised as follows:

(8) 3-vowel system

(a) Feature tree

[LOW] (non-low)
/a/
[LABIAL] (non-labial)
/u/ /i/

(b) Feature contrast table

/i/	/u/	/a/
[–]	[LABIAL]	[LOW]

This is an elegant analysis which produces the pattern of alternations set out in (9). Weak *i* alternations show no effect of the feature CORONAL, while strong *i* alternations do, since /i/ is specified for CORONAL. Strong *i* leads to palatalisation with surface [tʃ] and [ʎ].

(9) Palatalisation present and absent
Barrow Inupiaq weak and strong *i* (C&D (5) based on Kaplan 1981)

	stem	gloss	3SG.INTR /-tuq/	3SG.SUBJ /-luni/	Proto-Eskimo
(weak *i*)	isiq-	enter	isiq**t**uq	isiʁ**l**uni	*itəʁ-
(strong *i*)	isiq-	be-smoky	isiq**s**uq	isiʁ**ʎ**uni	*əð**i**ʁ-
(weak *i*)	makit-	stand up	makit**t**uq	makil**l**uni	*makət-
(strong *i*)	tikitʃ	arrive	tikit**tʃ**uk	tiki**ʎʎ**uni	*tək**i**t-

Although FUL agrees that the vowel /i/ is [CORONAL], it faces several problems with the assumption that CORONAL alone triggers palatalisation. The assumption in FUL is that palatalisation would normally occur with the additional feature [HIGH]; certainly the vowel /i/ is involved, but not the main place feature. Second, [CORONAL] would be underspecified, and thus will not play an active role. How could it work under these assumptions and would such an analysis be in any way preferable? We provide an alternative below.

First, the Inuit palatalisations affect all places of articulation; a summary from C&D's data is in (10).

(10) Surface outputs in Inuit due to palatalisation
n → ɲ
l → ʎ
k → ʧ
t → s

Note that the obstruents become strident, which would be the phonetic enhancement of the palatalisation process. It is actually not evident from C&D's analysis why [CORONAL] is the active feature relevant for palatalisation, since the inputs /t l s/ are all [CORONAL] to begin with. The only change in place of articulation is /k/ → /s/. All relevant features in FUL are tabulated in (11); the consonants [λ ɲ s tʃ] are listed for convenience, but they are in parentheses since they are derivatives of /l n t k/ in the context of /i/.

(11) FUL features for vowels (4-vowel system)

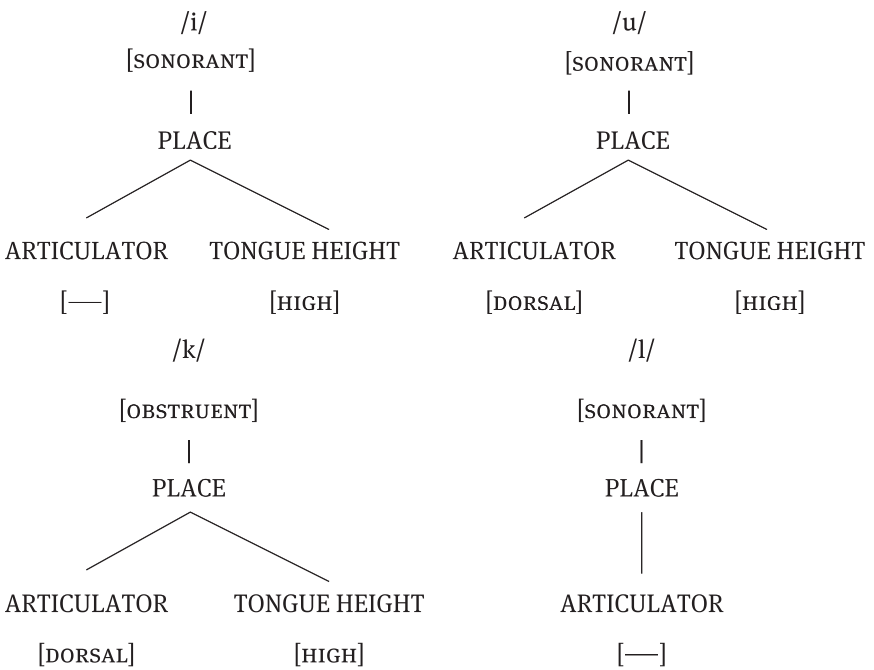
	i	u	a	ə
ART	COR	DORSAL	DORSAL	
TH	HIGH	HIGH	LOW	

(12) Features for relevant CORONAL consonants

	l	(ʎ)	t	(s)	n	(ɲ)	k	(tʃ)
ART	COR	COR	COR	COR	COR	COR	DOR	COR
TH		HIGH					√	√
				STRID				STRID

Although the tables show the distribution of features, a proper tree diagram is necessary to show the precise nature of the underlying representations and how the palatalisation process should work. On our analysis, the underlying representations of four contrasting vowels and consonants, /i u k l/, are as follows:

(13) Underlying representation of /i/ /u/ /k/ /l/

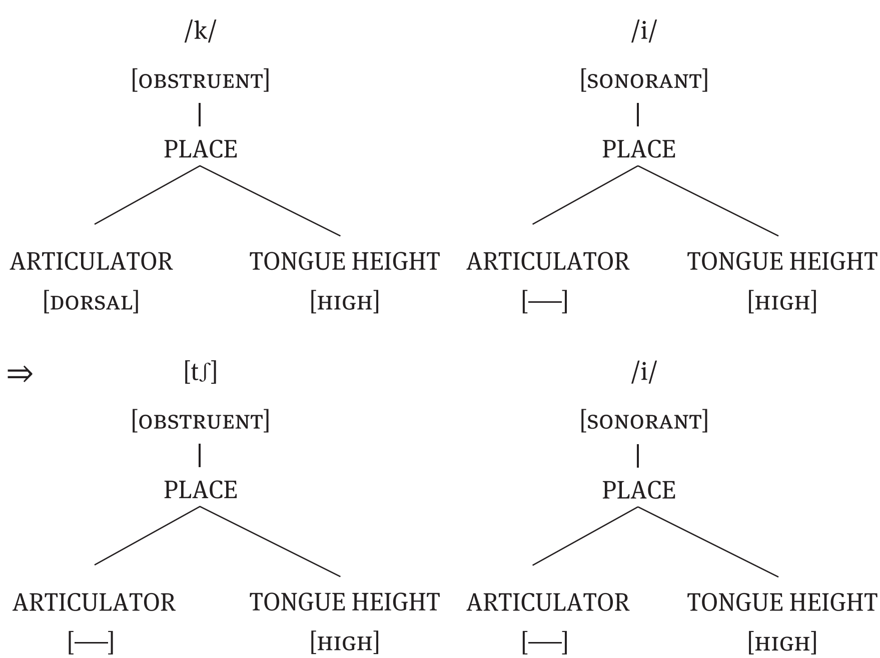


We distinguish between UNDERSPECIFIED features, which are marked as [—] with the relevant node (e.g., ART [—] for /i/), and NOT SPECIFIED such as the empty cell for ARTICULATOR for /ə/. We will see presently that the underspecified features will eventually have specific features filled in by production rules, while those that are not specified or redundant will be more variable. Thus, /ə/ will have a PLACE node but no ARTICULATOR node properly assigned; it may, therefore, obtain different features in production.

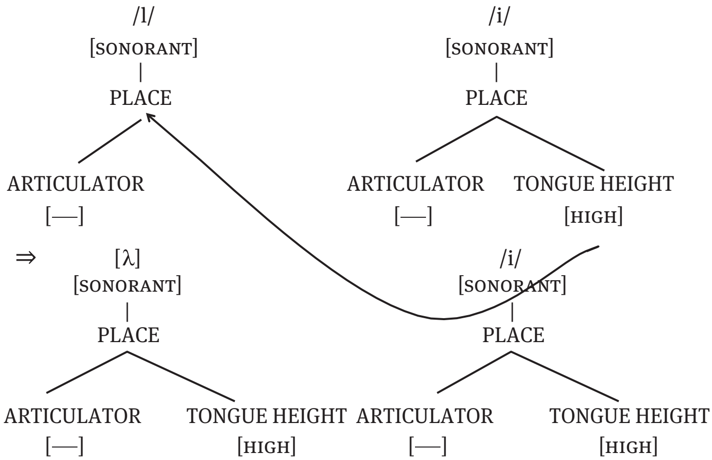
Palatalisation is triggered by /i/, which is ARTICULATOR-free but specified for TONGUE HEIGHT [HIGH]. Two processes are involved in the way /i/ "fronts" /k n l/, a not uncommon way to describe palatalisation. The first entails ensuring that the sequence of ARTICULATOR features do not mismatch, leading to [DORSAL] being deleted in the context of ARTICULATOR-free /i/. The second, where the ARTICULATOR features of the consonants /n l/ are unspecified, involves the spreading of [HIGH] to non-[HIGH] coronal consonants making them palatals and thereby [HIGH]. Both are illustrated in (14).

(14) Palatalisation

(a) /k/ → [tʃ]: deletion of [DORSAL]

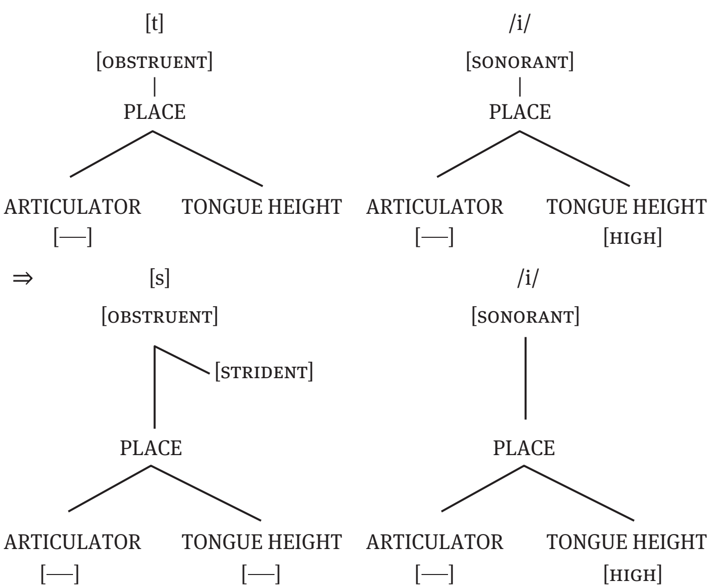


(b) Palatalisation of /l/ → [ʎ]: spreading of [HIGH]



There is a third palatalisation which is an assibilation process, where /t/ does not change the place of articulation, but becomes a strident [s]. To account for this, [STRIDENT] is incorporated as a fill-in surface rule as an effect of the spreading of [HIGH], as in (15). Languages differ in the way /t/ becomes a sibilant; in English, for instance, [HIGH] leads to /t/ becoming a /tʃ/, as in *don't you* → *don*[tʃ]*you*.

(15) Assibilation: /t/ → [s]



To obtain the correct surface forms we need further steps, viz., rules which fill in features for production (cf. Lahiri 2010; Plank & Lahiri 2015). An ARTICULATOR-free consonant will be provided with [CORONAL] as in (16). This will also include the addition of [STRIDENT] for /t/ in the context of /i/.

(16) Surface production rules for vowels
ART [—] → [CORONAL]
ART [DORSAL] & TH [HIGH] → ADD [LABIAL]

There are a few additional points to be made. First, we are able to account for palatalisation even if [CORONAL] is unspecified. However, why would this analysis be preferred over that of C&D, who assume that the [CORONAL] specification of /i/ can account for all the palatalisation processes? They elegantly connect the presence and absence of palatalisation and the specification of [CORONAL] for /i/. We do not deny that /i/ is [CORONAL] nor that it plays a significant role. However, C&D do not discuss the various ways in which [CORONAL] should affect the other consonants and in fact they do not show how palatalisation is actually realised. For instance, why is it that /l/ becomes /ʎ/ when [CORONAL] from /i/ spreads? Is /l/ not [CORONAL]? What about other coronal consonants such as /n/? Why does the addition of [CORONAL] from /i/ alone lead to palatalisation? Is it the vocalic element that is crucial and [CORONAL] from consonants has no effect?[5] For /k/-palatalisation, it is obvious that the place feature of the consonant changes. In our analysis, this is treated as an assimilation process whereby the ARTICULATOR features merge; this can be achieved by spreading or deletion. However, in our view palatalisation of the other consonants which are inherently all [CORONAL] is different. Thus, we crucially distinguish between palatalisations which affects back consonants and those which share the place feature with /i/. It is not clear how this is accounted for in C&D.

Second, the main aim of C&D's analysis is to confirm that the four-vowel and three-vowel systems have different feature distributions. Accordingly, for them the difference lies in the four-vowel systems requiring [CORONAL] to be specified for /i/, which triggers palatalisation, while it is unspecified in the three-vowel system (see above (7), (8)). Can our analysis account for this contrast, given that [CORONAL] is always underspecified and will always be filled in in the surface representation because it has an empty ARTICULATOR node? The answer is yes. Recall that in FUL it is not coronality *per se* which triggers palatalisation: it is [HIGH] that plays a crucial role. We compare the four- and three-vowel systems in FUL:

5 We are assuming that these consonants should be [CORONAL] in C&D based on the rest of their analysis.

(17) FUL features for vowels in Inuit dialects (3- and 4-vowel systems)

(a) 3-vowel system

	i	u	a
ART	[–]	DORSAL	DORSAL
TH			LOW

(b) 4-vowel system

	i	u	a	ə
ART	[–]	DORSAL	DORSAL	
TH	HIGH	HIGH	LOW	

Unlike C&D, it is not the presence or absence of coronality which is of central concern, but the TONGUE HEIGHT contrasts. In the three-vowel system, [HIGH] is not required, since the ARTICULATOR features are enough to distinguish /i/ and /u/. The first height feature is always [LOW]. If that is sufficient, there is no further need for [HIGH]. In the four-vowel system, the presence of a fourth vowel /ə/ requires [HIGH] to be specified. Since [HIGH] is essential for /i/ to trigger either fronting or assibilation, the three-vowel systems do not cater to palatalisation. Consequently, the lack of specification of [CORONAL] universally does not prevent us from accounting for the presence and absence of palatalisations.

3.3 Tahltan coronal harmony

Palatalisation in Inuit dialects directly leads us into a discussion of vowel harmony where coronal consonants differ in terms of their transparency, thereby either blocking or permitting harmony. Tahltan coronal harmony was analysed in Shaw (1991: 144–152), reconsidered in Clements (2001), and further discussed in Lahiri & Reetz (2010, henceforth L&R). In Shaw's account, Tahltan, an Athapaskan language, has a series of five coronal obstruents, and coronal harmony is only applicable across three sets — apical, laminal, and palatoalveolar consonants. The process involves fricatives of these places of articulation, which assimilate to all coronal place features, and stridency of any following coronal obstruent of one of these three sets. The simple and lateral series are transparent to this harmony process. Tahltan has four series of affricates and fricatives. The only true stops belong to the simple series.

Even in the lateral series, the consonants are not sonorants, but obstruent affricates and fricatives.

We compare Clements' analysis to L&R. The coronal obstruents and the relevant features proposed by Clements are given in (18) along with the corresponding features from FUL. Only the crucial features are listed.

(18) Tahltan coronal obstruents and their features (Clements' features: lat lateral, strid strident, distr distributed, ant anterior, apic apical, post posterior)

simple	lateral	apical	laminal	palatoalveolar
d	dl	ʣ	dð	ʤ
t	tɬ	ʦ	tθ	ʧ
t'	tɬ'	ʦ'	tθ'	ʧ'
	ɬ	s	θ	ʃ
	l	z	ð	ʒ

	Clements				FUL					
	ROOT				ROOT					
	lat	coronal						ARTICULATOR	TONGUE HEIGHT	
		strid	apic	post						
d					PLOSIVE			[–]		
dl	+					LAT		[–]		
s, ʣ		+					STRID	[–]		LOW
θ, dð			–				STRID	[–]		
ʃ, ʤ				+			STRID	[–]	HIGH	

In Clements (2001), the features [strident], [apical], and [posterior] are dominated by the [coronal] node, and only the marked feature values are specified, namely [+strident], [–apical], and [+posterior]. Thus, of the five coronal sets of a consonants, two are not specified for [coronal], but the others are. Stridency is a property only of coronal consonants; i.e., strident is dependent on coronal. The simple and the lateral series are unmarked for coronal, which is neither lexically specified nor active, and hence absent for these consonants. Thus, only the specified coronal consonants are engaged in harmony, but the others are transparent for harmony. In FUL, however, ALL coronal consonants, including the simple and the lateral consonants, are unspecified for the ARTICULATOR node and [STRIDENT] is independent of the ARTICULATOR node. An important assumption in FUL is that all fricatives and obstruent affricates in Tahltan are [STRIDENT]. Before we discuss the actual harmony process, we will look at some examples.

(19) Tahltan coronal harmony (Shaw 1991) (target within square brackets and trigger underlined)

(i) /-s/ ‘1SG subject marker’ /s/ → /θ/, /ʃ/

(a)	mεθε/s/εθ	mεθε[θ]εθ	I’m wearing (on feet)	*fricative trigger*
(b)	na/s/tθ’εt	na[θ]tθ’εt	I fell off (horse)	*affricate trigger*
(c)	dε/s/kʷʊθ	dε[θ]kʷʊθ	I cough	*intervening syllable*
(d)	xaʔε/s/t’aθ	xaʔε[θ]t’aθ	I’m cutting the hair off	*intervening simple t’*
(e)	ε/s/ʤɪni	ε[ʃ]ʤɪni	I’m singing	*voiced affricate trigger*
(f)	ya/s/tɬεʧ	ya[ʃ]tɬεʧ	I’m singing	*intervening lateral tɬ*
(g)	ε/s/dan	ε[s]dan	I’m drinking	*no change*

(ii) /-θ/ ‘1DUAL subject marker’ /θ/ → /s/, /ʃ/

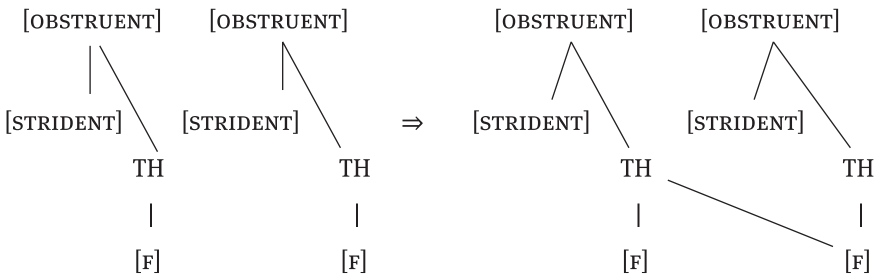
(h)	u/θ/iʤε	u[ʃ]iʤε	we are called	*voiced affricate trigger*
(i)	dε/θ/it’as	dε[s]it’as	we are walking	*intervening simple t’*
(j)	xa/θ/iːdεts	xa[s]iːdεts	we plucked it	*intervening simple d*

The differences between the first set, with /s/ changing to /θ/ /ʃ/, and the second set, with /θ/ changing to /s/ and /ʃ/, depend on the target: an apical (or perhaps dental) strident /s/ changes to the palatoalveolar or interdental in the respective contexts, while interdental /θ/ changes to palatoalveolar /ʃ/ or dental /s/.

In Shaw’s rule for harmony, the rightmost specified coronal node spreads leftwards with the concomitant delinking of the previous coronal specification of the target (cf. Lahiri & Reetz 2010 for a detailed analysis). The target is an immediately adjacent specified coronal node. Since both trigger and target need to be specified coronal nodes, the lateral and simple series are unaffected by the spreading and cannot block harmony. Clements accomplishes consonantal harmony with a single AGREE constraint which ensures that all coronal nodes containing the marked feature values must be identical within the word. This means that the coronal laterals and plosives remain untouched while the others are involved in harmony. Both Shaw and Clements need to separate the lateral and plosives from the other consonants in terms of coronal specification. They achieve the harmony process by ensuring that the simple [d] and the lateral [dl] series are free of the coronal node, while the other series require features which are dominated by the coronal node.

How does it work in FUL? Under our analysis, harmony is restricted to obstruents specified for STRIDENT; as mentioned before, [CORONAL] will surface, but is unspecified in the underlying representation. Moreover, the plosives and the laterals do not have the feature [STRIDENT].

(20) Tahltan harmony in FUL: for a sequence of [STRIDENT] obstruents, TONGUE HEIGHT features spread regressively within a word when no other [STRIDENT] obstruent intervenes



(21) Harmony examples in FUL with and without intervening consonants (intervening segments in bold and trigger underlined)

(i)	θ	**d**	tʃ	→	ʃ	**d**	tʃ
	[–]		[HIGH]		[HIGH]		[HIGH]
	[STRID]		[STRID]		[STRID]		[STRID]
(ii)	s	**tɬ'**	tʃ	→	ʃ	**tɬ'**	tʃ
	[LOW]		[HIGH]		[HIGH]		[HIGH]
	[STRID]		[STRID]		[STRID]		[STRID]
		[LATERAL]				[LATERAL]	
(iii)	θ	**d**	ts	→	s	**d**	ts
	[–]		[LOW]		[LOW]		[LOW]
	[STRID]		[STRID]		[STRID]		[STRID]
(iv)	s	**d**	θ	→	θ	**d**	θ
	[LOW]		[–]		[–]		[–]
	[STRID]		[STRID]		[STRID]		[STRID]

In (i) and (ii), [HIGH] dominates, turning both /θ and /s/ to /ʃ/, while in (iii) [LOW] spreads and /θ/ becomes /s/. For (iv), since assimilation is progressive, the TONGUE HEIGHT feature [LOW] of /ts/ is deleted to agree with the unspecified TONGUE HEIGHT feature of /θ/. The TONGUE HEIGHT features spread across the laterals (e.g., /tɬ'/) and plosives (e.g., /d/) which are both independent of the TONGUE HEIGHT node and does not block any feature spreading. No other feature is altered.

Thus, for Tahltan, in both Shaw and Clements' analyses, some of the coronal consonants could not be specified for coronality to obtain correct results for harmony. For both analyses, stridency was an additional complication since the distinguishing features for the various places of articulation with coronal consonants as well as the feature [STRIDENT] were dependent on [CORONAL]. Consequently, to prevent some of the coronal consonants from undergoing harmony or to be transparent to harmony, they were prevented from having the coronal feature or in Clements' terms, "coronal was not active". FUL does not have that choice. The feature CORONAL is always there and is always underspecified. Furthermore, since there are no features dependent on CORONAL, to obtain the other contrasts, different features are employed.

4 Lack of dependent features and CORONAL contrasts

4.1 Ways of accounting for CORONAL contrasts

As mentioned above, FUL disallows dependent features. Although this has positive aspects, we still need to be able to distinguish many places of articulation which are all [CORONAL]. Since SPE, the features [±anterior] and [±distributed] have been used to distinguish between the various coronal affricates and fricatives. The traditional SPE feature combinations (cf. (1)) for coronal consonants made by the tip and blade of the tongue are as follows:

(22) SPE features used to distinguish various coronal consonants

	dentals	[+anterior] [+distributed]
	alveolar	[+anterior] [−distributed]
	retroflex	[−anterior] [−distributed]
	palatoalveolar	[−anterior] [+distributed] [−back]
cf.	palatal	[−coronal] [−anterior] [+distributed]

In FUL, both palatal and retroflex consonants are [CORONAL] and [HIGH], and therefore are not distinguishable by these two features. These types of consonantal contrasts could be potential problems: palatal versus retroflex stops /c ʈ/ and nasals /ɲ ɳ/, and palatoalveolar versus retroflex sibilants /ʃ ʂ/.

Lahiri & Reetz (2010) maintain that it is extremely rare (if attested at all) that phonemic contrast occurs between dentals and alveolars on the one hand and retroflex and palatals on the other. For example, Malayalam has been claimed to have both alveolar and dental stops. However, the alveolar stop is always derived from a rhotic and the minimal pairs that can be obtained are via gemination. The rhotic, when geminated, becomes an alveolar (Lahiri et al. 1984). Palatals are definitely coronal (Lahiri & Blumstein 1984; Keating & Lahiri 1993), but we propose that a palatal versus retroflex underlying contrast in stops is only possible if the palatal stop is affricated or is an “alveopalatal” consonant, both of which would be [STRIDENT] (cf. Hall 1997), or if one is derived from the other. In Malayalam, which has both retroflex and palatal stops, only retroflex stops occur in the underlying inventory. The palatal stops are derived in specific morphological environments from intervocalic velars when preceded by front vowels. Mohanan & Mohanan (1984: 589) also suggest that, given the complex conditioning of the palatalisation rule, “[p]erhaps the right solution is to say that Palatalization is blocked when the segment has some ad hoc diacritical feature [–P]”. Mohanan & Mohanan also make a distinction between UNDERLYING and LEXICAL alphabet, the latter being derived by rules in the lexicon. Their claim is that the lexical alphabet “has significant consequences for human perception of speech sounds” (1984: 598). Possibly Mohanan & Mohanan’s lexical contrasts and our underlying contrasts are the same. A further possibility is that, like the dental/alveolar contrast, the feature [HIGH] is specified in one case and not in the other.

If a language has both palatal and retroflex nasals, FUL predicts that they are not truly contrastive. Either the palatal nasal /ɲ/ is an assimilated variant of an alveolar or dental /n/ in the context of a palatal or palatoalveolar stop, or the retroflex nasal is derived, or it consists of a nasal-plus-glide sequence. Again, Malayalam is a good example since it has seven phonetic nasals derived from three underlying ones which are labial, dental, and velar /m n ŋ/ (Mohanan & Mohanan 1984: 583–586, 596–598). Mohanan & Mohanan show that palatal and retroflex nasals are derived by a homorganic nasal assimilation rule in the context of following palatal and retroflex stops, and the palatal stops are in turn derived from velars. Thus, the feature contrast for a language like Pitta-Pitta, which has been claimed to have a series including dentals, alveolar, palatal, and retroflex stops and nasals (from Hall 1997) would be as follows.[6]

6 In Hall’s terminology, rather confusingly, traditional “palatals” are called “alveolopalatals”, and they differ in their coronality: “The term ‘palatals’ will used here to refer to true palatals, such as German [ç ʝ] and not to sounds like Hungarian [c ɟ], which are alveolopalatal” (1997: 70, §2.6). According to Hall, alveolopalatals are coronal whereas true palatals are not; thus, “alveopalatals” [c ɟ ɲ ɕ ʑ] are [+coronal], “true palatals” [ç ʝ] are [–back, +dorsal]; also, he assumes that a four-way contrast among a single series of [+coronal –cont] is maximal (1997: 88, (4)). Since [±back] is not an option, in FUL all of these consonants are [CORONAL]. Hall also states, and here

(23) Pitta-Pitta [CORONAL] segments in FUL

t̪	t	ʈ	c
n̪	n	ɳ	ɲ
[LOW]	[—]	[ATR]	[HIGH]

So far we have not considered secondary articulations, although we have discussed palatalisation and the spreading of the feature [HIGH] of coronal vowels. In the next section we compare the fronting of velars with the palatalisation of other coronal consonants.

4.2 Palatalised consonants and palatalisation

In Bhat's seminal work (1978: 60–61), three types of palatalisation have been shown to recur across languages: (i) fronting of velars (24a); (ii) change of place within coronal consonants, with alveolar/dental becoming palatoalveolar/palatal (24b); and (iii) addition of secondary articulation to any place of articulation (24c); the context is invariably high front vowel /i/ and glide /j/ and sometimes the front vowel /e/.

(24) Results of palatalisation
(a) k, x → tʃ, ç
(b) t, s → tʃ, ʃ
(c) p, t → p^j, k^j

Examples of (23a) include Slavic languages where [k g x] became [tʃ, dʒ, ʃ] (SPE, 421–422). Polish is known to have palatalisations as in (23b) where coronal consonants [t d s z r n l] become pre-palatal consonants before front vowels and glides (Rubach 1984: 60). English alveolars such as [t d] become [tʃ dʒ] in the context of [j]. Finally "secondary palatal" articulation occurs involving "raising the central part of the tongue while keeping the main articulator intact" (Bhat 1978: 67). Secondary palatalisation of this sort occurs in Dutch diminutive formation, to be discussed in more detail below. Two issues need to be addressed: palatalised

we agree, that no language contrasts alveolopalatals [ɕ] and palatoalveolars like [ʃ], and in fact the same holds true for palatals and palatalised velars – which is why, in his model, they have the same features. However, no language contrasts alveopalatal [ɕ] and palatal [c] either, and moreover there cannot be stops in both positions: one of the consonants has to be a continuant (cf. Lahiri & Blumstein 1984).

consonants, and particularly palatalised velars such as [k^j] vs. [c] or [ç], and palatalisation as a process.

There have been many discussions of palatalised consonants, succinctly summarised and discussed in Hall (1997). In our view, as argued above (cf. also Lahiri & Evers 1991; Lahiri & Reetz 2010), palatalisation is triggered by [CORONAL] and [HIGH]; to set the scene for its defense, let us look at a few notable alternatives.

To repeat, the crucial features traditionally implicated were [±anterior] and [±back]. The pertinent consonants had the following features:

(25) Differentiating front and back vowels and consonants

Dental-Alveolar	Palatoalveolar	Velar	Front vowels and [j]
Coronal	Coronal	Dorsal	Dorsal
[+anterior]	[–anterior]	[+back]	[–back]

Palatalisation: [k] → [tʃ] / —[i][7]

k	i	tʃ	i/j
Dorsal	Dorsal	Coronal	Dorsal
[+back]	[–back]		[–back]

Thus, a change from [k] to [tʃ] in the context of [i] or [j] would involve a change in the primary change of articulation of dorsal to coronal in the context of [–back], which was dominated by dorsal. This problem was addressed in detail by Clements and taken up by Hume, leading to the feature set we discussed above.

In the analysis of Clements (1989), the structure of palatalisation would involve the following features:

(26) Palatalisation according to Clements (1989)

	k	–	j	→	k^j	→	tʃ
C-place							
[coronal]							+
[dorsal]	+				+		
V-place							
[coronal]			+		+		
[dorsal]							

7 The change leads most often to a [HIGH] consonant such as [ç tʃ ʃ]. Sometimes /t/ also becomes /s/ in a similar context, but that is more of an assibilation whereby the stop becomes a sibilant fricative, again in the context of a high vowel or glide.

The first step involves a palatalised [kʲ], which has a C-place dorsal as well as a V-place coronal. This in turn undergoes tier promotion, complex segment formation, and concomitant affrication to become [tʃ]. This was a remarkable proposal, suggesting for the first time that [j] led to palatalisation because of its coronal status. Our view is similar, except that we do not have the independent tiers. However, before we delve into FUL's proposal, we briefly discuss Hall's take on this.

According to Hall (1997), palatals ("alveopalatals" in his terminology) differ from "true" palatals such as German [ç]. His features for these consonants would be as follows.

(27) Hall's features for palatalised consonants

	alveolar/dental	alveopalatal	palatal	palatalised velar	velar
	s	ɕ/ʃ	ç	xʲ	x
[coronal]	+	+			
[dorsal]			+	+	+
[anterior]	+	–			
[back]		–	–	–	+

This differs from the Clements & Hume's feature set:

(28) Features for palatalised consonants in Clements & Hume (1995)

	alveopalatal	palatal	palatalised velar	velar
	ɕ	ç	xʲ	x
CONS	+	+		
[coronal]			+	+
[dorsal]				
VOC	+		+	
[coronal]				

Hall argues that, in his terminology, the features deliberately do not contrast [ç] and [xʲ], because these two sounds never co-occur. The crucial point here is that under Hall's analysis, unlike Clements & Hume's, palatalisation is governed by a feature [+P], which is essentially [–back].

However, as seen above, [–back] would normally be dominated by [dorsal]. Under Hall's analysis, the palatalisation feature [+P] must, therefore, come under both [coronal] and [dorsal]. This is because under his analysis palatal [ç] is [dorsal] but unlike Sagey-Halle's analysis, front vowels and glides are coronal and not dorsal (1997: 79–83). In (29) we reproduce Hall's analysis of a velar and alveolar palatalisation, with velar [x] to [ç] being a regular phenomenon in German.

(29) Palatalisation of [x] > [ç], [s] > [ʃ] according to Hall (1997: 83 (73), 78 (63))

(a)
```
        i             x        —>      i            ç
     [place]       [place]          [place]      [place]
   [+coronal]     [+dorsal]       [+coronal]    [+dorsal]
        |                              \            /
  [+P]=[−back]                               [+P]
```

(b)
```
        s             i        —>      ʃ                        i
     [place]       [place]          [place]                  [place]
   [+coronal]    [+coronal]       [+coronal]               [+coronal]
                      |                \                        /
                [+P]=[−back]                      [+P]
```

(c)
```
          [+P]
        /      \
  [+coronal]  [+dorsal]
```

As Hall states, [+P] as [−back] presents an apparent formal problem, because it requires this feature to be located under both [+coronal] and [+dorsal] (1997: 83–84).

(30) Definition of the palatalisation feature [+P] (Hall 1997: 83)
"the segments that are marked [+P] include (a) front vowels like [i e æ], (b) palatoalveolars [ʃ ʒ], (c) alveolopalatals [ɕ ʑ], (d) palatals [ç ʝ], and (e) palatalized segments (e.g. p^j b^j t^j d^j k^j g^j). The property shared by all of these segment types in (a)-(e) is a fronted tongue body (see Sagey 1986: 278)"

Consequently, since front vowels are coronal (like in FUL), Hall's analysis dispenses with the awkwardness of having a dorsal [k] becoming a coronal palatoalveolar in the context of dorsal [i] or [j] via [−back], which too is dominated by dorsal. However, since the palatals are still dorsal (unlike FUL), the [+P] feature has to be dominated by BOTH coronal and dorsal.

Instead of this rather complex analysis, we follow Clements' assumptions that all palatals and palatoalveolars and front vowels and glides are coronal, and thus palatalisation which causes a fronting of velar consonants is an assimilation to a coronal place of articulation and by a coronal. However, as noted above, palatalisation involves also the "backing" of dentals/alveolars [t d] to [tʃ dʃ] or [ʃ ʒ] as well as adding secondary articulations. We turn to this below.

We have argued elsewhere (i) that neither fronted velars and palatals, nor palatalised velar and regular velar in the context of [i] may contrast in any single language (Keating & Lahiri 1993), and (ii) that alveopalatal and palatal stops do not co-occur in the same language (Lahiri & Blumstein 1984). Thus, features for these various coronal consonants as compared to a velar would be as in (31).

(31) Strident, fronted, palatalised, and velar consonants in FUL

		dental/ alveolar	palato- alveolar	palatal	palatalised velar	velar
		s	ɕ/ʃ	ç/c	x^j/k^j/c̱	x/k
ART						
	[CORONAL]	√	√	√		
	[DORSAL]				√	√
TH						
	[LOW]	√				
	[HIGH]		√	√	√	

Note that FUL's features for alveopalatal and palatal sounds are the same: if there is a contrast it has to be via [STRIDENT]. In FUL, the palatalisation of velars, as for example [k] → [ç] in German or [k] → [tʃ] in Slavic, would always have to be as follows:

(32) Velar palatalisation in FUL

(a) [k] → [ç]

i	x	→	i	ç
VOC	OBSTR		VOC	OBSTR
	CONTINUANT			CONTINUANT
ART TH	ART		ART TH	ART
[–] [HIGH]	[DOR]		[–] [HIGH]	[–]

(b) [k] → [tʃ]

k	i	→	tʃ
OBSTR	SON		OBSTR
			STRIDENT
ART	ART TH		ART
[DOR]	[–] [HIGH]		[–]

Earlier, in Lahiri & Evers (1991, henceforth L&E), where we permitted dependent features, palatal and palatoalveolar consonants were distinguished by [–anterior]. Thus, the various coronal consonants were distinguished as follows:

(33) Differentiating front and back vowels and consonants (A = Articulators, TP = Tongue Position, αF = mnemonic of different values for high and low] (adapted from L&E, 90, 11)

Dental-Alveolar	Palatoalveolar	[j]	Velar	Front Vowels
Place	Place	Place	Place	Place
|	|	/ \	|	/ \
A	A	A TP	A	A TP
Coronal	Coronal	Coronal [+high]	Dorsal	Coronal [αF]
|	|	|		|
[+anterior]	[–anterior]	[–anterior]		[–anterior]

Despite allowing both binary features and dependency, in L&E palatalisation of velars was a change of dorsal to coronal and crucially [+high] and not [–anterior]. However, [±anterior] played a crucial role in converting dental-alveolar consonants into palatoalveolars:

(34) L&E (a) velar palatalisation vs. (b) dental palatalisation

(a)

Velar	[j]		Palatoalveolar
Place	Place		Place
|	/ \	→	|
A	A TP		A
Dorsal	Coronal [+high]		Coronal

(b)

Dental-Alveolar [t]	[j]		Palatoalveolar [tʃ]
Place	Place		Place
|	/ \	→	|
A	A TP		A
Coronal	Coronal [+high]		Coronal
|	|		|
[+anterior]	[–anterior]		[–anterior]

We believe this was not the correct approach. In the FUL model, Lahiri & Reetz (2010) argued that the contrasts enabled by [±anterior] and [±distributed] were adequately dealt with by TONGUE HEIGHT [HIGH] & [LOW] features along with [ATR] and [RTR]. Within FUL, a move from dental to palatoalveolar or palatal would not be a change in main articulators. It would be more of a change to stridency lead by a combination of the feature [HIGH] and [CORONAL], both enhancing high frequency energy. Thus, the usual dental/alveolar change can lead to [ʃ] or [tʃ], i.e., a change to fricative or an affricate, both of which must be [STRIDENT]. Stridency comes as a concomitant change because, as argued earlier in Lahiri & Blumstein (1984), the palatoalveolar place of articulation cannot be articulated without fricativisation. Clements (1986, 2001) came to the same conclusion that there is concomitant affrication. Thus, dental palatalisation would be formalised as follows:

(35) Dental palatalisation in FUL

Dental-Alveolar [t]	[j]		Palatoalveolar [tʃ]
CONS	SON		CONS
			STRIDENT
PLACE	PLACE		PLACE
|	/ \	→	|
ART	ART TH		ART
[–]	[–] [HIGH]		[–]

What about secondary articulations involving palatalisation? We will argue that these do not involve any ARTICULATOR feature, but only the feature [HIGH].

For L&E, secondary palatalisations were NOT caused by a change of any ARTICULATOR feature but by height features. In FUL, the palatalised versions of all places of articulation likewise have a non-redundant [HIGH].

(36) Palatalised /k/ in FUL

k	i		→	k^j	
ART	ART	TH		ART	TH
[DOR]	[COR]	[HIGH]		[DOR]	[HIGH]

The contrast for other palatalised consonants as in the Finno-Ugric language Ter Lapp would also be marked by [HIGH]:

(37) Palatalised and non-palatalised consonants

p	p^j	v	v^j
[LAB]	[LAB] [HIGH]	[LAB]	[LAB] [HIGH]

An analysis of the Dutch diminutive (Trommelen 1984; Gussenhoven & Jacobs 2011, partially also discussed in L&E) sheds more light on palatalisation where alveolars become palatoalveolars. Labials and velars have a secondary articulation with devoiced [j].

(38) Dutch diminutives: underlying form /tjə/ (following Gussenhoven & Jacobs):

(a)	[t]-deletion + [jə]			
	i.	lɑp	lapʲə	‘rag’
	ii.	buk	bukʲə	‘book’
(b)	place assimilation and [jə]			
	iii.	ra:m	ra:mpʲə	‘window’
	iv.	ko:niŋ	ko:niŋkʲə	‘king’
(c)	[t]-deletion & palatalisation leading to [c], [ʃ]			
	v.	pɑs	pɑʃə	‘step’
	vi.	fa:s	fa:ʃə	‘vase’
	vii.	fut	fucə	‘foot’
	viii.	lint	liɲcə	‘ribbon’
	ix.	fœyst	fœyʃə	‘fist’
(d)	palatalisation			
	x.	ze:	ze:cə	‘sea’
	xi.	ma:n	mɑ:ncə	‘moon’
	xii.	pa:l	pa:lcə	‘post’
	xiii.	o:r	o:rcə	‘ear’
(e)	degemination of [t] in coda cluster			
	xiv.	kaft	kafʲə	‘book-cover’
	xv.	bɔχt	bɔχʲə	‘bend’
(f)	[ə] insertion and palatalisation			
	xvi.	bɔm	bɔməcə	‘bomb’
	xvii.	pɑn	pɑnəcə	‘pot
	xviii.	bɑl	bɑləcə	‘ball’

The underlying form of the diminutive is assumed to have a coronal stop [t] for two reasons. First, when the stem is disyllabic or contains a long vowel and ends in a non-coronal sonorant such as [m] or [ŋ], the underlying [t] assimilates in place, resulting in forms such as (38b iii, iv). Second, when the stem contains a short vowel followed by a sonorant (38f), an [ə] is inserted and the [t] becomes a palatalised stop [c]. Palatalisation is more obvious in (38c) and (38d). The [t] of the diminutive is deleted after a stem ending in an obstruent (38a). In (38c), after [t] is deleted, the stem-final coronal obstruent ([s] or [t]) becomes [ʃ] or [c] respectively. The examples in (xii) and (xiii) are particularly interesting because when there is a sequence of two [t]s, one deletes and the remaining palatalises.

Gussenhoven & Jacobs (2011, 2017) state that the underlying form is /tjə/ and the palatalised stop [c] is defined as [−anterior, −distributed] stop.[8] For our purposes, since both /t/ and /j/ are placeless, we could simply assume that there is only a CV morpheme. L&V analysed the diminutive suffix in a similar fashion with an empty obstruent root followed by a floating [−anterior] [+high] segment unspecified for any other feature and a schwa.

(39) Dutch diminutive suffix in L&E (with [±anterior]; R obst = ROOT [OBSTRUENT])

R obst   Place   ə (schwa)

TP

[−anterior]   [+high]

However, given that all palatalised segments in FUL are represented by the ARTICULATOR node with a [HIGH] under TONGUE HEIGHT, we could represent the diminutive morpheme as in (40), with the features of the relevant consonants in (41).

(40) Dutch diminutive morpheme in FUL

```
OBSTR     CONS      VOC
  |       /   \      |
 ART    ART   TH    [ə]
 [—]       [HIGH]
```

8 L&E assumed that the palatalisation of [t] lead to an affricate [tʃ]. This was an incorrect assumption, as Carlos Gussenhoven points out, because it ought to be more like [c], which is a stop. However, the second author of L&E, Vincent Evers, finds that the diminutive of *plaats* ‘place’ ends up as [pla:tʃə] and is, thus, not very different from the diminutive of *plaat* ‘plate’. What is important here is that for FUL, both are [CORONAL], differing in affrication.

Palatalisation for the diminutive involves [s] becoming [ʃ] and [t] becoming [c]. For FUL, both involve adding [HIGH]. To illustrate, we show the features of the relevant consonants in Dutch.

(41) Features of consonants involved in palatalisation in the Dutch diminutive

		t	s	ʃ	c	j
ROOT						
	[OBSTRUENT]	√	√	√	√	
	[SONORANT]					√
	[CONTINUANT]		√	√		
ARTICULATOR						
	[CORONAL]	√		√	√	
TONGUE HEIGHT						
	[HIGH]			√	√	√

In (42) we state the rules which are required to obtain the diminutive forms. The point we would like to make here is that the high front glide [j] which is part of the diminutive morpheme has the feature [HIGH] which in turn requires the obstruents [t s] to become [c ʃ] respectively. Since ALL consonants in question are [CORONAL], there is nothing else that is required. The only other relevant process is place assimilation where the place-underspecified [t] acquires the place of the final consonant in words like [ra:mp^{j}ə] from /ra:m – tjə/. Sample derivations are added in (43).

(42) Diminutive formation in FUL

(i) [ə] insertion: V [SONORANT] — DIMINUTIVE suffix
(ii) [t] deletion. [OBSTRUENT]$_{\text{DIMINUTIVE}}$ > Ø/ [OBSTRUENT] —
(iii) PLACE ASSIMILATION: spread specified features to the ARTICULATOR node
(iv) PALATALISATION: spread feature [HIGH], delete feature [CONS]

(43) Sample derivations (the rule numbers refer to those in (42))

	lint – tjə	ra:m – tjə	fut – tjə	fa:s – tje	bɔm – tjə
(i)	—	—	—	—	bɔmə - tjə
(ii)	lint – Øjə	—	fut – Øjə	fa:s – Øje	bɔmə - tjə
(iii)	—	ra:mpjə	—	—	—
(iv)	lincə	—	fucə	fa:ʃə	bɔməcə
Output	lincə	ra:mpə	fucə	fa:ʃə	bɔməcə

As for secondary palatalisation in forms such as [rɔkʲə] 'skirt-DIM', the crucial point we have made is that there is no real necessity to mark palatalised segments with special sets of features or as complex segments. Secondary palatalisation need not involve a change in place; thus, palatalised [k], which is [kʲ], would be represented as as ART[DORSAL], TH[HIGH], without change of ARTICULATOR. But dental consonants can change place of articulation. Palatalised dentals often undergo a change of place of articulation such as the Dutch [t] becoming [c]. Under our conception this can happen only if the context includes a high front vowel or a glide, not any front vowel. The general process of assimilation invoves the spreading of [HIGH]. Palatalised coronal stops can often also become strident affricates or fricatives because a combination of [CORONAL] and [HIGH] would provide a greater energy in the higher frequencies, a characteristic of strident segments. The addition of [STRIDENT] comes as a "free ride" since the unmarked articulation of all obstruents in the palatoalveolar region is with stridency (Lahiri & Blumstein 1984: 142).[9]

Second, it has been claimed that non-high front vowels can trigger secondary palatalisation for example in Nupe and Kinyarwanda (Sagey 1986: 209–218, 227–240). In these languages, secondary palatalisation is triggered not only by [i], but also by [e]. As in other languages, these consonants are phonetically produced by an offglide. We would argue (as in L&E, p. 95) that in these cases this glide could also be present phonologically as an onglide of the vowel such that [e] would be underlyingly [je]. If this is the case, it would predict that in the course of time the [j] triggering the palatalisation would be absorbed by the vowel and the consonant survives with a single major ARTICULATOR plus a TONGUE HEIGHT feature [HIGH]. This can be reflected in the orthography as in Russian, where the palatalisation mark of the consonant rests on the following vowel. Note that the fronting of velars is a matter of place change whereby a [DORSAL] [k] becomes a [CORONAL] consonant. Here, the context need not always be a high front vowel, but it could be any front vowel: it is [CORONAL] status that matters. However, as always, [i] and [j] are favoured.

5 Morphophonological alternation and language-specific underspecification

FUL accepts only monovalent and privative features along with underspecification of [CORONAL] and [PLOSIVE]. Consequently, minus features are not allowed. Since the mid to late eighties, the main articulator features LABIAL, CORONAL,

9 This comment has also been made by many phonologists including Sagey as well as in SPE.

DORSAL have been assumed to be monovalent. The question we ask is whether it is possible to account for complex analyses which may involve language-specific underspecification. This section is based on Hyman's analysis of vowel harmony in Kàlɔ̀ŋ, and what we would like to show is that despite the sparse nature of the FUL system, the complex set of alternations involving both specified and underspecified place features for vowels can be accounted for.

In Hyman's analysis of Kàlɔ̀ŋ, a Mbam language (Niger-Congo) of Cameroon, the stem-affix alternations are governed by a limited set of features, and there are three types of harmony: ATR, FRONT, and ROUND harmony. First, we examine the vowel /a/ and its realisations in different contexts. These realisations are summarised in (44).

(44) Realisations of affix /a/ adapted from Hyman (2003: 90 (7))[10]

	Prefix /a-/	Root Vowel	Suffix /-a/	
(i)	e-	i u	-e	a → ə → e /i a → ə → e /u
(ii)	e- o-	e o	-e -o	a→ e /e a → o / o
(iii)	ɛ- ɔ-	ɛ ɔ	-ɛ -ɔ	a → ɛ / ɛ a → ɔ / ɔ
(iv)	a-	a	-a	/a/ remains unchanged

The affix /a/ remains unchanged when the root also contains /a/ (iv). When the root has a high vowel, /a/ becomes /e/ (i), while it takes on the features of the root if they contain mid vowels /e ɛ o ɔ/.

The underlying features of the relevant vowels in Hyman's analysis are given in (45).

(45) Kàlɔ̀ŋ underlying features (Hyman 2003: 94)

	i	u	e	o	ɛ	ɔ	a	ə [e]
ATR	x	x	x	x				x
FRONT	x		x		x			
ROUND		x		x		x		
OPEN			x	x	x	x	x	x

10 When the root has the "abstract" vowels /I U/, which in turn surface as [i~e] or [u~ɔ], the suffix remains /a/. Our focus is not on the abstract vowels, which as Hyman shows are entirely transparent and predictable, but on the first three contexts.

Like Dresher and Clements, Hyman invokes the notion of “activity” and argues that only the “active” four features that are necessary to account for the data should be relevant. Using a system like that of Clements, ATR and OPEN fall under a single APERTURE node. The vowel [ə] does not surface, but is assumed to be the intermediate fronted vowel of /a/ when the root has a high vowel /i u/.

Examples for the first three harmony cases are given in (46).

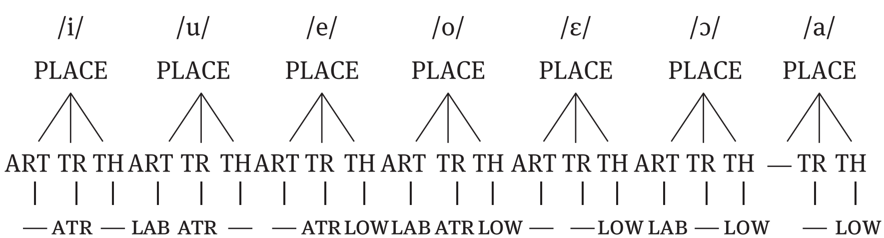
(46) Alternations with the RECENT PAST prefix /a/ (adapted from Hyman 2003: 93 (14); the English glosses are ours)

a.	root /i u/				
	ù-sà-tínìt	>	ù-sè-tínìt	il a couru	he ran/he has run
	ù-sà-tûm	>	ù-sè-tûm	il a commencé	he started/he has started
b.	root /e ɛ o ɔ/				
	ù-sà-télèmit	>	ù-sè-télèmit	il s’est levé	he got up/he has got up
	ù-sà-nɛ́ŋɛ̀	>	ù-sɛ̀-nɛ́ŋɛ̀	il a nagé	he swam/he has swum
	ù-sà-yòsòn	>	ù-sò-yòsòn	il a regardé	he watched/he has watched
	ù-sà-tɔ́ŋɔ̀	>	ù-sɔ̀-tɔ́ŋɔ̀	il a chanté	he sang/he has sung
c.	ù-sà-sàŋâ	>	ù-sà-sàŋâ	il a mangé	he ate/he has eaten

The features ATR, FRONT, and ROUND participate actively in the harmony process and the last two are “parasitic” on FRONT (Hyman 2003: 90). Our interest here is in the vowel /a/, which changes to [e] not only in the context of /i/, but also in the context of /u/ where, in a parallel scenario, it ought to change to [o]. Hyman argues that “the fronting of /a/ under ATR harmony is a secondary development, the primary one being to lower its F1”. That is, /a/ “first converts to a [+ATR] central vowel, here symbolised as schwa”, which in turn becomes /e/ (44(i)). Why should this be so in a perfectly regulated harmony system? Why does the spreading of ATR ignore the place features for the high vowels? We turn to FUL for an answer. (47), including a tree diagram representation, gives the features that FUL would assign on universal principles; note that CORONAL remains underspecified.

(47) Kàlɔ̀ŋ vowels in FUL: Underlying representation (shading indicates underspecification)

	i	u	e	o	ɛ	ɔ	a
PLACE	•	•	•	•	•	•	•
ARTICULATOR	•	•	•	•	•	•	
CORONAL	√		√		√		
LABIAL		√		√		√	
TONGUE ROOT	•	•	•	•	•	•	•
ATR	√	√	√	√			
TONGUE HEIGHT	•	•	•	•	•	•	•
LOW			√	√	√	√	√



A clear distinction needs to be made between the underspecified CORONAL and the lack of an ARTICULATOR node. As always, CORONAL is not specified in the representation, but if the vowel has an ARTICULATOR node, it will get the feature on the surface by a fill-in rule. Thus, /a/ will not get a CORONAL specification, but /i e ɛ/ will. A futher lack of feature specification involves TONGUE HEIGHT (TH) as well as TONGUE ROOT (TR) features: /i u/ are not specified for height, but they do have the TH node and /ɛ ɔ a/ are not specified for TR. The feature filling rules, which determine the surface features, are as follows:

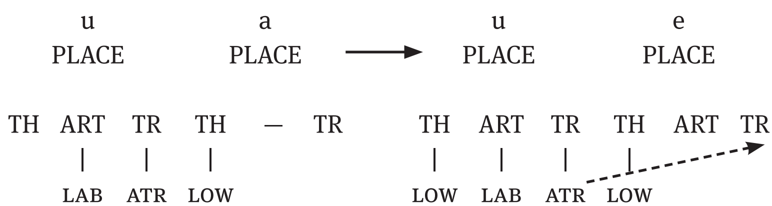
(48) Surface feature filling rules
- (i) LABIAL ⇒ DORSAL; any surface LABIAL vowel will get a DORSAL feature
- (ii) Unfilled ARTICULATOR nodes will be assigned CORONAL; i.e., /i e ɛ/ will be assigned CORONAL
- (iii) Unfilled TONGUE ROOT nodes will be assigned RTR; i.e., /ɛ, ɔ, a/ will be assigned RTR

Thus, /a/ has the feature LOW without precise place features suggesting that phonetically it can be in between.

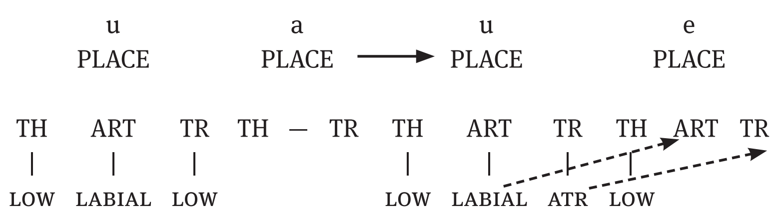
Under this representational hypothesis, it is clear why, when ATR spreads from /i u/, the suffix /a/ will automatically become /e/: /a/ and /e/ share the feature [LOW] and nothing else. Thus, spreading [ATR] from /i, u/ to /a/ turns it into /e/. The difference between /a/ and /e/ is that /a/ does not have an ARTICULATOR node. This gets filled in on the surface where it will then emerge as /e/ since ATR has spread. Consequently, unlike in Hyman's analysis, /a/ > [e] does not require an intermediate analysis which produces [ə] (49i). The harmony processes for high and mid vowels look different because of the mismatch between the TH features. These are spelt out with relevant examples below.

(49) Harmony processes

(a) ATR harmony: Mismatching TH between root and suffix



(b) ARTICULATOR and ATR spreading: Matching TH between root and suffix



Hyman mentions another interesting harmony process that includes two different underlying vowels which sometimes surface as [i u] but not always:

(50) /i, u/ vs. /I, U/ (cf. Hyman, (5))

Roots /I, U/ with /i~ɛ, u~ɔ/ in open and closed syllables

	closed σ	open σ – suffix /-a/	
/lÍk/	kù-lɛ̂k	kù-lík-à	'désirer' *kù-lík-è (no ATR harmony for final /a/)
/lɛ̀k/	kù-lɛ̂k	kù-lɛ́k-ɛ̀	'lecher' final /a/ assimilates to root
/lÙk/	kù-lɔ̀k	kù-lùk-à	'nommer' *kù-lùk-è (no ATR harmony for final /a/)
/lɔ̀k/	kù-lɔ̀k	kù-lɔ̀k-ɔ̀	'abîmer' final /a/ assimilates to root

Underlying /I U/ are realised as /ɛ ɔ/ in closed syllables and as /i u/ in open syllables. With the suffix /-a/, underlying /I U/ are not realised as *kù-lík-è and *kù-lùk-è, since underlying /a/ does not undergo ATR harmony, but underlying /ɛ ɔ/ remain in open syllables and /a/ assimilates to them. Consequently, Hyman analyses the vowels /I U/ as having only the features FRONT and ROUND; neither ATR nor OPEN are specified, which accounts for several distributions:

(51) Hyman's analysis of /I, U/ compared with /i u/

	i	u	I	U
ATR	x	x		
FRONT	x		x	
ROUND		x		x
OPEN				

– Each V has one feature specification
– /I U/ acquire ATR in open syllables, merging with /i u/
– /I U/ acquire OPEN in closed syllables, merging with /ɛ ɔ/
– The aspectual suffix /-a/ does not undergo ATR harmony with these root vowels

Lack of ATR and OPEN, then, ensue in the lack of harmony alternations.

(52) Consequences of the analysis

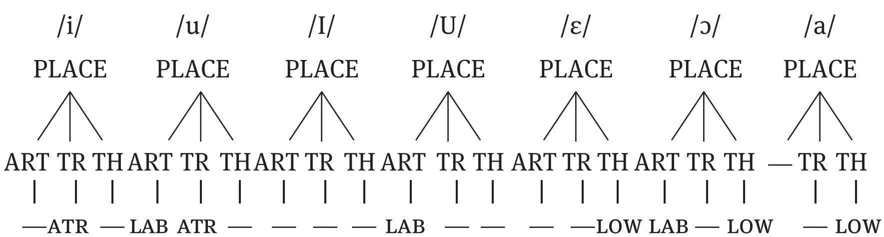
(a)	/I, U/ do not condition ATR harmony	/I, U/ lack ATR
(b)	/I/ never conditions FRONT harmony	/I/ lacks the OPEN feature
(c)	/U/ never conditions ROUND harmony	/U/ lacks the OPEN feature
(d)	/I, U/ become [i, u] by ATR harmony	/I, U/ differ from /i, u/ only in ATR
(e)	/I, U/ are transparent to FRONT/ROUND harmony	/I, U/ lack the OPEN feature

Is it possible to account for this complex situation in FUL, where not only CORONAL is underspecified, but the vowels /I U/ must lack height as well as ATR features? Our proposal is outlined in (53).

(53) FUL features for all vowels

	i	u	e	o	ɛ	ɔ	a	I	U
PLACE	•	•	•	•	•	•	•	•	•
ARTICULATOR	•	•	•	•	•	•		•	•
CORONAL	√		√		√			√	
LABIAL		√		√		√			√
TONGUE ROOT	•	•	•	•	•	•	•	•	•
ATR	√	√	√	√					
TONGUE HEIGHT	•	•	•	•	•	•	•	•	•
LOW			√	√	√	√	√		

Tree diagrams for /I U/ and their variants /i u ɛ ɔ/ and suffixal /a/



Thus, in closed syllables, the addition of [LOW] for unspecified TH of /I U/ would give /ɛ ɔ/, while in open syllables they would receive the feature [ATR].

(54) Surface variants of /I U/

closed syll	open syll	
/lÍk/	kù-lɛ̂k	kù-lík-à
[—] →	add LOW	add ATR
/lÙk/	kù-lɔ̂k	kù-lùk-à
[LAB] →	add LOW	add ATR
	[LAB, LOW]	[LAB, ATR]

We have seen, then, that the underspecification of [CORONAL] does not prevent FUL from accounting for such complex patterns as vowel harmony in Kàlɔ̀ŋ in a principled way. What is additionally required here is the lack of specification of ATR and OPEN (i.e., height) features, not a problem in the FUL framework: the raising and fronting of /a/ to [e] can then be achieved without an intermediate step.

6 Moving on

To sum up, FUL provides a set of monovalent features, along with underspecification of [CORONAL] and [PLOSIVE], which are intended to be universal. Thus, binary features like [±high] or [±voice] are not acceptable and the automatic consequence is that negative features cannot form natural classes. However, it is possible to refer to a node which does not contain a fully specified feature. Thus, ARTICULATOR remains empty for CORONAL, which gets filled in on the surface. Rules like English aspiration of voiceless consonants (under the assumption that underlying stops are unaspirated) could be realised as below:

(55) Aspiration in English (adding SPREAD GLOTTIS)

CONSONANTAL		CONSONANTAL	/
OBSTRUENT	⟶	OBSTRUENT	
LARYNGEAL		LARYNGEAL	σ[—
		|	
		SPREAD GLOTTIS	

The rule of aspiration says that when the LARYNGEAL node is "empty" and does not contain either SPREAD GLOTTIS or VOICE, the feature SPREAD GLOTTIS would be added. When, on the other hand, the feature VOICE is part of the LARYNGEAL node, then SPREAD GLOTTIS would not be added. Thus, in a word like /pɪn/, the initial consonant has no laryngeal feature and acquires SPREAD GLOTTIS in syllable-initial position, but since the LARYNGEAL node for /b/ (in words like /bɪn/) are already specified with the feature VOICE, no other feature can be added. Consequently, /b/ remains without aspiration.

In fleshing out a model like FUL, a host of further questions need to be tackled. We will only broach three here: they are ones where significant progress has been or is being made. First, since unlike contrastive theories that assume activation we assume that universal features are acquired first and always establish a contrast, then how do the other features become part of the system? Second, if CORONAL and PLOSIVE are always underspecified, then they must always be available in natural languages; but are they? Finally, we have claimed that underspecification has consequences for processing: but to what extent do we have evidence supporting this?

With respect to **acquisition**, if CORONAL must always be present, then the first cut is CORONAL vs. something else. Following Ghini (2001a), we maintain that PLACE-first is a universal principle. The acquisition literature suggests that LABIAL is produced first (cf. Jakobson 1941; Levelt 1995; Fikkert & Levelt 2008). Fikkert & Levelt find that words are undifferentiated with respect to features and the word node itself has LABIAL, with vowels and consonants sharing the same feature. Our assumption is that CORONAL is underspecified but present, and in fact the LABIAL VS. CORONAL contrast is the first one to be manifest on the surface. We also assume that all languages have PLOSIVES – not necessarily all places of articulation, but at least one. This tallies with Hyman (2008) who argues that two of the valid universals about phonological inventories are that all have oral stops and all have coronals. But CORONAL phonemes need not be PLOSIVES; they could be CONTINUANT for instance. Thus, in acquisition, we would first find a contrast of underspecified CORONAL vs. some other ARTICULATOR (in all probability LABIAL) and PLOSIVE vs. probably CONTINUANT. Recall that FUL assumes that vowels and consonants share PLACE. Thus, for vowels as well, the first cut is probably CORONAL VS. LABIAL. It could be the case that the LABIAL vowels are also DORSAL.

We have also suggested that in terms of TONGUE HEIGHT, [LOW] is acquired first. But we do not believe that this needs to be underspecified universally, because a language might only have one vowel, with no necessity to specify any height contrast. Thus, other features are built very much on the basis of contrast. The question is whether contrasts depend entirely on “activity” or on distribution. The answer is probably both. Initially, infants are not going to be exposed to lots of alternations which would conclusively estabish activity. However, distribution is something they inevitably enounter right away.

Challenging the assumption of the **universality** of coronals, Blevins (2009) has suggested that Northwest Mekeo lacks CORONAL obstruents, though it may acquire them via language contact. All Mekeo dialects, however, have coronal sonorants; /l/ occurs in other Mekeo dialects and Northwest Mekeo itself has a palatal glide /y/ (Blevins’ notation) which alternates with /ɛ/. Blevins argues that /l/ can be seen as primarily lateral with redundant coronal specification. That is not an assumption made by FUL, where PLACE is primary. Consequently, it is not the case that this universal “bites the dust”: CORONAL is very much present even in Northwest Mekeo, albeit perhaps not in obstruents. In Blevins’ own terms, CORONAL appears on the surface via assimilation, and with /i/.

(56) Palatalisation in Mekeo dialects (Blevins 2009: 267; combining her examples (6) and (7))

Northwest Mekeo	/g/ → [ʥʲ] / _ i	[gina][11]
West Mekeo	/g/ → [ʥʲ ,ʤ] / _ i	[dʒina]
North Mekeo	/k/ → [ʦʲ , ʤ] / _ i	[tʃina]
East Mekeo	/k/ → [ʦʲ ,ʧ] / _ i (optional)	[kina]
		‘sun, day’

11 Blevins provides these examples. If, however, /g/ > [dʒ] in Northwest Mekeo in the context of /i/ it is not obvious to us where the example *gina* comes from.

This fits in with FUL's assumptions perfectly. In FUL /i/ is CORONAL (underspecified, with only the ARTICULATOR node), and in its context, as we have seen earlier for palatalisation, DORSAL consonants will lose their feature. Our analysis is in (57).

(57) Mekeo palatalisation

/g/		/i/	
PLACE		PLACE	
ART	TH	ART	TH
|	|	|	|
[DOR]	[HIGH]	[–]	[HIGH]

⇒

/dʒ/		/i/	
PLACE		PLACE	
ART	TH	ART	TH
|	|	|	|
[–]	[HIGH]	[–]	[HIGH]

Whether the result is an affricate or is pronounced with a palatalised affricate is a matter of phonetic implementation. The crucial point is that /g/ loses its DORSAL feature in the CONTEXT of a CORONAL underspecified HIGH vowel.

Finally, in the FUL approach, underspecification in representations is intended to have consequences for **processing**. What is the evidence? We have shown in several experimental studies that CORONAL underspecifiation predicts asymmetries. For example, in an MMN (mismatch negativity) paradigm in an EEG experiment in German, when listeners were saturated with the nonsense syllable [egi] (played several times) and were then provided with a deviant stimulus [edi], the surface coronal feature from /d/ was found to mismatch with the DORSAL representation of /g/, triggering a high negative peak. However, the negative peak was significantly lower when the presentation of stimuli was reversed: when [edi] was the standard (surface CORONAL, mapping onto an underspecified representation) and was followed by deviant [egi], then the surface DORSAL was tolerated by the underspecified representation. The same asymmetric pattern is found with underspecified [PLOSIVE] and specified [NASAL]. This is illustrated in (58) and (59).

(58) CORONAL~DORSAL asymmetry in MMN (Cornell et al. 2013; Lahiri 2012; Lahiri & Kotzor 2017)

Acoustic stimulus (standard) [edi] CORONAL Representation [–] *underspecified*

Acoustic stimulus (deviant) [egi] DORSAL - - - → *NO-MISMATCH = low MMN*

Acoustic stimulus (standard)	[edi] DORSAL	Representation [DORSAL]	
Acoustic stimulus (deviant)	[edi] CORONAL		*MISMATCH = higher MMN*

(59) PLOSIVE~NASAL asymmetry in MMN (Cornell et al. 2013; Lahiri 2015; Lahiri & Kotzor 2017)

Acoustic stimulus (standard)	[edi] PLOSIVE	Representation [—] *underspecified*	
Acoustic stimulus (deviant)	[eni] NASAL		*NO-MISMATCH = lower MMN*
Acoustic stimulus (standard)	[eni] NASAL	Representation [NASAL]	
Acoustic stimulus (deviant)	[edi] PLOSIVE		*MISMATCH = higher MMN*

Aymmetries have also been observed in several other experimental designs such as lexical decision tasks with semantic priming (Roberts et al. 2013; Lahiri & Reetz 2010; Eulitz & Lahiri 2004).[12]

Typologically, FUL's general goal is to define and regulate a set of features which can cover all possible contrasts and alternations in the languages of the world; the ability to account for acquisition and processing are important added bonuses. Our focus here was on the CORONAL node where the largest set of contrasts needs to be accommodated; but, naturally, other contrasts, such as pharyngeal ones coming under the RADICAL node, would equally be taken care of along similar lines. Insofar as contrasts and alternations, however crosslinguistically diverse, fall into just those patterns that are dictated by a particular theoretical model, FUL, and not into any others conceivable, fundamental unity is revealed behind diversity.

12 Hybrid models which allow both abstract and episodic representations (Pierrehumbert 2016) are hard to test. FUL does not deny that native listeners are especially sensitive to familiar voices; surely one's mother's voice is easier to identify in a noisy environment than the voice of a salesperson. Nor do we disregard the fact that different dialects can cause hiccups in processing or that hearing an unfamiliar dialect for many days at a time leads to familiarisation. Nevertheless, we believe that individual lexical representations are abstract and do not contain details of individual voices or dialects. Certainly representations can change and become more flexible, but our claim is that basic contrasts and feature representations along with concomitant processing implications are universal.

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