CORONALITY AND VOCALIC UNDERSPECIFICATION*

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0. Introduction

The observation that a close relationship exists between front vowels and coronal consonants dates back to Jakobson, Fant & Halle (1952) and Clements (1976) and the proponents of the feature [grave] (Hyman 1973; Vago 1976). This topic has received revived interest in recent years in the work of Mester & Itô (1989), Pulleyblank (1989), Broselow & Niyondagara (1990), Cheng (1990), Clements (1990), Lahiri & Evers (1991) and Hume (1992) among others. These authors argue that front vowels and coronal consonants should be represented by the same articulator node, Coronal, although additional specifications may differ from analysis to analysis.

At the same time, the topic of the underspecification of coronal consonants has received considerable attention (Kiparsky 1985; Avery & Rice 1989; Paradis & Prunet 1989, 1990 and contributors to Paradis & Prunet 1991b). The argument has been made that, under most circumstances, the feature [coronal] is missing from the underlying representation of coronal consonants, being inserted only for purposes of phonetic implementation.

The logical follow–up question is then, if coronals are the least marked and unspecified class of consonants, does the same generalization hold true for front vowels, if they, too, are represented with a Coronal articulator? In this paper, I address this question, examining the role of front vowels in vowel sandhi, harmony processes and epenthesis. I adopt an inventory–driven model of vocalic specification, along the lines of Avery & Rice (1989). This approach accounts for the asymmetric patterning of front vowels in some languages, and their unremarkable behaviour in other languages. In section 1, I summarize some of the arguments for the two areas of research mentioned above and I discuss my approach to vocalic specification. In sections 2, 3 and 4 I examine the role of front vowels in some cases of vowel assimilation, vowel harmony and epenthesis respectively.

1. Front vowels, coronal consonants and underspecification

1.1. Front vowels and coronal consonants: a unified approach

Evidence that front vowels are best characterized as Coronal comes from their interaction with coronal consonants, as documented by Clements (1990), Hume (1992) and Clements & Hume (to appear). Clements proposes that the features [labial], [dorsal] and [coronal] be used to characterize round, back and front vowels respectively, an approach termed the "Unified Articulators" theory. Hume (1992) devotes her dissertation to the topic of the interaction between front vowels and coronal consonants, and argues persuasively for treating front vowels as coronal. Some of her arguments are discussed below, but the reader is referred to the main source for greater detail.

Coronalization (change to a palato-alveolar) and palatalization (addition of a secondary i-like articulation) are assimilatory processes whereby a consonant takes on the place of articulation

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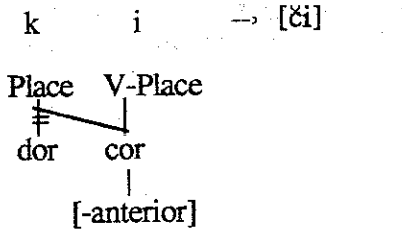
of a neighbouring front vowel. A typical case of coronalization converts an alveolar consonant to palato-alveolar, as shown by the following example from Amharic, in which the 2nd person singular feminine subject marker /-i/ triggers coronalization:

(1) a. /rut'- i/ --> ruč'(i) "run (fs.)!"
b. /kɨfəl- i/ --> kɨfəy(i) "pay (fs.)!"
c. /tənəs - i/ --> tənəš(i) "stand up (fs.)!"

Sagey (1986) proposes that coronalization involves spreading the feature [-back]. But, this yields a palatalized [tʲ], whose primary coronal and secondary dorsal articulators are then fused to a single [-anterior] coronal to produce [č]. However, the relationship of the feature [-anterior] to the quality of the front vowel is indirect. If front vowels are [-anterior] coronals, however, coronalization expresses a natural assimilation between two coronal segments.

In addition, coronalization commonly fronts a velar /k/ to a palato-alveolar /č/, as in Slovak. If [-back] is spread from the vowel, yielding [k̟], a restructuring rule inserting [coronal, -anterior] is required to capture the change to the palato-alveolar. But, the relationship between these features and [-back] is quite arbitrary. Under the front vowels as coronal approach, fronting of velars can be captured by delinking the consonant feature [dorsal] and spreading the vowel features [coronal, -anterior], thereby resulting in a [coronal, -anterior] consonant:

(2)



Lahiri & Evers (1991) propose that palatalization involve spreading the feature [+high]. But, this fails to explain (1) why other high vowels do not trigger palatalization and (2) why [-high] /e/ and /æ/ do.[1] If palatalization is expressed as spreading the vowel features [coronal, -anterior], we can explain why front vowels trigger the process, and why it is so closely related to coronalization.

Additional support for the front vowels as coronal position comes from cases in which vowels are fronted before coronal consonants, as in Fe?Fe? Bamileke, Moroccan Arabic and Maltese. For example, in Fe?Fe? Bamileke (Hyman 1973), a reduplicative vowel /ɨ/ is fronted to /i/ when followed by /i/ in the next syllable or by a coronal consonant and a front vowel of any height:

(3)

za	ziza	"to eat"
to	tito	"to punch"
keen	kikee	"to refuse"
ben	pɨpen	"to accept"
siim	sisii	"to spoil"
teen	titee	"to remove"
cen	cicɛn	"to moan"

[1] In comparison to the other front vowels, the low vowel /æ/ rarely triggers palatalization or coronalization. This could be due to Coronal not being its primary articulator (cf. Gorecka 1989).

Finally, Cheng (1990) discusses a cooccurence restriction in Cantonese which make crucial reference to both front vowels and coronal consonants being specified as coronal. If the onset and coda of a syllable are both coronal, the vowel cannot be back (u or o):

(4)	tit	"iron"	*tut
	tüt	"to take off"	*tsot
	tõn	"a shield"	*sut

In summary, all of the processes discussed in this section can be treated as processes of natural assimilation if front vowels and coronal consonants are characterized as coronal.

1.2 Coronal consonants and underspecification

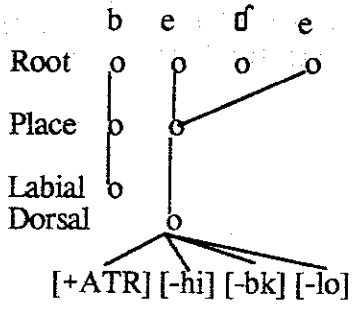
Kean (1975) and Kiparsky (1985) both point to /t/ as the unmarked consonantal segment. Arguments that coronal consonants are unspecified for a Coronal or Place node are based on various criteria (Paradis & Prunet 1991a): assimilation, neutralization, epenthesis and transparency, as well as external evidence, such as frequency in language inventories and order of phoneme acquisition.

For example, Paradis & Prunet (1989) argue that alveolar consonants are transparent to total vowel spreading or fusion in several West African languages and thus lack a Place node. Parkinson (1992) shows that the same is true of coronal sonorants in Rwaili Arabic. In Guere, Paradis & Prunet state that CVCV stems are subject to a constraint that they include at least one high vowel. Counterexamples to this constraint involve stems with identical vowels and an intervening coronal:

(5)	a.	wɔʃɔ	"wash"
	b.	beʃe	"hang"
	c.	duʃu	"chest"

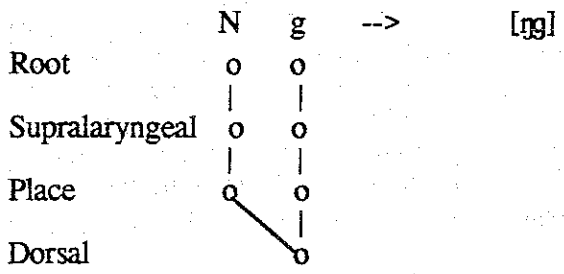
Paradis & Prunet analyse these cases as vowels fused at the Place node. Since all other consonants would have a Place node, total vowel fusion is only possible with coronals, which are unspecified:

(6)



In contrast to other consonants, coronal consonants undergo assimilation but do not trigger it. In Catalan (Kiparsky 1985:95), unlike the other nasals, the alveolar /n/ undergoes assimilation to all other places of articulation. This is captured as spreading the Place features of the other consonants to the unspecified [n] (Avery & Rice 1989):

(7)



Avery & Rice (1989) go on to show that Coronal is not always absent in underlying representation. Homorganic nasal place assimilation in Sanskrit, unlike in Catalan, is restricted to within the Coronal region. Coronal nasals only become retroflex or palato-alveolar (8a,b), but do not assimilate to other places of articulation (8c-d)

(8) a. tān - ḍimbhān --> tāṇḍimbhān
b. tān - janān --> tāñjanān
c. mahān - bhāgaḥ --> mahānbhāgaḥ
d. mahān - kaviḥ --> mahānkaviḥ

Avery & Rice attribute this to the distinction between dental, retroflex and palato-alveolar coronals in Sanskrit. They argue that coronal consonants will not be unspecified for a Coronal node if there is a contrast among the dependents of Coronal in a given language. This is captured by the Node Activation Condition given in (9):

(9) *Node Activation Condition (NAC)*
If a secondary content node is the sole distinguishing feature between two segments, then the primary feature is activated for the segments distinguished. Active nodes must be present in underlying representation.

Thus, their theory determines feature specification by contrasts within the segment inventory and by universal markedness considerations, and they also adopt monovalent features.

1.3 Vocalic specification

Regarding vowel specification, there have been varying opinions on the nature of the "unmarked" vowel, and which vowels should be unspecified, if at all.[2] The approach I adopt in this paper is based on that of Avery & Rice (1989). Just as with consonants, contrasts within the vowel inventory of a given language will determine selection of features, and Coronal is also the unmarked place of articulation for vowels in contrast to other articulator nodes. However,

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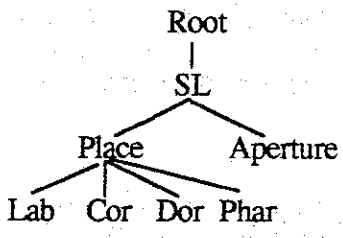
[2] I will not review all of the different theories on this controversial topic. However, three major approaches deserve mention: (1) Archangeli (1984, 1988), Pulleyblank (1988) and Archangeli & Pulleyblank (1989) on Radical Underspecification and (forthcoming) on Combinatorial Specification, in which feature selection is based on markedness theory and the behaviour of vowels within the phonology; (2) Contrastive Specification (Steriade 1987; Clements 1988; Calabrese 1988), whereby underspecification of vowels is calculated by examining the specification for the vowel inventory as a whole, and establishing contrasts between segments for both place features ([+/–back]) and height features; (3) "component" or "element"–based approaches to segment structure (Schane 1984; Kaye, Lowenstamm & Vergnaud 1985; Anderson & Ewen 1987; van der Hulst 1989, 1991), who do not generally assume any form of variable underspecification, but point to the unmarked vowel as a central vowel, either /ə/ or /ɨ/.

following Kaye, Lowenstamm & Vergnaud (1985) and Clements (1990), I assume that central vowels have no articulator.

The interplay between central and coronal vowels makes interesting predictions. If a front unrounded vowel does not minimally contrast with a central vowel of the same height, it will be unspecified for a Coronal node. This predicts that such unspecified front vowels should assimilate to other vowels or be neutral in vowel harmony systems. In the event that a front unrounded vowel contrasts with a central unrounded vowel of the same height, the central vowel will be specified for Place only, and the front vowels marked with Coronal to establish a contrast. In this case, these front vowels should display no special behaviour, but the central vowels should act as if less specified.[3] Data bearing on these predictions will be discussed in the remaining sections.

Before turning to the evidence, I would like to discuss the feature geometry I assume. Recent work on vowel geometry suggests that height features are arrayed on a separate tier from place features (Clements 1990; Goad 1991; Lahiri & Evers 1991; Odden 1991 and Rice & Avery 1991), as an Aperture or Tongue Position node. Height features are thus the vocalic counterpart to consonantal manner features. By analogy, if we adopt the Articulator nodes to characterize vowels, place contrasts will be examined in conjunction with height contrasts. This parallels Steriade's (1987) approach, but in a monovalent framework in which the same articulator nodes are used for both consonants and vowels.[4] The partial feature geometry I assume is given in (10). Height features are dependents of the Aperture node under Supralaryngeal (SL):[5]

(10)



I have included Pharyngeal under Place, but its position in the geometry is still a matter of debate, particularly since [atr] may not be a dependent of this node (Goad 1991). Nevertheless, the relationship between Pharyngeal consonants and low vowels would be difficult to explain if Pharyngeal were not a viable place feature for vowels (cf. Herzallah 1990; McCarthy 1991). Since the main focus of this paper is on Coronal vowels, I will treat the low vowels as being specified for Pharyngeal, but note that this issue deserves further research.

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[3] My approach closely resembles that of Goad (1991,1992) who argues for two privative features [front] and [round] which may be unspecified in different vowel systems, depending on the contrasts. In a system with a three-way contrast between front, central and back, both features are selected, and central vowels are unspecified throughout the derivation. However, she argues that in vowel systems with a backness contrast among low vowels, [front] may be selected and [round] unspecified, a position my analysis rules out (see sections 3.1 and 3.5).

[4] While both Clements (1990) and Hume (1992) consider [coronal] to be a bivalent feature, I take the position that it is an Articulator node, and as such inherently monovalent. See Yip (1989) for arguments against [-coronal].

[5] I abstract away from the separation of V-place and C-place features. Since this paper focusses on vowel interaction only, it is not a crucial issue.

2. Vowel sandhi

Resolution of vowel hiatus, either through deletion or assimilation, may depend on several factors. A vowel in a given position may assimilate to an adjacent vowel no matter what the specification, stressed vowels may be favoured over non–stressed vowels, or morphology may play a role. However, in systems where these considerations are irrelevant, front vowels tend to assimilate to other vowels.

2.1 Languages without central vowels

2.1.1 Afar

Front vowels assimilate to other vowels in the Cushitic language, Afar (Bliese 1981) whose vowel system is given below:

(11)

i		u	i:	u:
e		o	e:	o:
	a		a:	

The front vowels /i, e/ do not contrast with central vowels and are therefore unspecified for Coronal. The back vowels are specifed as Labial, and the low vowel as Pharyngeal. This predicts that the front vowels should assimilate to the other vowels.

(12)

i e	u o	a
Pl	Pl	Pl
	|	|
	Lab	Phar

In this language, /i/ assimilates to all the other vowels. /e/ and /u/ assimilate to /o/ and /a/, whatever order the vowels appear in (stress is marked with a preceding '):

(13) e–o, u–o –> oo (VV –> V in closed syllables -13b is an exception)

a. da'ro e'xe	–>	da'rooxe	"I gave grain"
b. diidaa'le oob'be	–>	diidaa'loobbe	"I heard a bee"
c. 'anu ok'me	–>	a'nokme	"I ate"

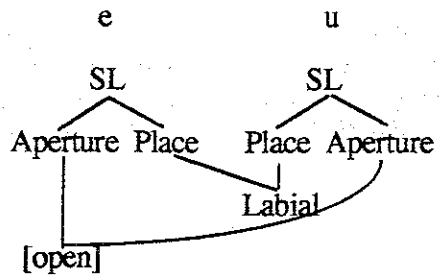
i–u –> uu i–o –> oo i–a –> aa (VV -> V in closed syllables)

d. tamaa'ri ur'te	–>	tamaa'rurte	"student got well"
e. a'nu irgiʕe	–>	a'nurgiʕe	"I cut"
f. 'rabbi–ow	–>	'rabbow	"master"
g. awki–'ard–u–k su'ge	–>	aw'karduk su'ge	"boy was running"
h. aw'ka ilaalis'se	–>	awkaalaalis'se	"girl watched"

The assimilation is primarily one of height, as high vowels assimilate to mid and low vowels. What is significant is that between vowels of equal height, the front vowels always assimilate to the back vowels (13a-b,d-e). The mid–front vowel /e/ only assimilates completely to vowels of equal or lower height. When /e/ is adjacent to /u/ a long /o/ is formed, indicating that /e/ spreads its height features, but assimilates in labiality. This is to be expected if /e/ has no articulator node, and the Labial node is spread[6]:

[6] I will assume that bare Aperture represents a high vowel (Goad 1991, Rice & Avery 1991)

(14)



2.1.2 Modern Greek

Modern Greek has a similar vowel system to Afar, but without the long vowels:

(15) i u
e o
a

In this language, high vowels delete in favour of low vowels. /i/ deletes when adjacent to /e,u,o,a/; /e/ to /i,u,o,a/; /u/ to /o,a/ and /o/ to /a/ (Mackridge 1985). Stress and order of vowels are irrelevant.[7] Comparable to Afar, when front and back vowels of equal height are juxtaposed, the front vowels are lost in favour of the back vowels (16a,d):

(16)	a.	to exo	–> toxo	"I have it"
	b.	to ixa	–> toxa	"I had it"
	c.	aftos pu erxete	–> aftos purxete	"the one who comes"
	d.	su ixa pi	–> suxa pi	"I'd told you"
	e.	se ia	–> sia	"I saw you"
	f.	apo akri se akri	–> apakri sakri	"right across"
	g.	mu aresi	–> maresi	"I like it"
	h.	ta ixa	–> taxa	"I had them"

The difference with Afar is that in Greek, there is deletion instead of assimilation. Also /e/ is deleted before all back vowels, regardless of height. To summarize, in both Afar and Greek, which have five-vowel inventories, the front vowels behave as if unspecified for Coronal, and do not trigger assimilation, but undergo it.

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[7] Kaisse (1977) documents different types of vowel hiatus in Modern Greek which may be syntax-sensitive. That discussed here is the post-lexical rule of "less sonorous vowel deletion"

2.2 *Languages with central vowels*

2.2.1 *Chaha*

Let us now consider a system with central vowels. The prediction is that front vowels will be specified as Coronal. The vowel inventory of Chaha has high and mid central vowels:

(17)

i	ɨ	u
e	ə	o
	a	

Based on contrasts and the assumption that central vowels have no articulator, the following specifications are present for the Chaha system:

(18)

i e	ɨ ə	u o	a
Pl	Pl	Pl	Pl
|		|	|
Cor		Lab	Phar

Evidence that the central vowels are unspecified and the front vowels are specified for Coronal comes from vowel hiatus. The central vowel /ə/ assimilates to the other vowels (19a-d) (ɨ is epenthetic, so would not appear in these contexts), but /i/ and /e/ behave in the same fashion as the back vowels, undergoing glide insertion (19e-i).

(19)

a.	dəwə–axə	–>	dəwaxə	"your relatives"
b.	yə–ef	–>	yef	"let him cover with a lid"
c.	yə–od	–>	yod	"let him tell"
d.	əc'ə-u	–>	əc'o	"it is wood"
e.	mezo–axə	–>	mezowaxə	"your five cents"
f.	kʷəte–axə	–>	kʷəteyaxə	"your footprint"
g.	c'əki–axə	–>	c'əkiyaxə	"your wooden pick"
h.	Turi–u	–>	? Turiwu/Turiyu	"he is an expert"
i.	gəβəre–u	–>	gəβərewu / ? gəβəreyu	"he is a farmer"

This demonstrates that the front vowels behave in the same manner as the back vowels. Note that if central vowels had no Place node, then the front vowels could be specified as bare Place. This predicts that front vowels should assimilate to back vowels. However, front vowels do not assimilate to back vowels (19h-i), but undergo glide insertion. From the data in (19e-g) it appears as if the choice of glide is conditioned by the type of vowel, /y/ when there is a front vowel, and /w/ when there is a round vowel. If we assume that the type of glide is the result of spreading from an adjacent vowel, this suggests that the front vowels are specified with a Coronal node. Furthermore, in (19h-i) both glides are possible (although one form is preferred).

2.2.2 *Korean*

Korean has a similar vowel system to Chaha, save for the additional vowel /æ/:

(20)

i	ɨ	u
e	ə	o
æ	a	

Optional vowel coalescence in Korean displays similar effects to Chaha, with the central vowels assimilating to the other vowels or glides (Goad 1992 after Sohn 1987):

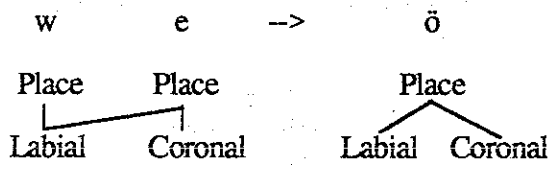
(21)	/is-ɨmyən/	--›	iimyən	"to connect"
	/p'yam/	--›	p'æm	"cheek"
	/pe-ə/	--›	pee	"to cut"
	/kæ-ə/	--›	kææ	"to fold"
	/cu-ə/	--›	coo	"to give"

In contrast to Chaha, a sequence of back and front vowels or glides yields a derived front rounded series:

(22)	/kwemul/	-->	kömul	"monster"
	/wisəŋ/	-->	üsəŋ	"hypocrisy"
	/p'yocok/	-->	p'öcok	"sharp"

The Coronal and Labial properties of both vocoids are being combined, conclusively demonstrating that Coronal must be present on the front vocoids, otherwise a back rounded series would have resulted:

(23)



3. Vowel harmony

Vowel harmony provides particularly rich evidence for the underspecification of vowels, and has been used to argue for both Radical Underspecification (Archangeli 1988) and Contrastive Specification (Steriade 1987). I will examine front–back harmony, generally found in Uralic and Altaic languages. Languages with some form of back harmony display a remarkable similarity in one respect: the neutral vowels are often /i/ and /e/. This is particularly true of languages which have front rounded vowels. My motivation in examining these cases is to show how the theory of vocalic specification I am adopting predicts the neutrality of certain vowels. I do not attempt to provide exhaustive analyses of how the vowel harmony operates in each language.

3.1 Finnish

Examples where coronal vowels have a special role in vowel harmony involve systems where there are no central vowels. In Finnish, /i/ and /e/ are both transparent to back harmony. The inventory is as follows:

(24)	i	ü	u
	e	ö	o
	æ	a	

In this system, the front rounded vowels are specified as Coronal to contrast them with the back rounded vowels. In addition, there are contrasts among the low vowels, so /æ/ is specified as Coronal. Note that contrasts among the low vowels does not involve invoking Coronal for all front vowels. Contrasts are established for each height separately.

(25)

i e	æ	u o	ü ö	a
Pl	Pl	Pl	Pl	Pl
	/ \	|	/ \	|
	Cor Phar	Lab	Lab Cor	Phar

Another option would be to underspecify all values of Coronal and to contrast the back vowels and the front vowels with Dorsal as follows. Under this approach spreading of Dorsal would account for front/back harmony:

(26)

i e	æ	u o	ü ö	a
Pl	Pl	Pl	Pl	Pl
	|	/ \	|	/ \
	Phar	Lab Dor	Lab	Dor Phar

This is ruled out on markedness grounds however, because the more common /u o a/ are structurally more complex than the rarer /ü ö æ/ (see Walker 1993 for similar assumptions). In addition, there is little evidence to suggest that Dorsal is specified phonologically for back rounded vowels.[8] Default rules also become problematic under this account. A global "Fill–in Coronal" rule would be necessary applying to all vowels except Dorsal vowels, which would be exempt by a constraint *Dorsal–Coronal. With option (25), however, the default rule would be bare Place –> Coronal, matching the consonantal default rule established for other languages. In sum, option (25) is chosen and Dorsal will be invoked only in systems which contrast central unrounded vowels and back unrounded vowels.

Stems in Finnish are either back or front harmonic. The neutral vowels /i/ and /e/ may occur with either back or front vowels. Data is from Harms (1964), Skousen (1973) and Goldsmith (1985):

(27)

a.	pöütæ	"table"
b.	sævü	"trait, character"
c.	vækevæ	"strong"
d.	pæivæ	"day"
e.	pouta	"fair weather"
f.	talo	"house"
g.	tuhma	"naughty, stupid"
h.	tunti	"hour"
i.	pelastua	"to be saved"
j.	pelæstüæ	"to be frightened"

Goldsmith (1985) analyzes the harmony as spreading of [front] and Demirdache (1988), in a Government framework, proposes to spread the element I. The harmony rule in my framework would be formulated as spread Coronal. Spreading Coronal to Labial vowels creates front rounded vowels. The low vowel /a/ is fronted to /æ/:

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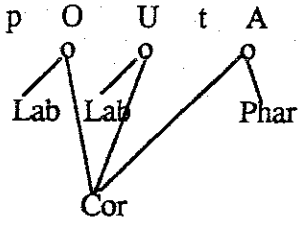
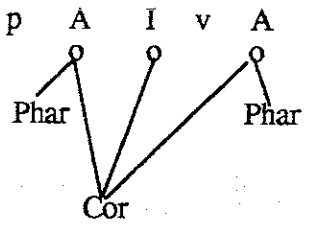
[8] Clements (1990) discusses some cases (Palestinian Arabic, Maxacali) in which Dorsal is spread from consonant to vowel. However, since Dorsal is only redundantly specified for vowels, it may receive Dorsal via spreading from a consonant. Note however, that we do not find cases of Dorsal spreading from vowel to consonant.

(28)



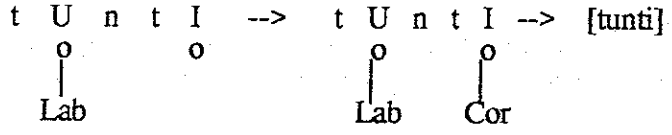
The neutral vowels /i, e/ are unspecified at Place, have height features, but receive Coronal specification by the spreading rule if Coronal is present:

(29)



In stems with no Coronal specification, that is, back harmony stems, they receive a Coronal default specification and still surface as /i/ and /e/:

(30)



Problem cases in Finnish harmony involve disharmonic (usually, loanword) stems and vacillating suffixes, which have been used as arguments for spreading of both values of [back] (Steriade 1987, Farkas & Beddor 1987 for related Hungarian). According to Campbell (1980), there are two dialects of Finnish, which he terms Prestigious and Colloquial. In the Prestigious dialect, /ü/ and /ö/ in loanwords do not trigger front harmony and the word takes back suffixes. In the Colloquial dialect, those vowels do trigger harmony and the suffixes are front.[9] However, only the back suffix variant is found when a back vowel intervenes between the suffix and /ü/ or /ö/ in the stem (31a,b):

(31)

	Prestigious	Colloquial	
a.	följetongi–a	följetongi–a/*æ	"feuilleton"
b.	türanni–ko	türanni–ko/*kö	"tyrant"
c.	analüüsi–a	analüüsi–æ	"analysis"
d.	jonglööri–a	jonglööri–æ	"juggler"

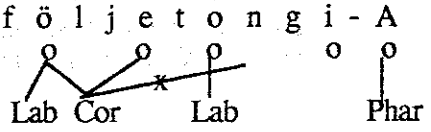
[9] Unlike the other front vowels specified as Coronal, /æ/ always triggers front harmony in loanwords if it is the last specified vowel in the word.

Clearly, harmony is non–operative within loanwords, but the last specified vowel determines the quality of the suffix vowel.[10]

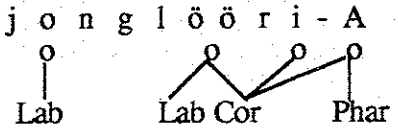
The optional and ungrammatical suffix forms can be explained in the following manner. The front harmonic vowels /ü ö/ behave as non–triggers of suffix harmony in the prestigious forms, and triggers in colloquial forms. However, the presence of a specified vowel to the right of one of these vowels in the stem will block harmony, since deriving new vowels within the stem is ruled out in loanwords (perhaps as a result of the Strict Cycle Condition; cf. Walker 1993 for Turkish). This accounts for the starred forms in (31ab) as shown in (32a). In contrast, spreading to the neutral vowels does not change the quality of the vowels, and is permitted, accounting for the forms in (31cd) as in (32b)[11]:

(32)

a) följetongi-a Prestigious dialect: no spreading
följetongi-a Colloquial dialect: spreading blocked by /o/



b) jonglööri-a Prestigious dialect: no spreading
jonglööri-æ Colloquial dialect: spreading of Coronal



Recall that the representation of vowels in (26), whereby the Coronal node of the front rounded vowels was unspecifed, was rejected on theoretical grounds. The loanwords provide empirical evidence that these representations are incorrect. None of the prestigious forms nor the ungrammatical forms in (31ab) can be accounted for under this approach. Dorsal would have to be spread from the back vowel to produce a back suffix. However, since the intervening /i/ has a

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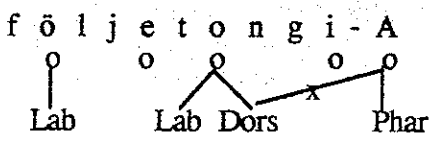
10 Walker (1993), in an insightful discussion of Turkish, attributes this property to a difference between underlyingly unlinked features in harmonic stems versus linked features in disharmonic stems. Harmony within stems is expressed as linking of features. Consequently, stems with previously linked features will not be subject to harmony.

11 An alternate approach would be to unspecify the neutral vowels completely for Place, in which case they would be transparent to harmony, a tactic adopted by Walker (1993) for Khalkha Mongolian. However, this is contra the theory of contrastive specification I am adopting, since /i/ and /e/ minimally contrast with /u/ and /o/ for Labial. In addition, it would predict that front unrounded vowels which contrast with central vowels in systems such as Chaha or Korean (§2.2) need only be specified as bare Place to establish a minimal contrast, which is not the case.

Place node, locality consideratons would prevent skipping it, so spreading is disallowed and the suffix vowel should surface with default Coronal as /æ/ in both dialects[12]:

(33)

*fōljetongi-æ Spread Dorsal, but blocked by locality



3.2 Classical Mongolian

Classical Mongolian vowel harmony provides evidence for the claim that each height determines its own Place specification.[13] The Classical Mongolian system is a seven vowel system; the /a/ vowel is treated as the same height as the mid vowels, since it alternates with them:[14]

(34)

	i	ü		u
	e	ö	a	o

We thus have a four–way low contrast and a three–way high contrast. The theory of underspecification in §1.3 predicts that /e/ should be specified with a Coronal node since it contrasts with /a/. /i/ does not contrast with a central vowel of the same height and therefore should be unspecified under Place. This predicts that /i/ will be neutral to front harmony. /i/ is indeed the neutral vowel, whereas /e/ participates in the harmony. /i/ can appear in back and front vowel stems (35a,d), and plays no role in determining the quality of the suffix. Stems with only /i/ take front vowel suffixes (35g-i). All examples are from Poppe (1954):

(35)

a.	egeçi–med	"elder"
b.	ali–mad	"whoever"
c.	aqa–mad	"senior"
d.	bayi–dal	"life, existence"
e.	oyu–dal	"seam"
f.	ükü–del	"corpse"
g.	ßiri–mel	"quilted"
h.	biçi–geçi	"writer/clerk"
i.	kir-te	"to become dirty"

---

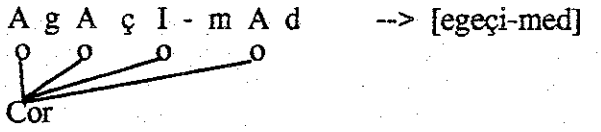
[12] Alternately, /i/ should undergo spreading and surface as */u/. Even if /i/ were transparent to the spreading (i.e. perhaps lacked a Place node), this account can still not handle the prestigious forms such as jonglööri-a. In this case, spreading is blocked by the intervening labial vowels, and the suffix should surface as front.

[13] I am using Classical instead of Khalka Mongolian harmony, as it has been argued that Khalka harmony is more accurately ATR (Rialland & Djamouri 1985; Svantesson 1985), but see Walker (1993) for arguments that the front/back distinction is still phonologically active.

[14] While an inventory-driven approach would normally predict that /a/ should be a separate height, the vowel harmony pattern in languages with this type of inventory seem to force an analysis of /a/ as merely non-high.

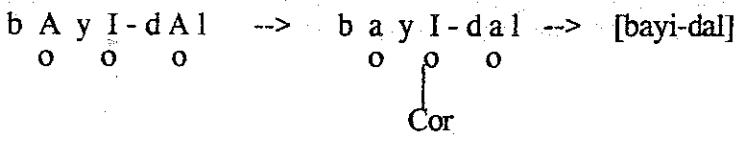
The rule triggering front harmony can be formulated as spread Coronal. /i/ receives its Coronal specification by this rule in a front stem:

(36)



As with Finnish, /i/ receives its Coronal specification by default when occurring in a back stem, crucially at a stage when vowel harmony has already taken place:

(37)



The neutral stems (35g-i), whose suffixes surface as front can be handled by appealing to a constraint requiring that a stem contain at least one vowel with a specification under Place (cf. Walker 1993 for a similar "minimial structure condition" for Buriat). Since the neutral stems contain vowels with only a bare Place node, the default value, Coronal, is supplied to the vowel and triggers harmony on the suffixes.

3.3 Turkish

So far I have been considering vowel harmony in systems with no or few central vowels. I now turn to an example in which central vowels contrast at both heights in a vowel harmony system, the case of Turkish (Crothers & Shibatani 1980; Clements & Sezer 1982). Turkish has an eight vowel system, including a four–way contrast for backness or Place. The /a/ vowel, as in Classical Mongolian, acts as a mid vowel. Since there is a contrast at both heights, we correctly predict that there are no neutral vowels to front harmony in the Turkish system:

(38)

i	ü	ɨ	u
e	ö	a	o

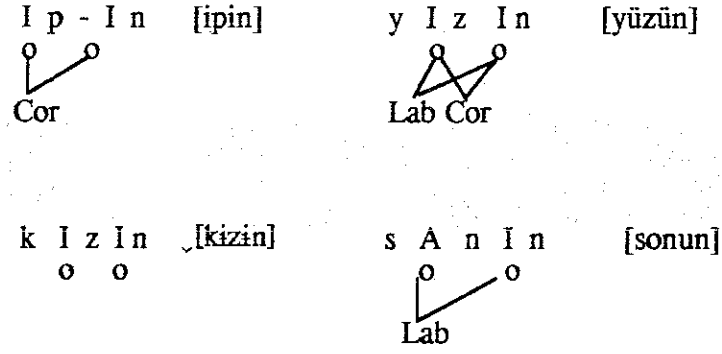
In the following forms, the suffix vowel agrees in backness with the preceding stem vowel. I assume that height specifications are underlyingly specified in the suffixes. We thus have an /i, ɨ/ alternation in the genitive marker and an /e, a/ alternation in the plural marker. Rounding harmony targets only high vowels, which explains the *–ün* and *–un* allomorphs of the genitive marker.

(39)

	nom.sg.	gen.sg.	nom.pl.	gen.pl.	
a.	ip	ip–in	ip-ler	ip–ler–in	"rope"
b.	kɨz	kɨz–ɨn	kɨz–lar	kɨz–lar–ɨn	"girl"
c.	yüz	yüz–ün	yüz–ler	yüz–ler–in	"face"
d.	pul	pul–un	pul–lar	pul–lar–in	"stamp"
e.	el	el–in	el–ler	el–ler–in	"hand"
f.	sap	sap–in	sap–lar	sap–lar–ɨn	"stalk"
g.	köy	köy–ün	köy–ler	köy–ler–in	"village"
h.	son	son–un	son–lar	son–lar–ɨn	"end"

While Clements and Sezer (1982) treat the central vowels /ɨ/ and /a/ as [+back], their behaviour can be equally well explained in a system in which they are unspecified except for Place. The underlying suffixes are /In/ and /lAr/, where the central vowels represent vowels specified only for height and bare Place. There are two rules, one spreading Coronal and the other spreading Labial. In this manner, the first rule changes /lAr/ into /ler/ following Coronal vowels, but the suffix undergoes no change following dorsal or central vowels. The second rule targets high vowels and spreads Labial. The suffix /In/ then undergoes both rules:

(40)



Note that the difference between the Turkish and the Classical Mongolian harmonies is the presence of a high central (unspecified) vowel in the Turkish inventory. This forces the underlying specification of /i/ as Coronal in the phonology of Turkish, but in Classical Mongolian, the /i/ remains neutral, as no contrast exists. The /e/, on the other hand, must be specified underlyingly for Coronal in both systems.

3.4 Eastern Cheremis (Mari)

Another language which has a four–way contrast for Place is Eastern Cheremis (Mari) (Odden 1991:271; Minn 1960; Ristinen 1960; Sebeok 1961; Sebeok & Ingemann 1961):

(41)

i	ü		u
e	ö	ə	o
		a	

In Eastern Cheremis there is a rule of vowel harmony targetting vowel–final word–final suffixes. Basically, /o/ appears after /u/ or /o/, /ö/ after /ü/ or /ö/, and /e/ after /i/, /e/, /ə/ and /a/. /ə/ is transparent to the harmony, as illustrated by (42j,l), in which the features of the preceding round vowel are spread to the suffix:

(42) **possessive suffix –žə**

a.	kit–še	"his hand"	g.	surt–šo	"his house"
b.	ergə-že	"his boy"	h.	üp–šö	"his hair"
c.	kobaštə–že	"its fur"	i.	šör–žö	"its milk"
d.	bokten–že	"beside it"	j.	kornə-žo	"his way"
e.	šužar–že	"his sister"	k.	boz–šo	"his wagon"
f.	kolbizə–še	"its twenty-fifth"	l.	pörtəštə-žō	"in his house"

Before proceeding to an analysis of the harmony, a comment is warranted concerning the vowel system of Eastern Cheremis. Contrastive specification predicts that /i/ should be unspecified under Place, since it does not contrast with a high unrounded central vowel. However, this is not the case, as shown by (42f) kolbizə–še/*kolbizə-šo, in which it is the /i/ and not the /o/ which is determining the quality of the suffix vowel. If /i/ were unspecified, it should behave as /ə/ in being transparent to harmony. It seems that /i e/ are unspecified as a class if there is a non-low central vowel plus /a/, either /ɨ a/ or /ə a/. If we compare the vowel systems of Eastern Cheremis and Classical Mongolian, this becomes evident. In Classical Mongolian /i/ is a neutral vowel, independently of the specification for the other non–low front unrounded vowel:

(43)

Eastern Cheremis				Classical Mongolian			
i	ü		u	i	ü		u
e	ö	ə	o	e	ö	a	o
		a					

It seems then, that the relevant distinction is between low and non-low vowels. Walker (1993) refers to a hierarchy in determining contrastive specification within an inventory. She claims that in systems such as Turkish, the first cut (or contrast) is made for height features, followed by Labial contrasts and then Coronal. We could enrich this theory for three-height inventories such as that of Eastern Cheremis and claim that the cuts are Low vs. Non-low segments, Labial vs. Non-labial, Coronal vs. Non-coronal and then High vs. non-high. In this manner, when the third cut is made to determine Coronal specification, /i/ and /e/ are treated as a class of non-low segments. If there is at least one contrasting non-low central vowel, as there is with Eastern Cheremis, both front segments will be specified as Coronal:[15]

(44)

	non-labial		LABIAL	
	CORONAL	non-coronal	CORONAL	non-coronal
non-low	i		ü	u
	e	ə	ö	o
LOW		a		

Finnish (§3.1) also has a three-height system, but there are no non-low central vowels, and consequently both /i/ and /e/ are unspecified:

[15] Another explanation for this, along the same lines, can be found in van der Hulst (1989) who argues that in two–height systems such as Classical Mongolian or Turkish, /e/ and /i/ do not have the same head, but rather the lower vowels are "a–governed".

(45)

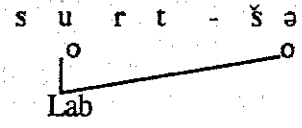
	non-labial		LABIAL	
	non-coronal		CORONAL	non-coronal
non-low	i		ü	u
	e		ö	o
LOW	æ	a		
	CORONAL	non-coronal		

The vowel specifications being determined, I now turn to the analysis of harmony. Odden (1991) assumes the suffix in (42) is underlyingly */–že/* and analyses the harmony process as a rule spreading [back] and [round], which in his model are linked under a single node. This involves a feature-changing rule delinking the features [-back], [-round] of /e/. I believe a more explanatory account is to assume that the rule is feature–filling and that the suffix vowel is /ə/, unspecified for Place features. Traditional descriptions of Eastern Cheremis (Minn 1960) in fact assume that the suffix vowel is /ə/.

First, the harmony targets only word–final vowel–final suffixes. Other /e/ vowels do not undergo harmony. If these suffixes have an underlying /ə/, spreading may be triggered by a constraint requiring that vowels have a Place specification in final position. The Place specifications of the immediately preceding specified vowel spread to satisfy this requirement. Second, under Odden's account, some suffixes such as /-de/ are treated as exceptions to the harmony rule. Under my account, they would simply contain underlying /e/, and therefore not trigger the harmony rule.

Consider the derivation of the word *surt–šə* 'his house'. The Labial specification of the preceding vowel is spread:

(46)



In cases where this spreading is not possible (words containing only /ə/ vowels or a preceding /a/), Coronal is supplied by default. We can assume that spreading Pharyngeal from /a/ is ruled out through Structure Preservation because the suffix vowel is specified as a mid vowel.

Words with /ə/ appear to present a problem, as these vowels should also undergo harmony because of their Place node, and yet they appear to be transparent. For example *kornəšə* "his way" should surface as *kornošə* I will in fact argue that that is precisely what occurs during the derivation, but that the vowel is further reduced to schwa. There is a vowel-reduction rule in the language changing mid vowels to /ə/ in morpheme-final position when followed by another consonant. This is illustrated with the non-alternating suffix /-de/:

(47)	šogə-de	'without standing'
	šogə-də-mo	'without standing'(nom)
	koč-de	'without eating'
	koč-də-mo	'without eating' (nom)

As does Odden, I will assume that the harmony rule also applies within stems. This leads me to posit that the harmony rule and the reduction rule are cyclic, applying at each level of the derivation. A sample derivation of *šogə-də-mo* is given below.

(48)

	/šogə-de-mə/
Vowel reduction	šogə-də-mə
Vowel harmony	šogo-do-mo
Vowel reduction	šogə-də-mo

Since the reduction rule is required independently to account for /de/ -> [də], we can conclude that /ə/ is not actually transparent to harmony, but surfaces as a result of this rule. All schwas would undergo the harmony and then are reduced to schwa. Thus, all surface instances of /ə/ are the result of this reduction or of low-level epenthesis.[16]

Odden states that the word-final condition is unusual, and uses this as an argument for one spreading rule instead of two. Recall that I claim that the word-final condition is the result of a constraint on the Place specification of the final vowel. This is not so unusual, and is encountered in other languages. For example, in Tigrinya, an Ethio–Semitic language, the epenthetic vowel, /ɨ/, is spelled out as [i] word–finally (Berhane 1991:97–100). In the following examples, (49a–d) demonstrate the behaviour of /ɨ/ finally and non–finally. This is contrasted in (49e–f) with a true word–final /i/:

(49) Tigrinya

	3fs poss.	1p poss.	
a. birki	birka	birkina	"knee"
b. ʔigri	ʔigra	ʔigrina	"leg"
c. gundi	gunda	gundina	"stem"
d. k'os'li	k'os'la	k'os'lina	"leaf"
e. hadani	hadaniʔa	hadanina	"hunter"
f. gomadi	gomadiʔa	gomadina	"cutter"

In both Eastern Cheremis and Tigrinya, the central epenthetic vowel is spelled out as the corresponding (in height) coronal vowel. If front and back vowels both have specifications, the reason the coronal vowel is selected follows from its unmarked status. This Place "requirement" may actually be linked to word–final lengthening, since central vowels /ɨ/ and /ə/ generally cannot lengthen. Denais (1990) notes that word–final /ə/ also sometimes surfaces as [e] in Tigrinya.

3.5 Chamorro

One language which presents a different type of harmony is Chamorro (Poser 1982:135 after Topping 1968). The vowel system is given in (50). There are also lax counterparts: /i,e/ -> [I], /u,o/ -> [U] and /æ, a/ -> [ə].

(50)

i	u
e	o
æ	a

In Chamorro, an initial back vowel in a stem harmonizes with a front vowel prefix:

---

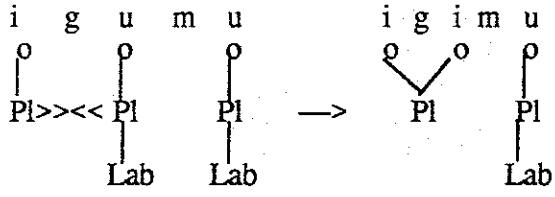
[16] Another possibility would be to assume, as does Odden, that schwas lack a Place node. Once again, this goes against the theory of vowel specification I am adopting (see footnote 11). In addition, it would entail that the suffix schwa vowel has a different representation, since it is a target of harmony (assuming no Node Generation).

(51)					
	a.	gúmə	"house"	i gímə	"the house"
	b.	tómU	"knee"	i témU	"the knee"
	c.	lahI	"male"	i læhI	"the male"
	d.	húlU?	"up"	sæn hílU?	"upward"
	e.	lagU	"north"	sæn lægU	"northward"
	f.	túnU?	"to know"	en tínU?	"you know"
	h.	ótdUt	"ant"	mi étdUt	"lots of ants"
	i.	óksU?	"hill"	gi éksU?	"at the hill"

My analysis would predict the non–low coronal vowels to be unspecified for Coronal, so they should not trigger harmony. Goad (1992) argues that in quadrangular systems like that of Chamorro, [front] is selected and [round] unspecified. However, this predicts that in vowel systems like Finnish where low vowels contrast for Place, all front vowels are specified as Coronal, which is demonstrably not the case.

I treat this as a local dissimilation effect, in which the prefix triggers fusion of the Place nodes. In fusion, the features of the trigger are maintained (Avery & Rice 1989), and therefore the (lack of) specification of the prefix vowel would result:[17]

(52)



In conclusion, the vowel harmony cases described above provide evidence for the hypothesis that front unrounded vowels are unspecified for Coronal unless central vowels are present in the inventory, in which case, the coronal vowels behave like the other vowels. In addition, in each of the cases of front/back vowel harmony, the harmony rule is uniformedly expressed as spreading of Coronal. This obviates the need to spread both values of [back]. Labial is spread only to account for rounding harmony. This approach also predicts that front harmony or assimilation should only occur in languages with front rounded vowels and/or central vowels, a prediction which seems to be borne out by the data presented here. Front rounded vowels trigger front harmony, but front unrounded vowels only do if they contrast with central unrounded vowels. I now turn to some evidence from epenthesis which also supports the view that coronal vowels are unmarked.

5. Epenthesis and Coronality

As opposed to Radical Underspecification, within a contrastive–style theory of underspecification, epenthesis is not a criterion for determining underspecification, but it may be considered a reflection of the type of underspecification predicted by the inventory. For consonants, for example, the coronal /t/ is often an epenthetic segment (Broselow 1984; Hume 1992; Spring 1990). Based on the analysis presented in the preceding sections, the default vowel should be a non–low central vowel. If there is no non–low central vowel, then the coronal unrounded vowels are the default. Below I give a brief list of some languages with and without non–high central vowels and the accompanying epenthetic vowel:

---

[17] This could be expressed as delinking of the Labial node, but since the vowel /æ/ also triggers fronting, and it is specified as Cor-Phar, fusion of Place nodes unifies both effects.

(53)	Vowel inventory	Language	Epenthetic vowel
a)	Central vowels		
	/i e a o u ə ɨ/	Tigrinya, Chaha	/ɨ/
	/i a u ɨ//	Moroccan Arabic	/ɨ/
	/i a u ə/	Snohomish (Salish)	/ə/
	/i e a o ə/	Klamath	/ə/
	/i e ɛ ü ö œ ə a ɑ o u ɔ ɔ̈ ä œ̈ ɛ̈/	French	/ə/
	/i e æ a o u ə ɨ/	Korean	/ɨ/
	/i ĩ u e o a/	Tamil	/i/
b)	No central vowels		
	/i a u/	Iraqi Arabic	/i/
	/i a o u/	Yawelmani	/i/
	/i e a o u/	Spanish	/e/
		Ponapean	/i/
		Maltese	/i/
	/i e ɛ a ɔ o u/	Yoruba	/i/
		Gengbe	/e/
	/i e ü ö u o a a:/	Cantonese	/i/
	/i e æ a o u/	Menomini	/e/

From the few inventories given above, a general pattern can be seen to be emerging, exactly as one expects given the assumptions I have been advocating about underspecification and coronality. Central vowels are selected as epenthetic in those languages where they occur. In languages where they are not present, the coronal (unrounded) vowels are chosen. In some cases, there are height differences (/i/ vs. /e/), but crucially other types of vowel do not tend to act as epenthetic.[18] The only exception to this is /a/, which does occur as epenthetic in some languages. Goad (1991) and Rice & Avery (1991) have proposed that low vowels have more complex height configurations than high vowels. The tendency to select the non-low vowels over /a/ as epenthetic could be due to this consideration. However, this may be overridden in some languages in favour of a less complex Place structure, which might be the case of /a/ if it were Placeless instead of Pharyngeal, as I have been assuming.

6. Conclusion

In this paper I have presented evidence that front unrounded vowels often behave as if unspecified. This falls in line with current hypotheses concerning the underspecification of coronal consonants and representations of consonants and vowels with a single set of articulator nodes. Coronal is thus the unmarked place of articulation for both vowels and consonants, as proposed by Hume (1992) for Maltese. In addition, I have provided support for the contrastive specification model proposed by Avery & Rice (1989) in which underspecification is determined on markedness grounds and on contrasts within the inventory. Contrasts are established for each vowel height separately. This model correctly predicts that when a contrast exists between front unrounded vowels and central unrounded vowels, the front vowels must be specified for Coronal. In those languages where this occurs, front vowels do not show any exceptional behaviour in vocalic phonological processes. On the other hand, where no contrast exists, front

[18] Labial and Coronal–Labial vowels are rare as epenthetic segments (although they may surface after assimilation). Fula (Paradis 1986) and Kannada (Bright 1975) are two exceptions which have epenthetic [u].

unrounded vowels are unspecified for Coronal. When unspecified, front unrounded vowels display neutrality in certain vowel harmony systems, undergo assimilation, and appear as epenthetic segments.

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