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LABIAL OPACITY AND ROUNDNESS HARMONY IN NAWURI*

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0. Introduction

It is a well-known characteristic of vowel-to-vowel assimilation processes that they generally ignore intervening consonants. In order to explain this fact, several recent models of segment structure (e.g., Clements 1991, Odden 1991) have assigned distinct place-nodes for consonant and vowel features, thereby predicting that plain consonants (i.e., those which lack a distinctive secondary articulation such as palatalization or labialization) should not block vowel-to-vowel place-feature assimilations.

In this paper I present evidence from Nawuri, a Kwa language of Ghana,[1] to show that the claim that intervening plain consonants are transparent to vowel-to-vowel place-feature assimilations is not universally true. The evidence concerns a process in which an underlying high front vowel becomes a back round vowel before a back round vowel in the following syllable. Of crucial interest is the fact that the process may be blocked, though not triggered, by the presence of an intervening labial consonant. I show that while the treatment of this blocking effect is straightforward in a framework such as that of Sagey (1986), in which labial consonants and round vowels are specified for a [labial] class node on the same tier, it is problematic for theories in which consonant and vowel place-features are arrayed on separate tiers.

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* I am indebted to the Nawuri speakers of the village of Kitare who provided the data on which this paper is based, especially Mr. Chris Okumtey-Oklas (now Nana Nkpanibakey II). A version of this paper was presented at the UCLA phonology seminar during the Winter 1993 quarter; I am grateful to those present for their comments. I would also like to thank Robert Kirchner, Dan Silverman, and especially Donca Steriade for their many helpful suggestions. Any shortcomings which remain are my own responsibility.

[1] More specifically, Nawuri belongs to the Guang subfamily of Tano (Stewart 1989), the same group that contains the more well-studied Akan languages. Previous work on Nawuri includes Sherwood (1982), Casali (1988, to appear), and Snider (1989, 1990).

1. Background

The consonant system of Nawuri is given in (1) (segments in parentheses are extremely rare).

(1)

labial	alveolar	palatal	velar	labiovelar
p p^w	t	tʃ ($tʃ^w$)	k k^w	kp
b b^w	d	dʒ	g	gb
f f^w	s s^w		h	
m (m^w)	n	ɲ	ŋ	ŋm
	l			
	r			
		y		w

The vowel system is a nine-vowel system of a type found in many other Kwa languages:

(2)

i		u
ɪ		ʊ
e		o
ɛ		ɔ
	a	

The language has a full system of ATR-based vowel harmony in which the non-low vowels are divided into two harmony sets: the [+ATR] vowels /i,u,e,o/ and the [-ATR] vowels /ɪ,ʊ,ɛ,ɔ/. In morphemes containing only non-low vowels, all the vowels will be drawn from a single set. The vowel /a/, though phonetically [-ATR], is "neutral", in that it may occur in morphemes containing vowels from either set. The vowel harmony is root-controlled: affix vowels harmonize in their value of [ATR] with the nearest root vowel.

Underlying short front vowels become centralized interconsonantally, a fact which will have some relevance to the analysis of rounding assimilation discussed in the next section. This is illustrated in (3),[2] in which [ɨ,ɪ̱,ə,ʌ] are centralized allophones of /i,ɪ,e,ɛ/ respectively.[3]

(3)	a. /a-libi/	[alɨbi]	'badness'
	/leNbiri/	[ləmbɨri]	'black'
	/o-liŋ/	[olɨŋ]	'root'
	/tekperi/	[təkpəri]	(type of grass)
	/ɔ-kɪŋ/	[ɔkɪ̱ŋ]	'fish'
	/gɪ-ba:/	[gɪ̱ba:]	'hand'
	/tʃɛ-mɪnɛ:/	[tʃʌmɪ̱nɛ:]	'friend'
	b. /tɛ N-fɪ:/	[tʌmfɪ:]	'sit here'
	/a-bite gi-du/	[abɨtəgudu]	'ten girls'
	/natɪ ba/	[natɪ̱ba]	'walk and come'
	/a+ɲaN-bi gɪ-lɪfa/	[aɲambɨgɪ̱lɪ̱fa]	'one hundred nails'
	c. /bɪ:la/	[bɪ:la]	'learn'
	/dʒe:si/	[dʒe:si]	'thread'
	/tʃɛ:gɪ/	[tʃɛ:gɪ]	'change'
	/si: ga+ma:/	[si:gama:]	'remain behind'

---

[2] The Nawuri examples in this paper are from my own field notes and were elicited from a variety of Nawuri speakers in the village of Kitare.

[3] Short /a/ is raised to [ʌ] in the same environment. As a result, contrast between /ɛ/ and /a/ is neutralized interconsonantally. This means that it is not possible to tell whether [ʌ]s which occur between two consonants within a single morpheme arise from /a/ or from /ɛ/, and the most plausible assumption is that these [ʌ]s are simply unspecified underlyingly for the features (presumably [low] and [back]) which distinguish /a/ from /ɛ/. In both phonetic and phonemic representation, I have consistently (and somewhat arbitrarily) represented these indeterminate [ʌ]s as *a*.

(N indicates a nasal consonant unspecified for place of articulation. Certain irrelevant phonetic details are ignored.) Note that the process takes place in open as well as closed syllables, i.e., it is not necessary that the flanking consonants belong to the same syllable. The examples in (3b) show that the process also applies across word boundaries, while the (3c) examples show that long vowels do not undergo centralization. Within single morphemes at least, centralization is obligatory, even in very deliberate speech.[4]

2. Labial Spreading

As stated above, affix vowels in Nawuri harmonize in their value of [ATR]. In addition, there is one affix which generally harmonizes in roundness with the nearest stem vowel. The harmonizing behavior of this morpheme, a singular noun class prefix /gI/ (where *I* represents a high vowel whose roundness and ATR value are determined by the following stem vowel), is illustrated in (4).

(4) a. Before [-ATR,-round] stem vowel:

[gɪ̱-ba:]	'hand'
[gɪ̱-ka:]	'head pad'
[gɪ̱-sɪ̱bɪ̱ta]	'sandal'

b. Before [-ATR,+round] stem vowel:

[gɷ-sɷ]	'ear'
[gɷ-kɷlɷŋ]	'one item'
[gɷ-lɔ]	'illness'

[4] Centralization sometimes fails to occur (or at least the degree of centralization may be less) when one or both of the flanking consonants is a palatal, especially /y/. While the precise circumstances under which this may occur is a matter that deserves further investigation, I suspect that the effect of centralization (which I consider to be a categorical phonological process) is simply being obscured by a coarticulatory fronting effect due to the palatal point of articulation of the consonant.

c. Before [+ATR,-round] stem vowel:

[gɨ-ɲi]	'tooth'
[gɨ-fitiri]	'grass'
[gɨ-ke:li:]	'kapok tree'

d. Before [+ATR,+round] stem vowel:

[gu-dʒo]	'yam'
[gu-ku:]	'digging'
[gu-tʃule:]	'mushroom'

Rounding also occurs when the noun stem begins with /w/, regardless of whether or not the following vowel is round:

(5)	[gɷ-wa:]	'doing'
	[gɷ-wɛ:]	'sympathy'
	[gɷ-wɷrɷ:]	'hat'
	[gu-wiya]	'bone'
	[gu-wurururi]	'throat'

Both before a round vowel in the following syllable as well as before /w/, rounding is obligatory even in careful speech, with one exception. When the prefix vowel is immediately followed by a stem-initial labial consonant (excluding /w/), rounding before a round vowel is optional and speech-rate dependent, being more likely to occur in faster speech:

(6)	(more likely) in fast speech:		(more likely) in slow speech:	
	[gu-mu]	~	[gɨ-mu]	'head'
	[gu-fufuli]	~	[gɨ-fufuli]	'white'
	[gu-pula]	~	[gɨ-pula]	'burial'
	[gʊ-mʊ]	~	[gɪ̠-mʊ]	'it'
	[gu-bo:to:]	~	[gɨ-bo:to:]	'leprosy'

I assume that whatever optional rounding occurs in these cases is not the result of a feature-affecting phonological process but is simply a matter of coarticulation, to be treated in the phonetic component. Such coarticulatory rounding clearly manifests itself elsewhere in the language. Word-final high front vowels may optionally become somewhat rounded before a round vowel in the first syllable of the following word:

(7)

a. /a-fitiri lo:-sa/ ---> [afɨtɨru lo:sa]
'grass for entering'

b. /ku:ri mɔ:-sa/ ---> [ku:ru mɔ:sa]
'a pig for killing'

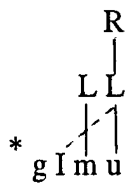
c. /na:tɪ gʊ-sʊ/ ---> [na:tʊ gʊsʊ]
'cow's ear'

d. /a-besi gu-du/ ---> [abəsu gudu]
'ten eggs'

Examples (7c) and (7d) show that the lexical rounding of the prefix vowel may feed this coarticulatory process. Example (7a) shows that the coarticulatory process is not itself iterative, i.e., we do not have *[afuturu lo:sa].

The ability of an intervening labial consonant to block rounding seems to indicate that the process involves the spreading of the class node [labial] rather than just the terminal feature [round].[5] Assuming, as in Sagey's (1986) conception, that both round vowels and labial consonants are specified (on the same tier) for a labial articulator node, the opaque behavior of the latter is predicted automatically, since the labial node of a round stem vowel could not spread leftward beyond a stem-initial labial consonant without yielding crossed association lines:

(8)

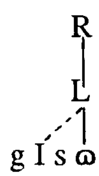


(L = [labial], R = [round])

'head'

Where the stem-initial consonant is non-labial, on the other hand, no crossing of association lines results and spreading is free to apply:

(9)



'ear'

The rule responsible for the rounding of the /gI/ prefix vowel may be stated parametrically (cf. Yip 1989) as in (10):

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[5] Labial consonants may apparently block prefix vowel rounding in other Guang languages as well. According to Snider (1988:139):

> the Guang languages exhibit a certain degree of round/back harmony within phonological words...when a prefix that is eligible for rounding is attached to a stem, the first vowel of which is round, the vowel of the prefix usually rounds. This process <u>tends</u> [Snider's emphasis--RC] to be blocked, however, by intervening labial consonants in many Guang languages.

(10) Labial Spread:

Focus:	[labial]
Action:	spread
Direction:	R to L
Target:	[+high] vowel
Source:	[+round]
Adjacency Condition:	between adjacent syllables

At this point, we may consider whether Labial Spread must be lexically restricted to the /gI/ prefix. The answer seems to be no. The fact that there are no other morphemes which actively undergo roundness alternations of this sort may be attributed to the simple fact that there are no other candidate prefixes with an eligible (i.e., high front) vowel. (An apparent exception, involving certain prefixes of the form [i]/[ɪ], will be dealt with below.) Furthermore, it turns out that, within single morphemes, a high non-round vowel may not precede a round vowel in the following syllable unless the two vowels are separated by a labial consonant. Thus while intramorphemic sequences such as [ɪ̱pɷ], [ɨmu], [ɨbo], and [ɨpo] are attested in the forms in (11), comparable sequences (e.g., *[ɨsu], *[ɪ̱kɷ]) in which the intervening consonant is non-labial do not occur.

(11)	[ga-bɷ-lɪ̱pɷ]	'sheep'
	[gɨ-gɨdɨmu]	'tadpole'
	[gɨ-ɲɨɲɨrɨboto:]	'millipede'
	[nɪ̱mɷ:]	'this'

(In fast speech the high vowels preceding the labial consonants in the forms in (11) may become at least partially rounded. I assume that this is due to the same coarticulatory phonetic process responsible for the optional rounding in (6).)

The remaining environment in which Labial Spread, if a general word-level rule, might be expected to apply, is where a high vowel precedes a suffix containing a round vowel. The only such suffix I have come across is an agentive suffix [pu]/[pɷ]. Some examples involving this morpheme are given in (12):

(12)	a. [o-kula:-pu]	'widow(er)'
	b. [ɔ-dɔ:-pɷ]	'farmer'
	c. [o-tiri-pu]	'pauper'
	d. [o-kisi-pu]	'enemy'

As can be seen from (12c) and (12d), vowels preceding this suffix do not undergo Labial Spread. But since the round vowel in this suffix is preceded by a labial consonant, this is exactly what we would expect, given the regular opacity of labial consonants to this process. Hence it does not appear to be necessary to lexically restrict Labial Spread to the morpheme /gI/. (The vowels preceding [pu] in (12c) and (12d) may exhibit a degree of rounding in fast speech. Here again, I consider this to be a matter of phonetic coarticulation.)

As things stand, however, there is a systematic class of exceptions to rule (10) in that word-initial prefixes of the form /I/ (using *I* to represent a vowel that is either /i/ or /ɪ/, depending on the [ATR] category of the stem vowels) regularly fail to undergo Labial Spread:[6]

(13)	[i-dʒo] 'yams'	(*[u-dʒo])
	[ɪ-kɔ] 'war'	(*[ɷ-kɔ])
	[ɪ-wɔdʒa] 'joke'	(*[ɷ-wɔdʒa])
	[ɪ-kɔ:lɪ fɷ] 'it suits you'	(*[ɷ-kɔ:lɪ fɷ])
	[ɪ-tʃɔ] 'it is plentiful'	(*[ɷ-tʃɔ])

[6] There are several such prefixes in the language, including a plural noun class prefix, a progressive aspect marker, and a focus marker.

While we could, if necessary, account for the failure of these prefixes to undergo rounding by lexically restricting Labial Spread to apply only to the /gI/ prefix, it may be significant that these same /I/ prefixes are also exempt from the centralization process discussed in Section 1 above, as the examples in (14) illustrate.[7] (Recall that centralization does occur across word boundaries under other circumstances, as in the examples in (3b).)

(14)

a. [ɪ-kɪ̠ŋ ɪ-sa] (*[ɪ-kɪ̠ŋ ɪ̠-sa])
'three fish'

b. [ɪ-saŋ ɪ-kɪ̠ŋ mɷ] (*[ɪ-saŋ ɪ̠-kɪ̠ŋ mɷ])
'the fish remain'

c. [ɪ-saŋ i-lɨŋ mɷ] (*[ɪ-saŋ ɨ-lɨŋ mɷ])
'the roots remain'

I suggest that centralization in Nawuri involves the delinking of [-back] from short front vowels interconsonantally. This rule will apply to the vowel of /gI/; it must not however apply to a word-initial /I/ prefix, since these vowels never centralize. (The actual formal means by which /I/ is to be exempted from centralization is not obvious, since the rule clearly applies postlexically in other cases. I will assume however that some satisfactory solution is possible.) If we now assume that Nawuri has a condition ruling out front round vowels, as in (15), we predict that word-initial /I/ will be immune to Labial Spread, since it will fail to undergo centralization and thus will retain its underlying [-back] specification.

(15) *[+round,-back]

The vowel of /gI/ on the other hand will lose its [-back] specification due to centralization and may therefore undergo Labial Spread without violating (15).

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[7] In fast speech the word-initial vowels in /ɪkɪŋ/ 'fishes' and /iliŋ/ 'roots' may be lowered to [ɛ] and [e] respectively when they follow a non-high vowel in the preceding word-final syllable, as they do in (14b,c). Regardless of whether or not they are phonetically lowered, the important point is that under no circumstances do they centralize.

3. Behavior of Labialized (Rounded) Consonants

Nawuri has seven labialized consonants /kʷ, tʃʷ, sʷ, pʷ, bʷ, fʷ, mʷ/ which contrast with their non-labialized counterparts before non-round vowels:[8]

(16)

labialized		non-labialized	
[kʷɪ:]	'to differ'	[kɪ:]	'to look'
[gada:tʃʷɛ:]	'gecko'	[tʃɛ:gɪ]	'to change'
[sʷa:]	'to be wounded'	[sa:]	'to draw water'
[bʷɪ:]	'to wither'	[bɪ:]	'to sing'
[pʊpʷɛ:]	'new'	[pɪpɛ:]	'red'
[fʷa:la]	'to greet'	[fa:ra:]	'to start'
[gɪ-lamʷɛ:]	'tiger nut'	[gɪ-mɛ:]	'duck'

Since these consonants are presumably [+round], it is natural to expect that they should pattern with /w/ in triggering the rounding of a preceding high vowel. Snider (1988) in fact explicitly states that rounding of the vowel in the /gI/ prefix (or its cognates) in Guang languages occurs before both /w/ and /Cʷ/. In the sense that rounding of the prefix vowel may occur, at least in some circumstances, before a stem-initial /Cʷ/, this statement is undoubtedly correct. While a scarcity of relevant examples in my data makes it difficult to draw a firm conclusion however, I believe that the precise facts are actually somewhat more complex. Specifically, it seems to be the case that whereas rounding of a high vowel is obligatory before /w/, and presumably before the "non-labial" /Cʷ/s (i.e., /kʷ, sʷ, tʃʷ/) as well (although crucial data is lacking), it is optional and gradient before

8 Before *round* vowels, all consonants in Nawuri are predictably rounded. In Casali (to appear) I argue on the basis of spectrographic evidence that this rounding is the result of a phonological feature-spreading process and not simply a matter of phonetic coarticulation.

the "labial" /C^{W}/s (i.e., /p^{W}, b^{W}, f^{W}, m^{W}/).[9] If this is so, then this latter rounding must be attributed not to the lexical rule of Labial Spread, but to the same coarticulatory phonetic

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9 Evidence that labial /C^{W}/s do not trigger Labial Spread onto a preceding vowel comes from several sources. First, although these consonants are relatively rare to begin with, there is one fairly common monomorphemic word, [la:tɪpwɛ:] 'afternoon', in which a high vowel preceding /p^{W}/ is regularly pronounced with little or no discernible rounding. Second, I have a tape-recorded wordlist made by a Nawuri speaker of Kitare which contains four words (each repeated three times) in which /gI/ precedes a stem-initial labial /C^{W}/:

/gI-p^{W}ɛ:/	'guilt'
/gI-b^{W}a:ru:/	'water yam'
/gI-b^{W}ɪ:ba:/	'guinea corn'
/gI-f^{W}ɪ/	'bodily gas'

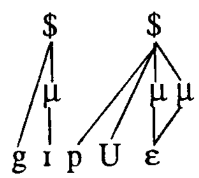
In listening to these words as they occur on tape, it does not seem to me that the prefix vowels are consistently round in all cases. In particular, none of the tokens of 'guilt' and 'guinea corn' impress me as having a clearly round prefix vowel, and in at least one token of each word I would definitely favor transcribing this vowel as [ɪ] rather than [ɷ]. A final source of evidence bearing on the issue comes from Snider's (1989) word-list of about 800 words from five closely-related Guang languages, Nawuri, Chumburung, Krachi, Gichode, and Gonja. His Nawuri data contains a single example with a stem-initial labial /C^{W}/ following the /gI/ prefix. The example is a phrase meaning 'proclaim guilty' (literally 'eat guilt'); Snider's phonetic transcription, [ji gɨp^{W}ɛ:ʔ], has a non-round prefix vowel preceding the labialized [p^{W}]. Perhaps more significant, in virtue of the some what greater number of relevant examples it contains, is his Chumburung data. He has a total of six words in which the cognate of the Nawuri prefix /gI/ (which is /kI/ in Chumburung) precedes a stem-initial /C^{W}/ before a non-round vowel. In three of these words, the stem-initial /C^{W}/ is a non-labial; in all three cases, the prefix vowel is round:

[ku-t^{W}etu]	'penis'
[kɷ-$k^{W}$$a^{I}$]	'drum'
[ku-k^{W}iʔ]	'heap'

process responsible for the rounding of a high vowel before a plain labial consonant followed by a round vowel, as in (6).

If it is indeed the case that the "labial" /C^W/s /p^W, b^W, f^W, m^W/ fail to trigger Labial Spread, one straightforward way of accounting for this would be to claim that /C^W/s are phonologically not unitary segments at all, but rather consonant plus glide sequences. Under this analysis, the representation of a word like /gI-p^Wɛ:/ 'guilt' will be as in (17) (where *U* represents a round vocoid unspecified for other features):

(17)



This representation clearly predicts that Labial Spread should not be able to apply to this form, since spreading of the labial node of /U/ ([w]) onto the prefix vowel would be blocked by the intervening labial node of /p/.

In Casali (1988), I rejected an analysis of [C^W]s as bisegmental /Cw/ sequences on the ground that it would require positing a slightly more complex syllable structure in

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In the remaining three words, the stem-initial /C^W/ is a labial. In each of these words, the prefix vowel has been transcribed by Snider as non-round:

[kɪ̱-b^Wanɔ]	'tooth'
[kɪ̱-$b^W$$a^I$]	'maize'
[kɨ-b^Wiʔ]	'yam store'

While the quantity of data is not overwhelming, these examples point to the conclusion that labial /C^W/s fail to trigger Labial Spread in Chumburung. Given that the behavior of the process is identical in every discernible respect in the two languages, the most natural conclusion which can be drawn from the limited available facts is that Labial Spread in both Nawuri and Chumburung is initiated by a round vowel, /w/, or a non-labial /C^W/, but not by a labial /C^W/.

the language, since there are no other clear cases of complex onsets. This is not a weighty objection, however, since the increased complexity in syllable structure which this analysis entails is offset by a corresponding decrease in the complexity of the segment structure conditions, since it is no longer necessary to posit conditions which allow the feature [round] in combination with the seven primary segments /p, f, b, m, k, s, tʃ/ while disallowing this feature with other [+consonantal] segments. Also, the fact, noted in Casali (1988), that the lip-rounding is largely simultaneous with the articulation of the syllable-initial consonant is not a valid objection to the analysis, since this can be regarded as purely a matter of coarticulatory timing, to be handled in the phonetic component.

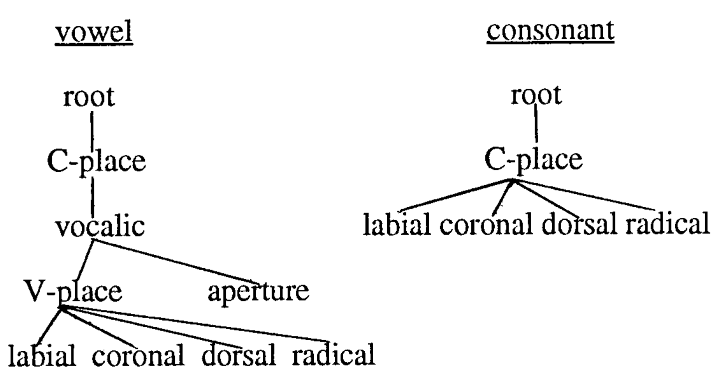
4. Labial Spread and Current Feature Geometries

Over the last few years a number of linguists have proposed theories of segment structure which, contrary to the earlier theories of Sagey (1986) and Clements (1985), involve some kind of segregation between consonantal and vocalic features. In this section I consider two specific proposals: those of Clements (1991) and Odden (1991). It will be clear that neither of these geometries can correctly account for the Nawuri data, since they both predict that a plain labial consonant should be unable to block vowel-to-vowel spreading of the feature [round].

4.1 Clements (1991)

Clements proposes a model in which consonantal and vocalic place-features appear on separate tiers, as in the partial representations in (18):

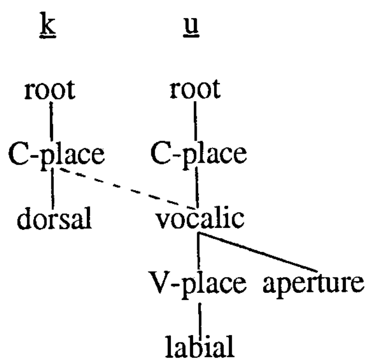
(18)



In using a unitary set of labels for the features, Clements intends to claim that a given feature [F] appearing under the C-place node is the *same feature* as an instance of [F] appearing under the V-place node.

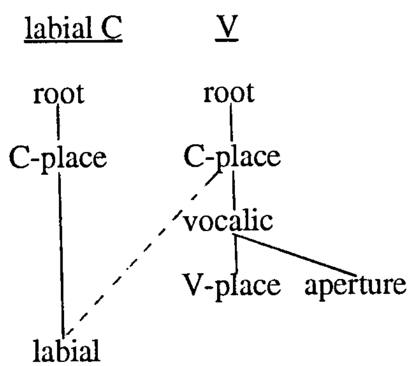
The fact that the consonantal and vocalic instances of a place-feature are on a different tier does not prevent interaction between the two. A consonant may acquire a feature specification by spreading from a neighboring vowel by as in (19), which shows a hypothetical case in which a consonant /k/ is labialized before a round vowel /u/.

(19)



Similarly, a vowel may assimilate a place-feature from an adjacent consonant. (20) illustrates the formal representation of a hypothetical case in which a vowel becomes round after a labial consonant:[10]

(20)



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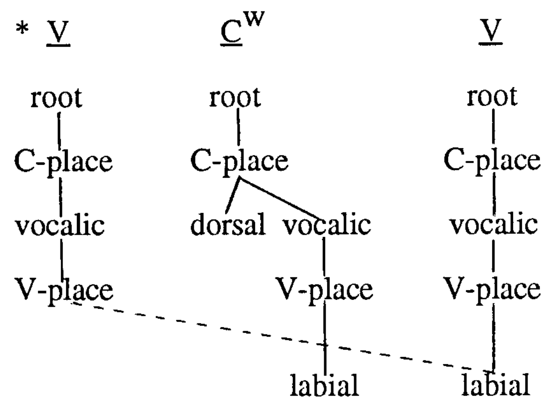
[10] While the normal state of affairs is for [labial] to link to the V-place node in vowels, Clements allows for the possibility that in some languages it may link directly to the C-place node of a vowel; hence the representation which results in (20) is not necessarily ill-formed.

The model also allows for cases in which an intervening consonant bearing a secondary specification for a feature [F] (where "secondary" refers, in Clements' model, to a feature specification under the V-place node) may block vowel-to-vowel assimilation. Such a case is illustrated in (21), where the leftward spreading of [labial] between two vowels across an intervening labialized velar consonant is ill-formed because it results in crossed association lines:

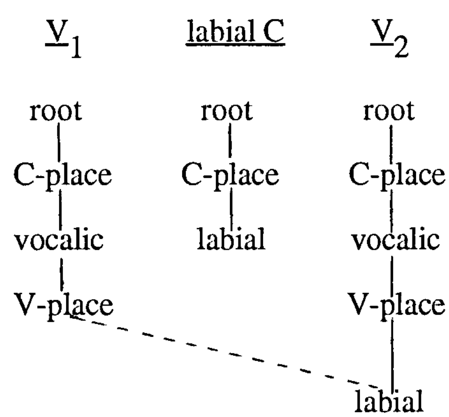
(21)



(The aperture node has been omitted in this representation for reasons of space.)

What Clements' feature geometry makes no provision for, however, is a case in which vowel-to-vowel spreading of [F] is blocked by an intervening consonant with a *primary* specification for [F]. This is illustrated in (22).

(22)



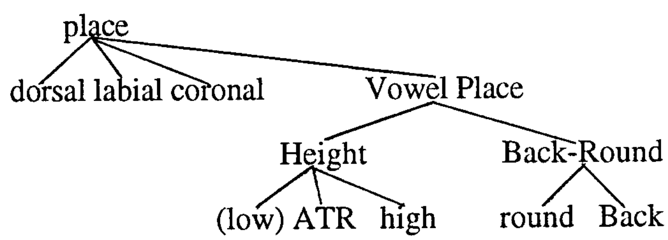
Here the spreading of the feature [labial] from V_2 to V_1 is not blocked by the [labial] specification of the intervening C, because the consonantal specification of this feature is not on the same tier as the vocalic specification of this feature; hence the spreading does not violate the ban against crossed association lines.

The impossibility within Clements' model of a plain labial consonant blocking vowel-to-vowel labial assimilation is not the result of an oversight on Clements' part; rather it stems from a deliberate and indeed well-justified response to the problem of accounting for the overwhelming cross-linguistic tendency for plain consonants to be transparent to vowel-to-vowel place-feature assimilation. Unfortunately, the Nawuri data (of which Clements was not aware) seem to show that the prediction that plain consonants should always be transparent to such assimilations is simply too strong.[11]

4.2 Odden (1991)

The basic structure of Odden's model is given in (23):

(23)



As in Clements' model, consonantal and vocalic place-features appear on separate tiers. Odden's proposal differs chiefly in that (1) the consonantal and vocalic place-features are not the same features, and (2) the vocalic place-features are further segregated into subgroups dominated by a Height node and a Back-Round node. These differences have

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[11] Clements' model does actually allow for some restricted cases in which plain consonants may block vowel-to-vowel place assimilation. For example, there are many languages (Clements cites Luganda) in which a vowel totally assimilates to another vowel, but only if the two vowels are strictly adjacent--where a consonant intervenes, assimilation is blocked. Clements points out that this may be handled by spreading a higher node such as C-place or the root node. What is important for our purposes, however, is that there does not seem to be any provision within Clements' model for handling cases like Nawuri, in which the vowel-to-vowel spreading of a single articulator node is blocked by plain consonants specified for the same articulator.

significant empirical consequences: they predict, for example, that [back] and [round] should be able to spread together as a unit. The important point for our purposes, however, is that Odden's model is in complete agreement with Clements' with respect to what it predicts about vowel-to-vowel assimilation: since consonantal and vocalic place-features are on different tiers (and indeed are different *features* in Odden's model), an intervening plain consonant should not be able to block the vowel-to-vowel spreading of one or more vocalic place-features. In particular, the process by which Nawuri /gI/ becomes round before a following round vowel would have to involve the spreading of either [round] or Back-Round in Odden's model; plain labial consonants, on the other hand, would be place-specified only for labial. (I assume that [round] is a privative feature, so that the possibility that the labial consonants might block spreading by being specified as [-round] is also ruled out.) Clearly, this [labial] specification should not be able to block the spreading process, since it resides on an entirely independent tier.

In summary, the models of Clements' (1991) and Odden (1991) both predict that a plain labial consonant should not be able to block a vowel-to-vowel place-feature assimilation. This prediction is a consequence of the segregation which exists in these models between consonantal and vocalic place-features. While it may be true that plain consonants are usually transparent to such assimilation, the Nawuri facts clearly indicate that this is not universally the case. This suggests that the assumption that consonantal and vocalic features appear on different tiers needs to be reexamined.

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VOWEL REDUCTION AND UNDERSPECIFICATION IN BRAZILIAN PORTUGUESE *

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0. Introduction

Brazilian Portuguese (BP hereafter) has been characterized as a language that utilizes some form of vowel reduction (Camara 1972, Major 1983). In such languages, the distribution of vowels in unstressed positions appears to be more restricted than in stressed positions. Furthermore, the set of vowels licensed in posttonic final position in such languages is more restricted than the set licensed pretonically.

In this paper I would like to present the facts of vowel reduction found in BP and to discuss some of the issues surrounding the relationship between prosodic structure and vowel reduction. In particular, I will examine the question of how changes in feature specification relate to prosodic structure. The process found in BP closely resembles the vowel reduction processes found in Catalan, and Raeto-Romance. I will therefore also consider whether some unified analysis can be provided for all these processes.

This paper is organized as follows. In section 1, I present the relevant data and describe the distribution of vowels in unstressed positions in BP. In section 2, I attempt to characterize the relation of the reduced vowels to the relevant prosodic structure. In section 3, I examine the consequences of the proposed analysis in terms of the degree of specification necessary to differentiate the underlying representation of segments in BP. An analysis of the data is presented within the framework of Radical Underspecification. Finally, in the last section, I try to extend the analysis proposed for BP to the two other romance languages with vowel reduction mentioned above. I conclude with some generalizations that might be beneficial to current underspecification theories.

1. Theoretical Background

Much recent work in phonology has been concerned with the amount of information that needs to be present in the lexicon. The standard assumption is that predictable information, such as prosodic structure and non-distinctive features, should

* I would like to thank Michael Dukes and Donca Steriade for comments on and help with various versions of this paper. Special thanks to Michael for helping me edit the paper.

not be present underlyingly if they can be derived by rule (Kahn 1976, Steriade 1982). In line with these assumptions there are two different theories of phonological underspecification that differ primarily with respect to the amount of information that may be left unspecified in the lexicon. The primary difference between these two theories can be stated as follows. Radical Underspecification theory (Kiparsky 1982, Archangeli 1984, Pulleyblank 1988) claims that only one value for each feature may be present in lexical representations, whereas Contrastive Underspecification (Clements 1987 and Steriade 1987) assumes that both values of a feature (i.e., + and -) may be present if the feature in question is contrastive in the language. Both of these theories assume that predictable information is derived through Redundancy Rules. I will present an analysis of vocalic segments in BP within the framework of Radical Underpecification (RU). Despite the fact that both theories can be extended to account for the BP data, I will argue that the BP data is most naturally accounted for under a Radical Underspecification account.

2. The Data

Brazilian Portuguese has seven phonemic oral vowels (a, e, ɛ, a, ɔ, o, u) and one derived oral vowel (ə).[1] I will show below that BP can be described as having three vowel systems with respect to stress. There is one system for vowels in pretonic position, a second one for vowels in tonic position and a third system for vowels in posttonic position. A description of these three vowel systems is given below.

2.1 Tonic Position

The following vowel system is licensed in tonic position :

(1)

i							u
	e					o	
		ɛ			ɔ		
			a				

Some examples illustrating the occurrence of these vowels in stressed syllables are given below:

[1] The set of nasal vowels in BP is (ĩ, ẽ, ə̃, õ, ũ); they behave very much like the set of pretonic and non-final posttonic vowels. Thus for reasons of space, they will not be discussed here.

(2) **penultimate syllable**

[síkə]	'food brand'
[sékə]	'dried'
[sɛ́tə]	'arrow, signal'
[sáku]	'bag'
[sóku]	'punch'
[sɔ́lə]	'sole'
[súku]	'juice'

(3) **ultimate syllable**

[əlí]	'there'
[fuzué]	'noise'
[kafɛ́]	'coffee'
[ʒəká]	'basket'
[pivó]	'pivot'
[ʒəkɔ́]	'bumpkin'
[ʒəkú]	'nerdlike'

(4) **antepenultimate syllable**

[síviku]	'civic'
[bébədu]	'drunk'
[sɛ́kulu]	'century'
[sábədu]	'Saturday'
[fólegu]	'breath'
[sɔ́lidu]	'solid'
[súbitu]	'unexpected'

Notice that the *position* of the stressed vowel has no effect on its quality. Under stress, any one of the seven phonemic vowels is allowed in any position. The majority of lexical items in BP receive stress on the penultimate syllable.

2.2 Pretonic Position

The distribution of vowels in pretonic position can be classified into two distinct sets depending on the presence or absence of secondary stress.

2.2.1 Pretonic Unstressed Position

There are five vowels that may surface in pretonic unstressed position; a subset of the phonemic vowels ([i, e, o, u]), as well as schwa ([ə]). Examples are given below:

(5) **Trisyllabic words**

/bɛl-eza/	cf. [bɛ́lu]	[belézə]	'beauty'
/mɔleza/	cf. [mɔ́li]	[molézə]	'softness'
/nativo/	cf. [nátu]	[nətʃívu]	'native'
/siʒilo/		[siʒílu]	'cautious'
/kurado/		[kurádu]	'healed'
/piloto/		[pilótu]	'pilot'
/ʒelado/		[ʒeládu]	'cold, icy'
/pɛlado/		[peládu]	'nude'
/palito/		[pəlítu]	'toothpick'
/ʒɔgado/		[ʒogádu]	'played'
/pulido/		[pulídu]	'polished'

2.2.2 Secondary Stressed Position

The set of vowels licensed in secondary stressed positions is the same as the set of vowels licensed in tonic position. In pretonic stressed position we observe [i, e, ɛ, a, ɔ, o, u]. The examples of pretonic unstressed vowels given above were limited to the syllable immediately preceding the primary stressed syllable. In the examples that follow we observe that when more than one syllable precedes the syllable that receives main stress, secondary stresses occur on every other syllable preceding the primary stressed syllable:

(6) **Polysyllabic Words**

/povoado/	[pòvuádu]	'village'
/itamarandiba/	[ìtəmàrə̃dʒíbə]	Itamarandiba (name of a city)
/demokrasia/	[demòkrəsíə]	'democracy'
/rekuperasə̃w̃/	[xèkupèrəsə̃́w̃]	'recovery'
/kolokasə̃õ/	[kolòkəsə̃w̃]	'position'
/fotokɔpia/	[fòtokɔ́piə]	'photocopy'
/eselensia/	[èselẽsiə]	'excellence'
/bɔtafogo/	[bɔ̀təfógo]	Botafogo (name of a suburb)
/prɛistɔriko/	[prɛ̀istɔ́riku]	'prehistorical'

Note that the main difference between the set of vowels in pretonic unstressed position and the set of vowels in pretonic stressed position is that [a], [ɛ] and [ɔ] may occur in pretonic position if it carries secondary stress (as shown in the second example given in (6)). We will see in a later section of this paper that the pretonic vowels given in (5) are subject to some form of vowel reduction, whereas the pretonic vowels given in (6) are not affected by the same process. This distinction will be useful when we propose an analysis of the pretonic vowels.

2.3 Posttonic Position

Vowels in posttonic position are subdivided into two categories, the posttonic nonfinal and the posttonic final.

2.3.1 Posttonic Final Position

Only two phonemic vowels [i, u] and schwa [ə] are licensed in posttonic nonfinal position. Examples are given in (7) below:

(7)

/fale/	cf. [falémus]	'pl. imperative'	[fáli]	'speak, imperative'
/falo/			[fálu]	'I speak'
/fala/	cf. [fələ́mus]	'we speak'	[fálə]	'he speaks'
/beiʒo/	cf. [beiʒokéru]		[béiʒu]	'kiss'
/peidu/	cf. [peidoxéru]		[péidu]	'fart'

This is the environment where the most comprehensive vowel reduction is observed.

2.3.2 (Unstressed) Posttonic Nonfinal Position

The following subset of vowels is licensed in posttonic nonfinal position (i, e, ə, o, u) which never bears secondary stress. Examples are given in (8) below:

(8)

/avido/	[ávidu]	'avid'
/kɔrego/	[kɔ́xegu]	'small river'
/əpɔstrofo/	[əpɔ́strofu]	'apostrophe'
/arabe/	[árəbi]	'arab'
/krepuskulu/	[krepúskulu]	'twilight'

The examples in (7) illustrated that only the vowels [i, ə, u] occur in unstressed word final position. The set of data given in (8) shows that [e, o, ə, i, u] occur in posttonic non-final position. That is, the set of vowels allowed in unstressed posttonic non-final position is identical to the set of vowels allowed in pretonic position.

2.4 Summary of the Data

In short, the set of data given in this section clearly demonstrate that there are three vowel systems found in BP. These systems are given below:

Tonic and Secondary Stressed	Unstressed Noninitial and Nonfinal	Unstressed Initial and Final
i u	i u	i u
e o	e o	ə
ɛ ɔ	ə	
a		

In the next section, I present a general introduction to the aspects of BP phonology relevant to the treatment of the phenomenon at hand.

3. Stress in BP

The above data suggest that the distribution of vowels in BP is constrained by stress. Since stress assignment depends on foot structure, I will attempt to give an account of stress assignment in BP. This section deals exclusively with the relation between stress and prosodic structure.

The rules of stress assignment in BP are identical to the rules of stress assignment in Spanish (Harris 1983) and Catalan (Mascaró 1974) as we will see later. The rules of stress assignment are given below:

3.1 Primary Stress Assignment

a. unmarked cases

1. If the last syllable is light, then stress the penultimate syllable;
   $\acute{\sigma} \quad \breve{\sigma}$
2. If the last syllable is heavy, then stress the ultimate syllable;
   $\sigma \quad \acute{\bar{\sigma}}$

b. marked cases

3. Stress the antepenultimate syllable if the ultimate and penultimate syllable are light; $\acute{\sigma} \quad \breve{\sigma} \quad \acute{\sigma}$
4. Stress the ultimate syllable if the penultimate or the antepenultimate is light; $\breve{\sigma} \quad \breve{\sigma} \quad \acute{\sigma}$

One generalization that can be made from the BP data is that stress typically falls on the penultimate syllable in the unmarked case. Following Hayes (1987 and 1991), I propose that the stress system of BP utilizes the so called "quantity sensitive" trochee. The quantitiy sensitive trochee consists of two mora as illustrated by the following foot construction rule:

Foot Construction: Construct a single bimoraic trochee from the right edge of the word.

For example :

'bread'	'house'	'civic'	
p ã w	k á z ə	síviku	
μ μ	μ μ	μ μ (μ)	morification
σ	σ σ	σ σ (σ)	syllabification
F	F	F	foot formation

Feet in BP are usually left-headed (as shown above), whether they contain heavy or light syllables. The stress assignment system of BP (i.e., the marked & unmarked cases) can be typologically classified as a moraic trochee system (as in Latin, Spanish, Japanese, etc (Steriade 201 lecture notes)).

3.2 Secondary Stress Assignment

Assign secondary stress to every other unstressed syllable that precedes the primary stress; $\grave{\sigma} \quad \sigma \quad \grave{\sigma} \quad \sigma \quad \acute{\sigma}$

The rules for stress assignment given above lead to several types of stress patterns in BP words, each of which is described below.

3.3 Words Bearing Penultimate Stress - The Unmarked Cases

The examples given in (9) illustrate the unmarked case of stress and foot assignment; that is, a bimoraic trochee is built from right to left and the leftmost syllable within this foot receives main stress:

(9)	/ mɔle/	/mɔl + eza/	underlying representation
	μ μ	μ μ	morification
	σ σ	σ σ	syllabification
	F	F	foot formation

3.4 Words Bearing Ultimate Stress

A few examples containing the relevant structure are given below illustrating main stress assignment to a final light syllable:

(10)	[sipɔ́]	[filɛ́]	[sàbiá]	[pànəmá]
	μ	μ	μ	μ
	σ	σ	σ	σ
	F	F	F	F
	'climbing plant'	'fillet'	'thrush'	'Panama'

3.5 Words Bearing Antepenultimate Stress - Bimoraic Nonfinal Feet

In the analysis given of the stress patterns in BP, I propose that in those cases where words bear an antepenultimate stress, the ultimate syllable is invisible for the rules of stress (i.e., it is extrametrical). Thus in these cases we construct a bimoraic trochee from right to left, skipping the rightmost syllable, as shown in the examples below:

(11)	[tráfe(gu)]	**[áxvo(ri)]**	[sɛ́le(bri)]
	μ μ	**μμ μ**	μ μ
	σ σ	**σ σ**	σ σ
	F	**F (F)**	F

Note that the foot structure given in the example in bold face does not consist of bimoraic feet. To account for similar cases, it is usually assumed that there is a degenerate monomoraic foot and therefore stress is realized on the head of the heavy syllable.[2]

On the basis of the above analysis of stress assignment I will give an account of the featural content of the vocalic segments in BP.

4. Featural Analysis of Vocalic Segments in BP

In this section, I would like to provide a possible specification for vowels within the framework of Radical Underspecification. First I will provide a full specification of the vocalic segments in BP. After I have provided a Radical Underspecification analysis of the underlying features of BP vowels I will discuss the featural content of the derived segment [ə].

[2] I am aware of the fact that the status of defooting is controversial. However at the moment I do not have an alternative analysis for this case.

(12) **Fully Specificied Surface Representations For BP Vowels**

	i	e	ɛ	a	ɔ	o	u	ə
High	+	-	-	-	-	-	+	-
Low	-	-	-	+	-	-	-	+
Round	-	-	-	-	+	+	+	-
ATR	+	+	-	-	-	+	+	+

Within the RU framework of Archangeli (1984) and Archangeli & Pulleyblank (1986) it is claimed that there is no need to have binary features underlyingly. They can be predicted by RRs. RU also predicts a link between epenthesis and redundancy rules. The idea is that the epenthesis rule inserts and fills an empty vowel slot. The values assigned to this featureless V-slot are predictable from Redundancy Rules. Thus, before I present the RU account of BP vowels, I will provide evidence that /i/ is the epenthetic vowel in BP. Thus I will show that its features are entirely predictable from RRs. Once we have established that /i/ is the epenthetic vowel, I will show how the assumption that /i/ is featureless fits naturally into a RU account of BP vowel specification.

4.1 Epenthesis in BP

BP disallow syllables more complex than (C)CVC. In the case of a CVCC (or a CVC which does not comply with the phonotactic constraints of the language), there is a template which inserts a V-slot between the two consonantal segments. Examples illustrating epenthesis in BP are given below:

(13)a. **Final epenthesis**

/market /	[márketʃi]	'market'
/fred/	[frɛ́dʒi]	'Fred'
/golf/	[gówfi]	'golf'
/defisit/	[dɛ́fisitʃi]	'deficit'

(13)b. **Initial epenthesis**

/stok/	[istɔ́ki]	'stock'
/studo/	[istúdu]	'study'
/skɔla/	[iskɔ́lə]	'school'
/smɔla/	[ismɔ́lə]	'donation'

To further confirm the claim that [i] is indeed the epenthetic vowel in BP, we find examples of [i] insertion in word medial position.

(13)c. **Medial position**

/subʒeisent/	[subiʒəsẽ́tʃi]	' underlying'
/subdesenvolvido/	[subidʒisĩvolvído]	' under developed'[3]
/pneu/	[pinéu]	' tires'

but:

/subalterno/	[subəltɛ́rnu]	' subordinate'
/subemprego/	[subĩprɛ́gu]	' low class job'

I will now present the set of features that RU might predict for BP vowels.

4.2 Underlying Feature Specification of BP Vowels Within RU

(14)

	i	e	ɛ	a	ɔ	o	u	(ə)
Low				+				+
ATR			-	-	-			
High		-	-		-	-		
round					+	+	+	

Within this framework only unpredictable values for features are present underlyingly. Recall from section 4.1 that /i/ is the epenthetic vowel. Within RU this requires that /i/ bears no features underlyingly (as shown in the table immediately above). One immediate advantage of this assumption lies in the fact that the feature specification [+ high] is not specified in the lexicon but is inserted by rule. As we will see below, this assumptions fits in rather nicely with an important aspect of vowel reduction.

The vowel /a/ is the only vowel specified for the feature [+low] underlyingly. The motivation for the assumption that [+low] is needed for /a/ comes from the vowel reduction process. The vocalic alternations presented in section 2 illustrated that ɛ/ɔ in unstressed position become e/o; but /a/ becomes [ə]. If I assume that these three vowels are unspecified for the feature [+low] then it will be difficult to capture this generalization in terms of feature specification. I assume that it is the presence of the feature [+low] in /a/ and the absence of this feature in the lower mid vowels which triggers this contrast. The Raeto-Romance vowel inventory is identical to BP and apparently the vowel reduction process in Raeto-Romance is governed by the same principles proposed for BP. However, the ouput of vowel reduction when it applies to /ɛ, ɔ, a/ in Raeto-Romanceis always schwa. This is exactly what RU allows for; namely, languages containing identical sets of vowels may have different epenthetic vowels and therefore different sets of features present underlyingly. I will return to the treatment of

[3] Note that epenthesis is motivated in these first two examples because /b/ is not a possible coda in BP.

Raeto-Romance later; the point here was to justify the claim that /a/ is the only vowel specified for the feature [+ low] underlyingly in BP.

In the case of schwa (which is derived from an underlyingly /a/), I am assuming that at least in BP it bears the feature [+low] in surface representation (like [a]). Although schwa is generally assumed to be a featureless vowel in some other languages, it is not the epenthetic vowel in BP and therefore it cannot be featureless within an RU account. The vowel [i], for instance, is assumed to be specified for the feature [high] in some languages but unspecified for this same feature in other languages. There seems to be no reason why the same kind of reasoning could not be applied to [ə].

Before I present an account of the vowel reduction alternations, I will briefly discuss the status of the feature [ATR] in BP. We can observe from (14) that I am assuming the feature [-ATR] is present underlyingly in BP. This claim is motivated by the fact that the feature [- ATR] could not be inserted by rule because it is not predictable in stressed positions. A few examples are given below:

(15) Mid and lower mid vowels are in parallel distribution:

[əvó]	'grandfather'
[əvɔ́]	'grandmother'
[pélu]	'fur'
[pɛ́lu]	' I cut'

These examples demonstrate quite clearly that the distinction between the pairs of vowels /ɛ/ and /e/, and /ɔ/ and /o/ must be specified in the lexicon via an [ATR] contrast. The data discussed in section 2 clearly demonstrate that the feature [- ATR] is not allowed in unstressed positions.

4.3.1 Redundancy Rules and Filters for BP

Below I give the set of RRs which I employ to derive the fully specified segments illustrated in (12).

(16)a. **Redundancy Rules**

[ ] ---> [- back]
[ ] ---> [+ high]
[ ] ---> [- low]
[ ] ---> [- round]
[ ] --> [+ ATR]

(16)b. **Filters**

Universal Filter:	**Language Specific Filters:**
* [+ low, + high]	* [+ round, - back]
	* [- ATR, + high]
	* [+ round, - back]

I will now show how the link between RRs and underspecified vocalic representations can be exploited within RU to account for the vowel reduction data given in section 2.

4.3.2 Vowel Height Restrictions in Unstressed Positions

4.3.2.1 Mid/Lower-Mid Alternation

The distinction between mid and lower mid vowels in BP is neutralized when stress shifts off a vowel. This alternation is observed in all positions that do not receive a primary or secondary stress. The word formation process described below illustrates this claim. The suffix [-ezə] attaches to adjectives to form abstract nouns as shown in (17)a. The prefixes em- and a- and the suffix -ar also trigger stress shift, as shown in (17)b.

(17)a	/bɛl+o/	[bɛ́lu]	'beautiful'	/bɛl+ezə/	[belézə]	'beauty'
	/sɛɾt+o/	[sɛ́xtú]	'certain'	/sɛɾt+ezə/	[sextézə]	'certaint'

(17)b	/embelezar/	[ẽbelezáx]	'to beautify'
	/asɛɾtar/	[asextax̃]	'to pay off'

In terms of feature specification, suppose that we adopt the analysis suggested earlier in which we characterize the lower mid vowels as having the feature [- ATR] underlyingly and we restrict the presence of the feature [- ATR] to stressed position. Then this feature must be removed from lower mid vowels in unstressed position. Here are some examples illustrating the process by which [- ATR] is removed:

(18)

[- ATR]	
|	
/avɔ/	'grandma'
|	
[-ATR]	
/avɔ́/	stress assignment
əvɔ́	[-ATR] constraint
-------	word boundary constraint
[əvɔ́]	phonetic output

(19)

[0ATR]
|
/avo/ 'grandpa'
|
[-ATR]

/avó/	stress assignment
əvó	[-ATR] constraint
-------	word boundary constraint
[əvó]	phonetic output

We observe in (18) that the vowel is specified for the feature [- ATR], whereas in (19) it is not. In the example given in (18), the vowel [ɔ] receives main stress, thus the feature [- ATR] is allowed in that position. The example that follows below illustrates a case where the vowel is underlyingly specified for the feature [- ATR] but since the vowel is not in a position where it can carry stress, the feature [- ATR] is removed by what I call the '[- ATR] constraint', which is given in (20) below.

(20) **[- ATR] Constraint:** *[- ATR] in unstressed position.

(21)

[- ATR]
|
/sɛrt + eza/ 'certain'
|
[- ATR]

sɛrtéza	'stress assignment'
------	[-ATR] constraint (the [-ATR] feature is not licensed in unstresed position, therefore [- ATR] ->Ø)
[sextézə]	phonetic output[4]

4.3.2.2 Low / Schwa Alternation

The second generalization drawn from the data given in section 2 is that [a] like [ɛ] and [ɔ] does not occur in unstressed positions; the allophone [ə] appears instead (as was discussed briefly in 4.2).

[4]The alternation observed here between [a] and [ə] will be dealt with in the next section.

(22) Example illustrating complementary distribution of [a] and [ə] in BP

/kal+a/	[kálə]	*[kála]	'he's quiet'
/kal+ a+do/	[kəládu]	*[kaládo]	'quiet, past participle'

This example illustrates that [ə] is derived from /a/. The low/schwa alternation will be accounted for by the same process as the mid/lower mid alternations. That is, I assume that the [- ATR] constraint also deletes the [- ATR] specification carried by /a/ in unstressed position.

In summary, we have shown that the vowels [ɛ, ɔ, a] do not occur in unstressed positions. Furthermore, we have accounted for alternations involving these vowels via the single constraint given in (20).

4.3.2.3 Mid / High Alternations

The examples below illustrate the mid / high alternation discussed in section 2; the reader will recall that underlying mid vowels surface as high vowels in all unstressed word boundary syllables (for some discussion of apparently lexically conditioned exceptions to the mid / high alternation, see the appendix to this paper).

(23)a **Mid/High Alternation in Initial syllables**

	motivo			motivação	
/motivo/	[mutʃívu]	'motive'	cf.	[motʃivasã́w̃]	'motivation'
	decidir			decisão	
/desidir/	[dʒisidʒíx]	'to decide'	cf.	[desizã́w̃]	'decision'
	conversa			conversação	
/konversa/	[kũvɛ́xsə]	'he converses'	cf.	[konversasã́w̃]	'conversation'

(23)b **Mid/High Alternation in Final Syllables**

/kɔxego/	[kɔ́xegu]	corrego,	'little stream, brook'
/bebado/	[bébədu]	bebado,	'drunk'

As can be seen in the examples in (23)a, stress shift creates alternations between high vowels in the left column and mid vowels in the right column. The mechanism responsible for these mid/high alternations does not trigger reduction of vowels specified for [- ATR] underlyingly. Thus, for instance, in the examples taken from (3) above (repeated here for convenience as (24)), we see that [- ATR] vowels do not undergo 'double raising':

(24)		/bɛl+ezə/	[belézə]	*[bilezə]	'beauty'
	cf.	/bɛlo/	[bɛ́lu]	*[belu], *[bilu]	'beautiful'
		/bɔl+ao/	[bolãw̃]	*[bulãw̃]	'big ball'
	cf.	/bɔla/	[bɔ́lə]	*[bolə], *[bulə]	'ball'

This suggests that only the [+ATR] vowels may be raised to [high] in an initial or final syllable. I propose that there is a word-boundary constraint which restricts the vowels in word boundary syllables from being specified for the feature [-high]. This constraint removes any [- high] feature from unstressed vowels in initial or final syllables. Subsequently the RR [ ] --> [+high] applies. The constraint is stated in (25).

(25) **Word-boundary Constraint**
* [- high] in unstressed boundary syllables in BP.

4.4 Summary

To sum up, the process of vowel reduction in BP has been shown to involve the removal of the feature [- ATR] from any unstressed position and the removal of the feature [- high] from unstressed word (boundary) positions. Furthermore, I have shown that the RU account of BP vowels provides a link between Redundancy Rules and vowel reduction. That is, after the removal of the feature [- high] from a vowel in a boundary syllable the RR [ ] ---> [+ high] inserts the feature high in that position. This analysis accounts for the neutralization of the mid/high distinction in word boundary syllables. The neutralization of mid and lower mid vowels and the complementary distribution between [a] and [ə] was also accounted for.

4.5 Some Phonological Rules and Rule Ordering

In this section I briefly show that other phonological processes operative in BP are compatible with a RU approach and I demonstrate how the constraints proposed above interact with other phonological rules in BP.

4.5.1 Palatalization

The place of articulation for coronal obstruents in BP varies depending on the environment. That is, /t/ and /d/ surface as [t] and [d] before [e, ɛ, a, ɔ, o, u] but they become [tʃ] and [dʒ] before the high front vowel [i]. Some examples are given below.

(26)	/tita/ [tʃítə]	/teta/ [tétə]	/diva/ [dʒívʌ]	/devo/ [dévu]
	'Tita'	'nipple'	'Diva'	'I ought'

These examples illustrate that /tʃ/ and /dʒ/ are derived from /t/ and /d/ in BP. That is, we might assume (following Sagey 1986) that the feature [+ high] from the vowel is imposed on the preceding consonant. The vowel reduction process must precede palatalization because the reduced vowel induces palatalization. This implies that the vowel /i/ must acquire all of its features prior to the palatalization. An example derivation is given below:

(27) mate, 'Paraguay tea'

/mate/	Underlying Representation
máte	Stress Assignment
máte	Word-boundary Constraint
máti	RR ([ ] --> [+ high])
[mátʃi]	Palatalization

To account for the fact that the high vowel is the null vowel (i.e., the featureless vowel) and yet triggers the palatalization of coronal obstruents in BP, we must assume that the Word-boundary Constraint first removes the feature [- high] from the unstressed word final vowel (as shown above), and then the RR inserts the feature [+ high]. Finally, /i/ triggers the palatalization of the coronal obstruent. To account for the rule ordering proposed above, I follow Archangeli's (1984:50) RROC principle:

(28) **The Redundancy Rule Ordering Constraint (RROC):**
A universal redundancy rule assigning [α F] (where α = + or -) is automatically assigned to the first stratum in which reference is made to [αF].

According to this principle, the default values corresponding to /i/are inserted in the V-slot prior to the application of the rule of palatalization. Thus, we observe that RU can be made compatible with the BP data in accounting for the rule of palatalization as long as we are willing to allow ordering of the phonological rules.

4.5.2. Vowel Harmony in First Person Singular Present Indicative

In this section I will show that vowels in BP verb stems may alter depending on the quality of the theme vowel.[5] This vocalic alternation, which is clearly visible in verbs in the first person present indicative form, is predictable in BP. The vowel which precedes the theme vowel in the first person singular present indicative agrees in height and ATRness with the theme vowel.

4.5.2.1 Verbs with /a/ as Theme Vowel

/a/ theme vowels spread the feature [- ATR] onto the preceding vowel in the verb stem. A few examples are given below:

(29)	[- ATR]	[- ATR]	[- ATR]	[-ATR]
	/ʃór + a + o/	/apel + a + o/	/err + a + o/	/kõsert + a + o/
	[ʃɔ́ru]	[əpɛ́lu]	[ɛ́xu]	[kõsɛ́xtu]
	'I cry'	' I appeal'	'I err'	'I fix'

The feature [-ATR] is blocked from spreading to the nasalized vowel [õ] in [kõsextu] by a constraint that does not allow a nasalized vowel to carry the feature [- ATR] (the constraint is formalized in Wetzels 1990). The evidence for the underlying representation proposed for the stems given above comes from the infinitival forms, which are given below.

(30) **Infinitival forms for /a/ theme verbs**

chorar	apelar	errar	consertar
[ʃoráx]	[əpeláx]	[exáx]	[kõsextáx]
'to cry'	'to appeal'	'to err'	'to fix'

Note that the spreading of the feature [-ATR] takes place only when the theme vowel which carries the feature [- ATR] is deleted. Since the theme vowel is retained in the

[5]The theme vowel is the final vowel in the infinitival form of regular verbs in Portuguese and it determines the conjugational class of the verb. The choice of theme vowel (/a/, /e/ or /i/) is lexically conditioned.

infinitival forms the spreading of the feature [- ATR] does not take place.[6] I assume that within the RU account adopted here, /a/ is underlyingly [- ATR]. Since [- ATR] spreading only occurs when the theme vowel deletes, I assume that theme vowel deletion occurs first and then the floating [- ATR] feature must reassociate to the preceding vowel. When the vowel does not delete, [- ATR] remains associated to the theme vowel. The account is thus compatible with the RU approach.

4.5.2.2 Verbs with /i/ as Theme Vowel

The variation in vowel quality of verb stem vowels that precede the theme vowel /i/ can be stated as follows:

The theme vowel /i/ spreads the feature [+ high] onto the preceding vowel in the verb stem. Some examples are given below:

(31)	(a)	/serv+i+o/	(b)	/dorm+i+o/ but	(c)	/part+i+o/
		[síxvu]		[dúxmu]		[páxtu]
		'I serve'		'sleep'		'I leave'

In (c) we observe that the assimilation rule has failed to apply. In this case, the assimilation rule is blocked by a universal filter repeated here as (32):

(32) *[+high, +low]

Note that all of the non-low vowels are affected by this process. Two more examples are given below to complete the paradigm of non-low vowels in BP:

(33)	/kobr+i+o/	/desp+i+o/
	[kúbru]	[dʒíspu]
	'I cover'	'I undress'

A RU account of this process would have to say that the vowel /i/ must be specified for the feature [+high] prior to the assimilation rule. The height assimilation rule spreads [+ high] onto mid and lower mid vowels but not onto the low vowel /a/.

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[6][- ATR] also fails to spread in deverbals. I do not have an account of this fact but perhaps they simply lack an underlying theme vowel.

[ʃóru]	[əpélu]	[éxu]	[kõséxtu]
'crying'	'appealing'	'mistake'	'concert'

In short, the processes described above demonstrate that the mid and lower mid vowels pattern alike in regards to rules that target the [- high] value (as shown in (31) & (33)). Furthermore, as expected, the vowel /a/ is not affected by these processes.

5. Vowel Reduction In Other Romance Languages

I will now consider the vowel reduction processes found in two related languages. I will discuss vowel reduction in Catalan and Raeto-Romance. The goal is to see if the analysis proposed for the BP data can be extended to the processes found in these languages. We will see that the vowel reduction processes found in Catalan and Raeto-Romance closely resemble the process found in BP.

5.1 The Catalan Data

The phonemic inventory of oral vowels in Catalan is identical to BP but there are only two vowel systems with respect to stress; a tonic system, in which all seven phonemic vowels appear and an atonic system, in which only [i], [u] and [ə] appear (as in the third system of BP). The Catalan data comes from Mascaró 1974:

(34) **Vowel Systems in Catalan**

a **Tonic**

i i
e o
ɛ ɔ
a

b **Atonic**

i u
ə

The full set of phonemic vowels given in (34)a is allowed only in stressed positions. A few examples are given in (35)a.

(35)a	[prím]	'thin'
	[sérp]	'snake'
	[pɛ́l]	'hair'
	[sák]	'bag'
	[pəɾ]	'for'
	[pɔ́ɾt]	'harbor'
	[gós]	'dog'
	[ʎúm]	'light'

In unstressed syllables, only two of the phonemic vowels are allowed along with schwa, as shown in (35)b.

(35)b	[əprimá]	'to make thin'
	[sərpɔ́tə]	'big snake'
	[pəlút]	'hairy'
	[səkɛ́t]	'small bag'
	[purtuári]	'related to harbor' (adj.)
	[gusás]	'big dog'
	[ʎuminoś]	'light' (adj.)

Note the alternations between (35)a and (35)b. The related forms presented in (36) further demonstrate that the feature [- ATR] is not allowed in unstressed position:

(36)	/fotɔ/	[fótu] 'photo'	cf.	[fótɔgrəf]	'photograph'
	/numɛr/	[numərál] 'number'		[numɛ́rik]	'numerical'
	/po/	[pó] 'fear'		[purúk]	'fearful'

As we observe from the data, the vowel reduction process in Catalan resembles the one found in BP. It appears to involve the removal of the feature [- ATR] from any unstressed position. However, despite the fact that the end result of vowel reduction in Catalan is the same as the tonic and boundary systems of BP, the vocalic alternations in Catalan must be assumed to involve slightly different feature specifications because the epenthetic vowel in Catalan is [ə] and not [i] (as in BP). The vocalic reductions found in Catalan are summarized below:

(37) /a/ --> [ə]
/e/ --> [ə]
/ɛ/ --> [e] --> [ə]
/i/ --> [i]
/u/ --> [u]
/o/ --> [u]
/ɔ/ --> [o] --> [u]

Note that lower mid vowels undergo 'double reduction' as in the following examples:

(38)	[flɔ́] 'flower'		[flurɛ́tə]	'small flower'
	[kafɛ́] 'coffee'		[kəfətəríə]	'coffeehouse'

In terms of feature specification within a RU analysis, I assume that the following features are present underlyingly in Catalan:

(39)

	i	e	ɛ	a	ɔ	o	u	(ə)
Low				+				
ATR			-	-	-			
High	+						+	
Round					+	+	+	
Back	-	-	-					

The set of RRs that I propose for Catalan is given in (40).

(40) [ ] ---> [+ ATR]
[ ] ---> [- Low]
[ ] ---> [- Round]
[ ] ---> [+ Back]
[ ] ---> [- high]

We observe from the feature specifications given above that schwa is the featureless vowel in this system. The vowels [ɛ, ɔ, a] form the set of [- ATR] vowels in Catalan. The assumption that these vowels form a natural class is motivated by the fact that they are not allowed in unstressed position. According to the system given in (39), the underlying feature specification that they all have in common is [- ATR]. When the feature [- ATR] is removed, the distinction between mid and lower-mid vowels is neutralized (i.e., [ɛ, ɔ] become [+ ATR] via the first RR given in (40) above. Likewise the allophonic variations between [a], [ɛ], [e] and [ə] are captured by the presence versus absence of [-ATR]. The feature [back] is not predictable from the feature [round] in Catalan. That is, unlike BP, Catalan has two back unrounded vowels [a] and [ə].

A preliminary formulation of the process of vowel reduction in Catalan is given below:

(41) i. [- ATR] --->Ø/_________ ε ---> e
[-stress] ɔ ---> o
a ---> ə

ii. [-back] ----> Ø/__________ e ---> ə
[-high] [-stress]

iii. [+ low] ---> Ø/ __________ a---> ə
[- stress]

iv. [+ round] ---> [high] /_______ o ---> u
[-stress]

As noted above, the epenthetic vowel in Catalan is [ə]. RU predicts that the null vowel and the epenthetic vowel should be the same. The difference between BP and Catalan is that in Catalan [ə] is inserted by the rules of syllabification or by reduction of /a/, /e/ and /ε/; whereas in BP it is only derived by reducing the low vowel /a/ in unstressed position. Thus it is reasonable to assume that [ə], the epenthetic vowel in Catalan, has a surface representation which differs considerably from [ə] in BP. A second major difference between the process of vowel reduction in BP and Catalan is that the process of vowel reduction in BP was characterized by the removal of some features (i.e., [- ATR] and [- high]) from unstressed position whereas in Catalan the process of vowel reduction cannot be characterized simply by the removal of features. The feature [round] in Catalan appears to play some role in the vowel reduction process. That is, unrounded vowels in unstressed position are centralized but the rounded vowels are raised to [+ high]. At this point this extra condition on vowel reduction in Catalan must stand as a stipulation.

5.2 The Raeto-Romance Data

The segment inventory of Raeto-Romance is identical to that of BP and Catalan. The two vowel systems found in Raeto-Romance are given below and are the same as Catalan although the constraints upon them will be shown to be slightly different (data from Kamprath 1991).

(42)a **Stressed Positions** b **Unstressed Positions**

a. Stressed Positions		b. Unstressed Positions	
i	i	i	u
e	o	ə	
ɛ	ɔ		
a			

The vocalic alternations found in Raeto-Romance are given in (43).[7] Underlying forms when unstressed undergo the following changes:

(43) /ɛ/ --> [ə]
/ɔ/ --> [ə]
/a/ --> [ə]
/e/ --> [i]
/i/ --> [i]
/o/ --> [u]
/u/ --> [u]

Based on the vocalic alternation illustrated above, a possible RU account of the Raeto-Romance vocalic system is as follows:[8]

(44) Feature Specifications

	i	e	ɛ	a	ɔ	o	u	(ə)
high		-				-		
Low			+	+	+			+
Back					+	+	+	
ATR			-	-	-			

(45) Redundancy Rules
[ ] -->[+high]
[ ] -->[- low]
[ ] -->[- back]

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[7] Unfortunately these alternations must be taken on faith because Kamprath does not provide any examples.

[8] Kamprath does not tell us what the epenthetic vowel is in Raeto-Romance and I have not been able to determine what it is. I will assume here that it is [i] .

Since the features [- ATR] and [- high] are apparently licensed only under stress in Raeto-Romance, the rules for the characterization of the process of vowel reduction in Raeto-Romance are given below:

(45)

a. [- ATR] ---> Ø /________
[- stress]

b. [- high] ---> Ø /_______
[- stress]

The vowels [ɛ, ɔ, a] in Raeto-Romance behave exactly like the vowels [ɛ, a] in Catalan. They all become schwa in unstressed position. The mid vowels, on the other hand, behave exactly like the mid vowels in BP. That is, mid vowels raise to [+ high] in unstressed position. Note that unlike Catalan, the vowel reduction process in Raeto-Romance can be described solely by feature removal rules. First the feature [- high] is removed from unstressed position. Then the redundancy rule applies and raises the mid vowels to high. [-ATR] is removed from unstressed positions. The removal of [- ATR] derives schwa, which is a [+low] vowel.

6. Radical Underspecification and Vowel Reduction

In examining the phonological systems of Catalan, BP and Raeto-Romance, we observe that these three languages have identical sets of vowels but do not have identical sets of features present in their underlying representation. A crucial key to determining underlying features has been provided by the assumption that the epenthetic vowel in a given language is also the featureless vowel in that language. Variation in underlying features explains the fact that the vowels [ɛ, ɔ, a] form a natural class in both Catalan and BP. They form the set of vowels underlyingly specified for the feature [- ATR]. In Romance, however, the same vowels [ɛ, ɔ, a] form the class of low vowels. Thus the vocalic alternations observed in these languages conform to what the theory of Radical Underspecification allows. The RU analysis proposed for each of these languages is based on the output of language specific phonological rules. We have also seen that it is the features underlyingly present in the vocalic system of each language that govern the alternation from tonic to atonic positions. The facts drawn from these three languages indicate that the notion of natural class relevant for vowel reduction varies slightly from language to language. Languages like Catalan seem to remove the features [- back] and

[- ATR] while languages like Raeto-Romance and BP remove the feature [- ATR] to characterize related alternations.

It was also shown that the process of vowel reduction in these three languages can largely be characterized by the *removal* of features from unstressed positions. A clear link between vowel reduction and insertion of default values by the RRs was also established, suggesting that RU should be the preferred framework to account for the vowel reduction processes found in these three languages. The reason for this assertion is that the amount of information underlying present in the representation of each segment is reduced to the minimum necessary, as encapsulated in the Feature Minimization Principle (Archangeli 1984). If one underlying feature value is sufficient to account for the data, there is simply no reason to postulate both values underlyingly. Indeed it may even turn out to complicate the analysis.

7. Conclusion

This preliminary study has shed some light on the vowel reduction processes found in three romance languages and an internally coherent description of vowel reduction within the framework of Radical Underspecification (Archangeli & Pulleyblank 1986) was provided. However, three crucial questions arising from the analysis remain unanswered. Firstly, the account provides no formal link between stresslessness and loss of feature specification. Secondly, there is no formal explanation for the relevance of some features rather than others in vowel reduction; why, for example, should [ATR] and [high] be affected by destressing in BP and Romance but [back] and [round] in Catalan? Thirdly, the Word-boundary Constraint appealed to in accounting for the three vowel systems in BP lacks independent motivation. It is not clear why a syllable at a boundary should be more susceptible to vowel reduction than a word internal syllable. Current phonological representations seem to provide little or no means of answering these questions in an insightful way at present. I hope that this paper at least helps to provide a basis for examining these deeper questions.

Appendix - Optional Cases of Vowel Reduction in BP

One idiosyncrasy of pretonic vowels in BP is the fact that (in some dialects at least) there are a number of lexical items in which we see /e/ alternating with /i/ and /o/ with /u/ in pretonic position. Within the class of words that have mid vowels in pretonic position there are three subdivisions with respect to vowel reduction; a class in which the mid/high vowel reduction is obligatory, a second class in which the same alternation is optional and a third class in which vowel reduction is impossible. A few examples illustrating cases of obligatory vowel reduction are given in (i) below:

(i) **Obligatory Alternation**

/teatro/	[tʃiátru]	*[teatru]	'theater'
/veado/	[viádu]	*[veadu]	'deer'
/ʒosɛ/	[ʒuzɛ́]	*[ʒozɛ̃]	'Joseph'
/koeʎo/	[kuéʎu]	*[koeʎu]	'rabbit'
/koar/	[kuáx]	*[koax]	'to filter'
/boato/	[buátu]	*[boatu]	'rumor'

Since there is no evidence in the language for a synchronic raising rule applying to these vowels, I assume that these cases involve a diachronic change. The evidence for the diachronic change comes from the more conservative spelling and from the fact that there are some dialects of BP in which the unstressed vowels in these position are not raised. For instance, the dialects of BP spoken in the northeast of Brazil would have the pronunciation of the lexical items given in (23) in the rightmost column (which are starred in my dialect, which forms the basis for this paper).

Alongside the above examples, there are instances of mid vowels in prevocalic position that may not undergo the vowel reduction process. Some examples involving impossible vowel reduction in prevocalic position are given below:

(ii) **Impossible Alternation**[9]

/poesia/	[poéziə]	*[pueziə]	' poem'
/doasãõ/	[doəsə̃w̃]	*[duasə̃w̃]	' donation'
/ʒeada/	[ʒeádə]	*[ʒiadə]	' frost'
/sear/	[seáx]	*[siax]	'to dine'
/peãõ/	[peə̃w̃]	*[piə̃w̃]	'workman'

Finally, there are also instances of mid vowels in prevocalic positions where the vowel raising appears to be optional. A few examples are given below:

[9] Note that these cases involves proto-romance consonants between vowels, except 'poezi'', as pointed out to me by Donca Steriade (p.c.).

(iii) **Optional Alternation**

/moeda/	[muɛ́də]	[moɛ́də]	'coin'
/seara/	[siərá]	[seərá]	'proper noun'
/poeira/	[puéirə]	[poérə]	'dust'
/toaʎa/	[tuáʎə]	[toáʎə]	'towel'
/ʒoeʎo/	[juéʎu]	[joéʎu]	'knee'

It is not clear to me how to account for these variations in the mid/high alternation process within recent frameworks because the variation is lexically conditioned. I will leave the status of these variations for a future study. As for now, I am assuming that this phenomenon is part of a historical process that is still in progress in the language.

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PREDICTABILITY IN GARIFUNA VOWEL ALTERNATIONS: A PROBLEM FOR RADICAL UNDERSPECIFICATION

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0. Introduction

This paper discusses several vowel alternations in Garifuna, an Arawakan language spoken in Central America, which present a basic problem for Radical Underspecification theory, as developed by Archangeli (1984) and Archangeli and Pulleyblank (1986), among others. Rule-governed alternations in the high vowels of Garifuna will be shown to be incompatible with fundamental tenets of Radical Underspecification. While Radical Underspecification theory might be adapted to account for the Garifuna data, such adaptations considerably weaken the theory.

Under the present analysis, underspecification does not result from a requirement to reduce the amount of information allowed in the underlying representation, as in Radical Underspecification. For the Garifuna case, underspecified segments are restricted to certain "harmonic" morphemes or result from the epenthesis of melodically un(der)specified prosodic slots.

1. Radical Underspecification

A distinguishing characteristic of recent formulations of Radical Underspecification is the concept of Feature Minimization . Archangeli (1984) defines Feature Minimization as a condition on the relative economy and value of (potentially) competing grammars.

> "A grammar is most highly valued when underlying representations include the minimal number of features necessary to make different the phonemes of the language." (Archangeli 1984, p. 50)

A corollary to Feature Minimization is that every grammar will have one completely underspecified segment, one whose features will be determined completely by context-free feature fill-in rules. These rules provide the complementary feature values to the underlyingly available feature values for those segments which remain unspecified for a given feature. This is in many ways similar to earlier conceptions of underspecification. Halle (1959) invoked underspecified representations to reduce the number of marks necessary to distinguish one form from another for purposes of efficient memory storage in the lexicon. Halle's conception of underspecification immediately filled in all features prior to entering the phonological rule component. However, in Radical Underspecification, underspecified representations persist throughout the derivation for as long as possible.

Redundancy Rules, rules which fill in a value for some feature [F] in predictable environments, are universally preferred to be ordered last in the lexical phonology. However, in the versions of Radical Underspecification being discussed here, they must be reordered to occur immediately before the first 'real' phonological rule which mentions feature [F]. This is accomplished by the Redundancy Rule Ordering Constraint (Archangeli, 1984), which has the effect of obviating any difference between underlyingly specified and redundantly specified segments at every relevant level of representation.

In models where vowel epenthesis is a process in which a melodically unspecified vowel slot is inserted into a string, the default features of an epenthetic vowel must be specified by context-free fill-in (default) rules, which are also ordered as late as possible (although other surface realizations of such an unspecified vowel might result from the prior application of other phonological rules). In Radical Underspecification this completely unspecified epenthetic vowel will be equivalent to the completely featureless underlying segment predicted by Feature Minimization at every relevant level of representation. The default values of language-particular underspecified representations are therefore trivially recoverable from the positive evidence of epenthesis, and information about the available underlying feature values is freely available to the language learner.

2. Garifuna Vowel Alternations in a Radically Underspecified Phonology

2.1 Background

Garifuna is an Arawakan language spoken by some 30,000 speakers in Central America, particularly Guatemala, Honduras, and Belize (Taylor, 1987). Spoken originally on the island of St. Vincent by displaced Africans who intermarried with a native Arawakan population, the Garifuna were deported to Honduras in the late 18th century. Garifuna has a long history of contact with other languages, both colonial and native, many of which have different syllable structure requirements than Garifuna. The language has an extensive loan vocabulary of varying degrees antiquity and nativization.

Garifuna has 16 consonant phonemes and six vowel phonemes. Two of the phonemes (the voiced postalveolar affricate /ʤ/, written <j>, and the mid, back vowel /o/)

are restricted to loanwords. While words with <j> are quite rare and are always judged as foreign-sounding by the native speaker, words with phonemic /o/ are rather common and seem not to strike Garifuna speakers as unusual. The phonemes of Garifuna are presented in (1) in the UCLA orthography, which is based on one proposed by Cayetano (n.d.). Garifuna stress and vowel nasalization are phonemic.

(1) Phonemic inventory in UCLA orthography

Consonants:

p,b	t,d	ch,j	k,g	
f	s			
m	n			
	l			
w	r	y		h

Vowels:

i		u, ü	(<ü> = IPA [ɯ])
e		o	
	a		

Additional orthographic conventions:
stress = v́ (ǘ = û) nasalization = Vn

The standard featural representations (Chomsky and Halle, 1968) of the vowels are given in (2). In particular, note the presence of three high vowels in the inventory, indicated in bold italics in (2): front, unround [i]; back, round [u]; and back, unround [ɯ], written <ü>.

(2) Garifuna vowels, as fully specified SPE feature matrices

Orthographic:	***i***	e	a	o	***u***	***ü***
high:	+	–	–	–	+	+
low:	–	–	+	–	–	–
back:	–	–	+	+	+	+
round:	–	–	–	+	+	–

2.2 *A Radically Underspecified account of stem final epenthesis*

According to Radical Underspecification, by examining a productive rule of vowel epenthesis, a language provides positive evidence as to what feature values are provided by default rules and which are underlyingly present. Garifuna stem-final epenthesis is just such a rule.

Garifuna allows only open syllables and very few onset clusters in its native and nativized vocabulary. It tolerates certain consonant clusters word-medially in recent borrowings, but does not allow syllables to be closed word-finally. In recent borrowings and proper names with closed final syllables, [i] or [u] is epenthesized to the end of the stem.

When the stem-final consonant is labial, the epenthesized vowel is [u], as in (3). The labial consonants have the expected phonetic values -- [p], [b] and [m] are bilabial, [f] is labiodental, and [w] is labiovelar. These consonants behave as a class for purposes of several rules, including those discussed here (Hagiwara, 1992).

(3) Stem-final epenthesis after a labial

néfu̲	['ne fu̥]	'nine'	< Fr. *neuf* 'nine'
Garífu̲na		'Garifuna'	cf. "Carib" + *-na* (attributive, 'from a place')
pásam-u̲		'possum'	< E. *possum*
Pam-u̲			(proper name)
Rob-u̲			(proper name)

When the stem-final consonant is not one of the labials, as illustrated in (4), the epenthetic vowel is [i].

(4) Stem final epenthesis after a non-labial

a-féindi̲-ha-t-i	[a 'fə̃́ĩ di ha ti̥]	'painter (m); he paints'	< E. *paint*
inglés-i̲	[ĩ 'gle si̥]	'English, Briton'	< Sp. *inglés* 'English'
John-i̲		(proper name)	
Jonathan-i̲		(proper name)	
Shantel-i̲		(proper name)	

The generalization to be made is clear. The [u] quality of this vowel arises as a result of assimilation to the labiality of the adjacent consonant. A Redundancy Rule such as "[+round] → [+back]" will ensure the derivation of a back vowel when the epenthetic vowel is labial. The features of the [i] quality, minimally [+high, –back], will be filled in by late default rules. The features [–high] and [+back] are thus identified as the values expected in underlying representation. The addition of the feature [+round], allows Radical Underspecification to distinguish the six vowels of Garifuna, as demonstrated in (5).

(5) Garifuna vowels as Radically Underspecified feature matrices

Orthographic:	i	e	a	o	u	ü
high:		–	–	–		
back:			+			+
round:				+	+	

(5) again uses standard SPE feature values. The analysis would have to be altered slightly if [round] is taken to be privative or a phonetic reflex of a LABIAL class node in a vocalic segment, but this would not change the argument significantly. If low, central /a/ is taken to be neither front nor back (and therefore could not be considered [+back]), the feature [+low] would have to be added. However, Feature Minimization would disallow the use of four features to distinguish only six vowels, since only three should be necessary. Three binary features can, of course, distinguish up to eight categories; four binary features can distinguish sixteen categories. While gaps in inventories are not necessarily disallowed in Radical Underspecification, Feature Minimization would require the removal of a feature when doing so would reduce the number of gaps.

Given such a vowel system, Garifuna stem-final epenthesis would follow the sequence in (6).

(6) Derivational steps in stem-final epenthesis

a. epenthesize an empty vowel slot to satisfy lexical syllable structure constraints
b. spread [+ round] (or LABIAL) to empty vowel slot
c. [+back] $\rightarrow$ [+low] (Redundancy Rule)
d. [+round] $\rightarrow$ [+ back] (Redundancy Rule)
e. context-free default rules (to complete derivation of [u]; derive [i])

Radical Underspecification makes one further prediction for Garifuna. The status of [i] as the 'default' surface quality of a clearly epenthetic vowel suggests that underlying /i/ (or rather, melodically featureless vowel slots in morphemes which surface as [i]), while potentially the target of assimilations, cannot trigger or block assimilation rules precisely because it is featureless.

2.3 A problem for Radical Underspecification: possessive prefix alternation

Garifuna marks possessed nouns with a prefix which surfaces either as [i] or [u]. The possessed noun is generally then prefixed again with a person marker which identifies the possessor. On occasions when the person, number, and gender features of the possessor are unavailable, such as in WH-forms exemplified in (7), the prefix appears on the noun by itself. This vowel is thus identified as a morpheme rather than the result of epenthesis between a consonant-initial stem and a consonantal prefix.

(7) Possessive prefix in WH-constructions

ká <u>i</u>-gárada	'whose book?'	cf. *ká gárada* 'what book, which book?'
ká <u>u</u>-péni	'whose pen?'	cf. *ká péne* 'what pen, which pen?'

The alternation of the final vowel in *péne* 'pen' when possessed is part of a process described by Taylor (1956), in which possessed nouns are distinguished from unpossessed nouns by several processes that effect the final vowel of the noun stem. The fact that this alternation occurs will be of some importance in Section 3 of this paper, but the details of this and other phonological alternations in the data which do not directly bear on the discussion of underspecification will not be commented on. Many are discussed in Hagiwara (1992).

As (7) suggests, the conditions which determine the surface quality of the possessive prefix vowel are similar to those which determine the quality of stem-final epenthetic vowel. When the following (stem) consonant is labial (8), [u] surfaces. If the stem consonant is not labial (9), then [i] surfaces. In most of the examples which follow, the possessive prefix is preceded by the first person singular prefix, *n-*.

(8) Possessive prefixation before a labial

nupéni	'my pen'	<	péne	'pen' (< E. *pen*)
nubésina	'my neighbor'	<	besína	'neighbor' (< Sp. *vecino*)
nufáluma	'my coconut'	<	fáluma	'coconut' (< Sp. *palma* 'palm')
numúrisi	'my murisi (palm)'	<	murísi	'murisi palm'
nuwéyali	'my man'	<	wéyali	'man'

(9) Possessive prefixation before a non-labial

niléma	'my wood/my fire'	<	léma	'wood/fire'
niháti	'my (special) month'	<	háti	'month, moon'
ninádiri	'my plant'	<	nádiri	'plant'
nigárada	'my book'	<	gárada	'book' (< Sp. *carta* 'letter')

However, there is an additional twist to the possessive prefix alternations. When the stem consonant is labial but it is followed by an underlying /i/, the surface quality of the prefix vowel is not [u], but [i]. This is illustrated in (10).

(10) Possessive prefixation before a labial which is followed by /i/

nibímena	'my banana'	<	bímena	'banana'
nimíbi	'my vine'	<	míbi	'vine'
nifíyadü	'my dollar'	<	fiyádaü	'dollar' (< Sp. *fiado* 'credit')

This presents a dilemma for Radical Underspecition. On the one hand, the strongest form of Radical Underspecification requires that no "underlying /i/" should be more fully specified than any other surface [i] at any level of representation. In particular, the /i/ of the stem should not have any features that the underspecified prefixal vowel (ultimately [i]) does not have.

On the other hand, the /i/ in the stem seems to bleed assimilation or spreading of the labial features from the consonant onto the prefixal vowel. The obvious way to block the association of labiality features from the stem consonant onto the prefix is to first have assimilated the prefix to some feature of the stem vowel with which [+round] is incompatible, perhaps [–back]. By invoking Structure Preservation (Kiparsky, 1985) or otherwise disallowing [+round, –back] segments, labial assimilation will fail to take place, and the default features of [i] will be filled in.

This requires /i/ in a stem have feature specifications other than the [i] of the prefix. If this is so, then underlying /i/ cannot be featureless, and thus neither the [i] quality of the possessive prefix nor the stem-final epenthetic vowel provide any explicit clues as to the underlying features available in lexical entries. This directly violates a very basic assumption of Radical Underspecification theory.

3. Underspecification Is Restricted to Certain Morphemes

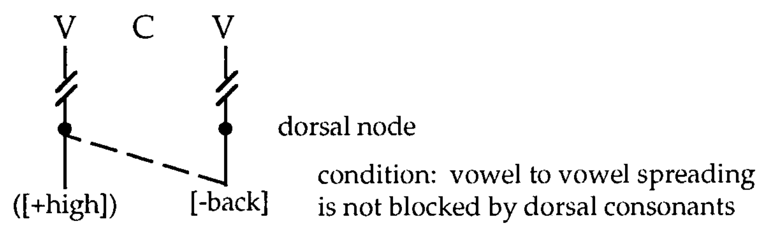
Retreating from Radical Underspecification, the question remains how best to deal with the Garifuna data. The concept of Feature Minimization must certainly be abandoned. Certain other assumptions made in Radical Underspecification should be preserved. These include assimilation as spreading of features, assimilation as feature-filling rather than feature-changing, and Structure Preservation.

Since rounding of the prefixal vowel and the stem-final epenthetic vowel is assimilatory, the natural solution is to spread the relevant feature ([+round] or a LABIAL class node), in a feature filling manner, and to allow this to guide the remaining feature-filling rules. Further, because the condition in which rounding does not apply is exactly the case where the stem vowel is identical to the ultimate surface quality of the prefix, it is fair to assume that this too is due a kind of assimilation -- a non-local assimilation, or harmony.

By allowing morphemes to differ in the degree to which they are fully specified, a grammar arises in which some morphemes are targets of local assimilations or harmonies, and others are not. Non-alternating /i/ in Garifuna stems is fully specified; the possessive prefix, like the non-morphemic epenthetic vowel, is melodically underspecified. Under this view, underspecification is a property of particular morphemes or classes of morphemes in Garifuna, rather than a property of the phonological grammar *per se.*

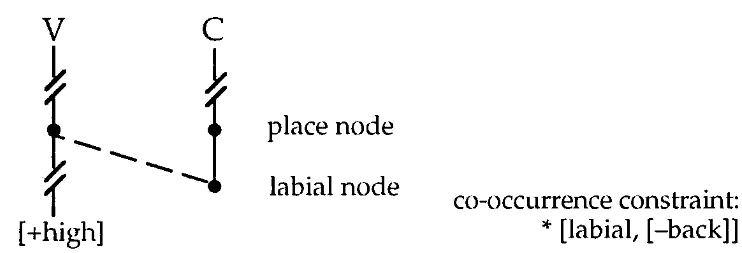
An analysis along these lines would require two rules. The first rule assimilates the possessive prefix to a following /i/ in the stem by spreading [–back]. In a feature geometry model such as proposed by Sagey (1986), such a rule might take the form in (11).

(11) Fronting



Fronting will not only result in the prefix vowel assimilating to the [–back] feature of the stem vowel, it will have the effect of bleeding the rule in (12), which spreads the LABIAL class node from the consonant onto a preceding underspecified vowel, subject to the constraint that the output cannot be an illicit [+round, –back] vowel.

(12) Rounding



The status of [+high] in these rules is at present unclear. Having abandoned Radical Underspecification and the requirements of Feature Minimization, there is no particular reason to exclude [+high] from the prefix. Doing so might well aid in identifying contrastive and non-contrastive environments for the more 'active' features, as in Contrastive Underspecification (Steriade, 1987). In Garifuna, [o] is of indeterminate status phonemically, and does not alternate with [e]; neither appears in prefixes. The alternations expressed in (11) and (12) may thus be restricted to high vowels. In general, the mid vowels do not appear as prefixes, except as the result of some other phonological rule (Hagiwara, 1992).

(11) and (12) are not the only possible formulations of these rules. This discussion is primarily intended to demonstrate the feasibility of such an approach. The precise formulations, including feature values, conditions and filters are not of primary concern to this paper, as they do not bear on the question of underspecification, but on feature geometry, privativity, and other issues.

When neither rule applies, the prefix vowel remains underspecified. Thus recourse to some kind of 'default' rule, specifying the features of [i] just in the case when no other features are available, is still necessary. This is not necessarily an undesirable result, since additional evidence suggests that in fast or casual speech, other high vowel qualities may 'spread' over a dorsal consonant onto the underspecified vowel (13).

(13) 'Unexpected' vowel qualities in fast speech

[nu̲ 'gu sĩ j̃ũ]	<	*nigúsiyun*	'my knife'	(< Sp. *cuchillo*)
[nɯ̲ 'gɯ̃ĩ wi]	<	*nigûnwi*	'my fish hook'	

(13) is explained by adopting the view of Keating (1988), that some forms of underspecification persist not only through the phonology, but into the phonetic component as well. It is only in the case when neither of the rules in (11) or (12) can apply to a possessive prefix when forms such as in (13) surface.

It might also be noted that the Rounding rule in (12) need not be directional. In the case of stem-final epenthesis, when the blocking rule in (11) has never been observed to apply, Rounding applies left-to-right. Rounding does not apply left-to-right, however, on the cycle which prefixes the person marker to the possessed form. In particular, the second person singular prefix, *b*-, does not trigger Rounding on an otherwise unspecified possessive prefix, that is, one to which neither Fronting nor Rounding could apply on an earlier cycle, as in (14).

(14) Second person singular possessives

binádiri	'my plant'	<	*b* + *V* + *nádiri* 'plant'	cf. *bunádiri
bigárada	'my book'	<	*b* + *V* + *gárada* 'book'	cf. *bugárada

This does not pose a problem for this analysis. Fronting and Rounding are likely to be early lexical rules (Hagiwara, 1992). The person markers, being inflectional, are likely to be affixed at a later lexical level than the one at which Fronting and Rounding apply. The WH-constructions in (7) suggest that marking a noun as possessed may be derivational in Garifuna. Possessed nouns appear to undergo a number of phonological rules (Taylor, 1956; Sands, 1991), which may be explained by possessive prefixation occurring relatively early in the lexicon. If this is so, assigning the possessive prefix to a higher morphological level than the person markers explains why Rounding may not be triggered by the second person singular prefix. Similarly, stem-final epenthesis probably occurs relatively early in the lexicon, since it is presumably the result of lexical syllable structure conditions.

4.0 Conclusion

This paper has presented data which require an analysis in which an underlying vowel must be more fully specified than an epenthetic vowel of the same surface quality, contrary to the assumptions of Radical Underspecification (Archangeli, 1984; Archangeli and Pulleyblank, 1986). Setting the assumptions of Radical Underspecification aside, an analysis has been proposed which nonetheless makes use of underspecified representations, but ones which do not result from an arbitrary requirement to reduce the number of marks in the lexicon.

In Garifuna, a melodically underspecified segment may be introduced by epenthesis to satisfy independently motivated requirements of syllable structure. Additionally, at least one particular morpheme, the possessive prefix, is lexically "harmonic"; it is the target of assimilatory spreading of features because it comprises a melodically underspecified segment. Whether this kind of underspecification is cross-linguistically specific to particular morphemes or morpheme classes, or can be derived from lack-of-contrast concerns or co-occurrence constraints for given segments, morphemes, prosodic positions, etc., as suggested by Contrastive Underspecification (Steriade, 1987), remains to be seen.

Underspecified morphemes become the targets of assimilations. The assimilation rules associated with alternations in such morphemes may be general, as in the case of Garifuna, specifying not only harmonic features in underspecified morphemes, but default features in unspecified segments produced by prosodic structure (i.e. epenthetic vowels).

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THE POSITION OF [LATERAL] IN FEATURE GEOMETRY*

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1. Introduction

Two approaches to the position of the feature [lateral] have been proposed in recent literature. Based on laterals' restriction to the coronal place, Levin (1988) argues that the feature [lateral] is a place-dependent of the coronal node. In contrast, Rice and Avery (1991) and Shaw (1991) argue that [lateral] resides higher in the feature tree (Rice and Avery put [lateral] under the spontaneous voicing node, while Shaw treats it as an immediate daughter of the root node.) In this paper, I will focus on the question whether [lateral] is under coronal or higher in the tree.

To compare the two theories, I will consider the following questions. Does the position of [lateral] within the repective theories match its functional role? How do the theories capture feature cooccurrence restrictions? How do they explain phonological phenomena in which laterals pattern with coronals? How do they explain phonological phenomena in which laterals do not pattern with coronals? How do they explain phonological phenomena in which laterals pattern with other sonorant consonants such as nasals? Are they compatible with underspecification theory? The discussion of the above questions will lead us to the conclusion that [lateral] should be treated as a root dependent, not a coronal dependent feature.

2. Functional Role

As discussed in Rice and Avery (1991), the status of [lateral] as a place dependent is at odds with the general assumptions in which [lateral] is treated as a manner feature. It seems obvious that [lateral] characterizes different phonetic properties from the usual place features such as labial, dorsal, anterior, etc. which typically characterize the specific articulator involved in sound production. If this fuctional aspect of [lateral] in phonetics is considered, it would be more plausible to position it higher in the tree, like the feature [nasal].

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3. Restriction to Coronal

Laterals typically do not occur with places other than coronal. Within Levin's (1988) theory, this cooccurrence restriction is captured directly in the structure of feature geometry. Since [lateral] is a dependent of coronal, it cannot be linked to other place nodes. Rather, any reported case of non-coronal laterals would be a counterexample to Levin's theory. According to Levin (1988), some velar and palatal laterals have been reported. She attempts to avoid this problem by assuming complex articulations for them:

(1) velar laterals as complex corono-dorsal segments (Levin 1988:12)

```
[lateral]
    |
Coronal  Dorsal
      \   /
      Place
```

Since Levin assumes a complex corono-dorsal representation for both velar and palatal laterals, I will just focus on the velar laterals in the following discussion without losing any important generalizations.[1] Levin does not mention any other non-coronal laterals. I am not aware of any other non-coronal laterals, either. If the above representation is correct, why are other non-coronal laterals not reported? In principle, any articulator can form a doubly-articulated segment with coronal (dominating [lateral]). What is more interesting is why only velar, not labial, can form a doubly-articulated segment with coronal dominating [lateral]. This seems to have something to do with the possible range of laterals. Let us consider the definition of [lateral] by Chomsky and Halle (1968):

(2) Lateral sounds are produced by lowering the mid section of the tongue at both sides or at only one side, thereby allowing the air to flow out of the mouth in the vicinity of the molar teeth....

It is obvious that laterals should involve the tongue as an articulator. Thus, according to the definition of [lateral], dorsals can have laterality even though the possibility is low compared with coronals which involve the laminal part of the tongue. In contrast, labials have no chance to be laterals since they do not involve any part of the tongue in the

[1] In distinguishing between velar and palatal laterals, Levin (1988:34) states,"... the mere presence of specifications for [anterior] and [distributed] distinguishes such palatal laterals from velar laterals which lack specifications for [anterior] and [distributed]."

articulation. In other words, the existence of velar laterals and the nonexistence of labial laterals do not seem to be an accident, as it would be in Levin's analysis of velar laterals: if velar laterals are actually doubly-articulated, labial laterals are also predicted. In other words, velar laterals are real velar laterals, which is predicted from SPE definition of [lateral]. Consequently, the approach assuming [lateral] as a coronal dependent cannot provide a plausible account for velar laterals.

We are now in a position to discuss how an approach positioning [lateral] high in the tree deals with the coocurrence restrictions on laterals. Since this approach allows [lateral] to cooccur with any articulator, the universal marking condition such as (3) has to handle the feature cooccurrence restrictions.

(3) *[lateral, labial or dorsal]

This constraint allows only coronal laterals. This kind of universal condition is commonly used in the current phonology to capture feature cooccurrence restrictions. For instance, the constraint *[+son, -voice] excludes the possibility of voiceless sonorants. Thus, positing the constraint (3) seems plausible. There is an advantage to this kind of marking condition compared to Levin's (1988) proposal in which non-coronal laterals are structually excluded in the geometry tree. The stages of the derivation in which the marking condition applies can be defined. Also, the point in which the application of the condition ceases can be defined. Thus, it is open to the possibility in which the condition does not hold. More specifically, laterals with a place other than coronal, velar laterals, can be derived.

Consequently, the existence of velar laterals can be a serious problem for the approach assuming [lateral] as a coronal dependent feature, while it can be easily couched in the approach positioning [lateral] high in the tree.

4. Phonological Behavior

4.1. Coronal Behavior

Laterals pattern with coronals in a number of phonological phenomena. To consider how the two theories can deal with the coronal behavior of laterals, I will discuss Selayarese nasal assimilation, discussed by Levin (1988). This discussion will be closely bear on the discussion in section 3.

(4) Selayares Nasal Assimilation (Mithun and Basri, 1985, from Levin)

g. annam poke '6 spears'

h. annan tau '6 persons'
i. annan rupa '6 kinds'
j. annaŋ jaran '6 horses'
k. annaŋ koko '6 gardens'
l. annal loka '6 bananas'

The final nasal assimilates in place to the following consonant. Notice that in (4l), the nasal completely assimilates to the following lateral. Within the approach assuming [lateral] as a coronal dependent, this lateral assimilation results from regular place assimilation since whenever place (more specifically coronal) spreads, its dependent, [lateral] has to spread. Thus, the feature geometry itself predicts this kind of place assimilation with [lateral].

The approach positioning [lateral] high in the tree has to treat this place assimilation in a more complicated way, since the spreading of [lateral] will have to follow place assimilation separately. Thus, Levin's theory is more successful since any motivation for independent lateral spreading is not known. In section 4.3., I will deal with lateral assimilation independent from place assimilation.

4.2. Noncoronal behavior

In Korean, [lateral] does not undergo place assimilation, unlike other coronals:

(5) (i) t k --> k k
(ii) t p --> p p
(iii) l k -/-> k k
(jv) l p -/-> p p

To explain this noncoronal behavior of [lateral], Yip (1990) and Cho (1991) propose the opposite assumptions. Yip proposes that only the lateral has place feature whereas the other coronals are underspecified with respect to place, and thus only the latter are susceptible to Place spreading. Ironically, Cho proposes the opposite assumption, that only lateral is underspecified with respect to place and so does not have a place node as a target for spreading. Roughly speaking, Yip's proposal is compatible with Levin's theory of [lateral] whereas Cho's proposal is compatible with the approach positioning [lateral] high in the tree. This is because Levin's theory cannot underspecify the place of [lateral], but the other theory can. Therefore, comparing Yip's and Cho's theories may help determine which approach is preferable concerning the position of [lateral].

It seems Yip's theory needs an additional mechanism to explain the directionality of right-to-left place spreading.

(6) (i) k t -/-> k k
(ii) p t -/-> p p

Actually, Cho's proposal is subject to a similar argument since it requires the place node, which cannot simply be classificatory, to be a target of the spreading. But, there is a better treatment which is compatible with the approach positioning [lateral] as a root dependent. Once the spreading of place is specified as right-to-left, we do not have to worry about the resistance of [lateral] since the universal marking condition, which prohibits laterals with place specification other than coronal, will prevent dorsal or labial from spreading onto a [lateral] segment. Consequently, the noncoronal behavior of the Korean lateral can best be explained by the approach treating [lateral] as a root dependent.

4.3. Lateralization

In Korean, [lateral] spreads to adjacent homorganic sonorants in bidirectional fashion (i, ii). Also, like nasals, [lateral] spreads to adjacent non-nasal coronals in a right-to-left fashion (iii-vi).

(7) (i) n l --> l l
(ii) l n --> l l
(iii) t l --> l l
(iv) l t -/-> l l
(v) n t -/-> n n
(vi) t n --> n n

Thus, the best solution to the data in (7) will be that [lateral] spreads to the adjacent homorganic sonorant consonant bidirectionally after right-to-left spreading of [+son] between adjacent consonants. (This is very similar to the treatment of Rice and Avery (1991), except that it does not assume the spontaneous voicing node.) The simplest rule would refer to only the trigger and the target of spreading. Thus, if [lateral] is a root-dependent, the rule would plausibly be stated as follows:

(8) mirror image

[+son, +cons] [+son, +cons]

lateral

However, if [lateral] is a coronal dependent, the rule has to include the information about sonority which is neither target nor trigger of spreading:

(9) mirror image

[+son, +cons] [+son, +cons]

coronal coronal

lateral

If the place node is not classificatory[2], this will be even worse since the rule includes "PLACE" node which, like the root node, is not actively involved in the rule. Consequently, the simplest rule of Korean lateralization prefers the positioning of [lateral] high in the tree.

I conclude that the approach treating the lateral as a root dependent seems better than Levin's approach, in dealing with the phonological behavior, except place assimilation with [lateral]. However, since in the analysis of place assimilation with [lateral], positing an independent spreading of [lateral] is not ad-hoc as discussed in section 4.3., this is not really problematic for the approach assuming a root dependent lateral.

5. Underspecification

The two theories that we have discussed thus far make different predictions with respect to the underspecification theory. As was discussed briefly in section 4.2., if [lateral] is a dependent of the coronal node, it will be difficult to underspecify the place of [lateral], since the existence of [lateral] presupposes the existence of its mother node, coronal. In contrast, if [lateral] is higher in the tree, the place of [lateral] can be underspecified since the place can be predicted from the existence of [lateral]. Shaw (1991) elaborates this point by discussing the transparency of [lateral] in Chumash Coronal Harmony and Tahltan Coronal Harmony. To the same end, Yip (1990) discusses OCP

[2]A class node, which has classificatory function only, does not operate as an autosegment: it is just an abstract category.

effects in Cambodian and Javanese. I will here summarize Shaw's analysis of Chumash coronal harmony.

In Chumash, all coronal sibilants assimilate for the feature anterior to the rightmost sibilant:

(10) Chumash [anterior] harmony (Shaw 1991:140)

a. k-sunon-us	'I obey him'
k-šunon-š	'I am obedient'
b. ušla	'with the hand'
usla-siq	'to press firmly by hand'
c. uqsti	'of throwing'
š-uxšti-meš	'throw over to'
d. /s-iš-tiši-yep-us/	'they two show him'
[s-is-tisi-yep-us]	(3-dual-show-3obj)

However, the coronal segments /t n l/ are transparent in the assimilation process.

(11) Chumash Transparent Segments (Shaw 1991:141)

a. š-api-čo-it	'I have good luck'
s-api-co-us	'he has good luck'
b. k-šunon-š	'I am obedient'
k-sunon-us	'I obey him'
c. ha-s-xintila	'his Indian name'
ha-š-hintila-waš	'his former Indian name'

Also, they are neither triggers nor targets of [+anterior] spreading. If we assume that the target of [+anterior] spreading is coronal, /t n l/ should not have coronal when the assimilation occurs, since otherwise they will undergo the assimilation. Consequently, /l/ will be underspecified with respect to place, supporting the argument that [lateral] is high in the tree, not under coronal.

6. Conclusion

To decide the location of [lateral] in feature geometry, several phonological aspects were considered: the function of [lateral] in phonetics, feature cooccurrence restrictions, phonological behavior, and underspecification theory. From the discussion of these aspects, it is concluded that [lateral] is high in the geometry tree, not under coronal.

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THE CORONAL UNDERSPECIFICATION HYPOTHESIS[1]

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0. Introduction

In the introduction to their volume on coronal consonants, Paradis & Prunet (1991) discuss an array of facts which suggest that the coronal place of articulation is special. For instance, they observe that in Maddieson's (1984) survey, all languages save one, Hawaiian, have a coronal stop. By contrast, labial or velar stops are more frequently absent from consonant inventories. Maddieson also notes that in languages with only one fricative, 88% of the time that fricative is a coronal. Paradis & Prunet go on to assert that the behavior of coronals demonstrates that they are underspecified for place of articulation features. I will refer to this as the Coronal Underspecification Hypothesis. As will be discussed in section (1.1), the Coronal Underspecification Hypothesis is a consequence of the principles of Radical Underspecification, developed in the work of Kiparsky (1982), Archangeli (1984, 1988), Archangeli & Pulleyblank (1986), and others. The theory of Contrastive Underspecification (Steriade 1987b) predicts that in most cases coronal consonants will be specified for place features in underlying representations. Therefore, within the framework of Contrastive Underspecification, the behavior of coronal consonants is not explained by their unmarked, and thus underspecified status. In this paper I will survey some of the literature on coronal underspecification, comparing the predictions made by Radical Underspecification with the very different predictions made by the theory of Constrastive Underspecification (Steriade 1987b).

The Coronal Underspecification Hypothesis has been invoked to explain the behavior of coronals in the application of certain phonological rules and morpheme structure constraints. In this paper I will be concerned with those arguments which are based on the behavior of coronal consonants in rules. It has been noted that coronals tend to be targeted by place of articulation assimilation rules. Some researchers have suggested that this vulnerability to assimilation is due to the fact that coronal consonants lack place features, and thus are likely targets of feature-filling spreading rules. The languages typically cited as instantiating this tendancy are Catalan and Sanskrit. I will discuss

[1] I would like to thank Donca Steriade, Bruce Hayes and Jongho Jun for their generous help on this project. I would also like to thank the editors of this volume for taking the time to review this manuscript.

Kiparsky's (1985) analysis of Catalan nasal assimilation, followed by a presentation of Cho's (1991) treatment of Sanskrit coronal assimilation and n-retroflexion. It has also been claimed that a sequence of identical vowels which arguably share a single set of place features sometimes allows an intervening coronal consonant. Arguments of this kind have been made in Paradis & Prunet (1989b) and in Parkinson (1993). Finally, the transparency of certain coronal consonants in harmony systems which spread features dependent on the Coronal Node has been cited by Shaw (1991) as evidence for the Coronal Underspecification Hypothesis.

I will show that of those phenomena surveyed, the only cases which are appropriately analyzed as involving underspecification are the coronal harmony systems discussed in Shaw (1991). In those systems, the missing feature is not the Coronal Node, but rather the coronal dependent [anterior]. Furthermore, I will show that the basic pattern predicted by Radical Underspecification -- that in which the entire series of unmarked coronals are demonstrably underspecified for place features -- has not been documented in the literature on coronal underspecification. I will conclude that the Coronal Underspecification Hypothesis is not supported in the literature, and should therefore be abandoned as a means of explaining the behavior of coronal consonants.

1. Radical vs. Contrastive Underspecification

Mester & Itô (1989) provide a useful summary contrasting the two competing theories of underspecification, and outline the very different predictions which each theory makes. In this section I provide a summary similar to that given in their article.

1.1 Radical Underspecification

Radical Underspecification (Archangeli 1984, Archangeli & Pulleyblank 1986, etc.) is driven by the hypothesis that underlying representations are entirely free of redundancy. All predictable feature values are inserted by rule. The essence of this theory is embodied in the Feature Minimization Principle, proposed by Archangeli (1984, p. 50):

(1) Feature Minimization Principle

> A Grammar is most highly valued when underlying representations include the minimal number of features necessary to make different the phonemes of the language.

If no redundancy is allowed in underlying representations, then it follows that only one value of a given feature may be present in underlying representations: If a given segment is

[αF], then it must be the case that the segment is not [-αF]. Within Archangeli's (1984) model, predictable feature values are introduced into the representation by Redundancy Rules, and the stage in the derivation at which such rules apply is governed by the Redundancy Rule Ordering Constraint (RROC):

(2) Redundancy-Rule Ordering Constraint (RROC)

> A redundancy rule assigning β to F, where β is "+" or "-", is automatically ordered prior to the first rule referring to [β F] in the structural description.

Markedness is incorporated into theory of Radical Underspecification as follows: In the absence of language-particular evidence to the contrary, Redundancy Rules will specify the feature values supplied by Universal Grammar (see Archangeli 1988, p. 193).

1.2 Contrastive Underspecification

The theory of Contrastive Underspecification (Steriade 1987b) is based on how features function within particular segment classes, rather than on the hypothesis that redundancy is not allowed in underlying representations. Within a given class of segments, a feature value may be distinctive (D-value) or redundant (R-value). Steriade cites as an example the feature [voice] in English. This feature functions contrastively only within the class of obstruents. Thus, within the class of obstruents in English [voice] is a D-value. Within the class of sonorants, [voice] is an R-value. The theory of Contrastive Underspecification dictates that only R-values are necessarily missing in underlying representations. Therefore, both [+voice] and [-voice] are present in the underlying representations of obstruents. The feature [voice] is unspecified for sonorants.

1.3 Predictions of the Two Models of Underspecification[2]

Radical Underspecification and Contrastive Underspecification make very different predictions regarding when place features will be absent from underlying representations. Let us consider the consonant inventory of Nimboran, an Indo-Pacific language spoken in Northwestern New Guinea (Anceaux 1965, Maddieson 1984):

---

[2]This discussion is modeled on section 1.2 of Itô & Mester (1989).

(3) Nimboran Consonant Inventory

p	t̪	k	
b	d̪	g	
	s̪		
			h
m	n	ŋ	
	r̪r̪		

Assuming the model of feature geometry proposed in Sagey (1986), the consonants of Nimboran are represented with the three articulator nodes Labial, Coronal and Dorsal. The Feature Minimization Principle requires that one of these three articulators be absent from underlying representations. Since Universal Grammar will assign Coronal by default, in the absence of Nimboran-specific evidence to the contrary, the consonants will have the underlying representations given in (4), and the universal default rule in (5) will supply a placeless consonant with a Coronal Node:

(4)

Labial	Alveolar	Velar
Root	Root[3]	Root
|		|
Place		Place
|		|
LAB		DOR

(5) Universal Default Rule

[ ] -> Coronal

The Feature Minimization Principle dictates that *the entire coronal series* in a language like Nimboran will be underlyingly placeless.

The theory of Contrastive Underspecification predicts that in a language like Nimboran, only the liquid [r̪r̪] , the fricative [s̪], and the glide [h] will lack place specifications underlyingly, since only within the class of liquids, fricatives and glides is place of articulation redundant.

Now consider an inventory in which numerous contrasts obtain within the class of coronals. Bāgandji, an Austronesian language spoken in Australia, has a four-way

[3] I will assume that a place node is projected only if it is needed to support an articulator node.

contrast among coronals. Hercus (1982) describes the coronal points of articulation as lamino-dental, apico-alveolar, apico-domal (retroflex) and lamino-palatal:

(6) <u>Bāgandji</u> (Austronesian, Hercus (1982))

b	d̪	d	ḍ	ɟ	g
m	n̪	n	ṇ	ɲ	ŋ
	l̪	l	ḷ	ʎ	
		r	ṛ		
w				y	

These contrasts may be represented using the features [distributed] and [anterior]:

(7)	lamino-dent.	apico-alveolar	apico-domal	lamino-palatal
[distributed]	+	-	-	+
[anterior]	+	+	-	-

The Feature Minimization Principle dictates that only one value of a given feature may be present in underlying representations. If we assume that the values [+anterior] and [-distributed] are supplied by Universal Grammar, the following matrix emerges:

(8)	lamino-dental	apico-alveolar	apico-domal	lamino-palatal
[distributed]	+			+
[anterior]			-	-

Now assuming that the Coronal articulator is supplied by a universal default rule, it should be the case that the Coronal Node is present only in the representation of those segments for which it is required to support a dependent feature. The apico-alveolars of the language should therefore not be specified as coronal in underlying representations:

(9)	<u>lamino-dental</u>	<u>apico-alveolar</u>	<u>apico-domal</u>	<u>lamino-palatal</u>
	COR | [+dist]		COR | [-ant]	COR / \\ [+dist] [-ant]

The universal default rules listed in (10) will yield the fully-specified structures in (11):

(10) Default Rules (Universal)

a. [ ] -> coronal
b. coronal-> [-distributed]
c. coronal-> [+anterior]

(11)

lamino-dental	apico-alveolar	apico-domal	lamino-palatal
COR	COR	COR	COR
/ \	/ \	/ \	/ \
[+ant] [+dist]	[+ant] [-dist]	[-ant] [-dist]	[-ant] [+dist]

Therefore we see that for a language containing multiple series of coronal consonants, the principles of Radical Underspecification dictate that all else equal, the entire series of *unmarked* coronals must underlyingly lack specification for the coronal articulator.

Contrastive Underspecification, on the other hand, predicts that no class of segments in Bāgandji will lack place features underlyingly, since place is distinctive within each stricture category.

To summarize, Radical Underspecification is characterized by the tenet that underlying featural representation is entirely free of redundancy. As a consequence, within any given consonant inventory, at least one point of articulation class must entirely lack place specifications at underlying representation. Markedness is claimed to be encoded into the theory by the preference of universal default rules over language-specific (i.e. learned) default rules. Since coronal is widely assumed to be the unmarked articulator, the theory of Radical Underspecification predicts that we will find rules in which the entire series of plain coronals behaves as if it lacks place specifications. Within the theory of Contrastive Underspecification a feature will be underspecified for a given class of segments only if that feature does not serve to characterize a minimal contrast within that class of segments. Therefore, a segment is expected to exhibit "placelessness" with regard to the application of phonological rules only if place is redundant within that segment's stricture class.

2. Assimilation

Coronal consonants are sometimes targeted by place of articulation assimilation rules which do not target non-coronals. Such rules exist in Catalan, Sanskrit and Yakut, for example. It has been proposed that coronal consonants are inherently placeless, and are thus subject to spreading rules which supply them with place specifications. In this section I will consider the two assimilation rules which are typically cited as instantiating this phenomenon, namely Catalan nasal assimilation (Kiparsky 1985) and Sanskrit coronal assimilation (Cho 1991).

2.1. Catalan Nasal Assimilation

In Catalan, as discussed in Mascaró (1976) and Kiparsky (1985), /n/ assimilates in place features to a following consonant, whereas the other nasals (/m/, /ŋ/ and /ɲ/) do not:[4]

(12) Coronal Nasal (total assimilation to following Consonant)

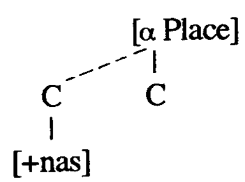
a.	son amics	'they are friends'(alveolar)
b.	som pocs	'they are few' (labial)
c.	siɱ feliços	'they are happy' (labiodental)
d.	son̪ dos	'they are two' (dental)
e.	soṇ rics	'they are rich' (postalveolar)
f.	soɲ žermans	'they are brothers' (laminopalatal)
g.	soŋ grans	'they are big' (velar)

(13) Other Nasals

a.	som amics	'we are friends'
b.	som pocs	'we are few'
c.	som dos	'we are two'
d.	tiŋ pa	'I have bread'
e.	aɲ felic	'happy year'

Kiparsky's analysis works as follows. The rule of nasal assimilation applies in a feature-filling manner, spreading the place features of a consonant onto a preceding nasal which itself lacks place features:

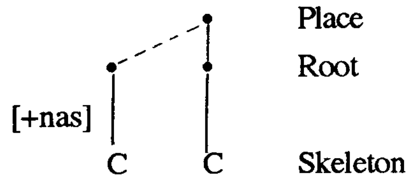
(14) Nasal Assimilation I



In a current model of feature geometry, such as that proposed in Sagey (1986), the rule would spread the Place Node leftward, as shown here:

[4]/m/ assimilates to a following labiodental, but this is analyzed by Kiparsky as resulting from the postlexical application of the Shared Features Convention (Steriade 1982).

(15) <u>Nasal Assimilation II</u>



Kiparsky discusses a second rule of Catalan by which a stop is deleted when preceded by a homorganic tautosyllabic consonant. Nasal assimilation feeds this rule:

(16) <u>Examples of Cluster Reduction</u>

a.	/kaNp/	→ kamp	→ kam (*kan)	'field'
b.	/bεNk/	→ bεŋk	→ bεŋ (*bεn)	'I sell'
c.	/biNt/	→ bint	→ bin	'twenty'
d.	/surt li/		→ sur li	'go out to him'

Kiparsky formulates the deletion rule as shown in (17), although it should be noted that the rule deletes only stops:

(17) <u>Consonant Cluster Reduction</u>

```
[α Place]
   / \
  C   C
   \ǂ
    σ
```

Two facts regarding the relation between Nasal Assimilation and Consonant Cluster Reduction are clear: (i) Nasal Assimilation must precede Consonant Cluster Reducation and (ii) A sequence of two coronal consonants is targeted by Consonant Cluster Reduction. That Nasal Assimilation precedes Cluster Reduction is apparent from the fact that words such as /kaNp/ surface as [kam] and not *[kan]. That Cluster Reduction applies to a sequence of two coronal consonants is evident from the fact that /biNt/ surfaces as [bin] and not as *[bint]. Kiparsky assumes that Cluster Reduction is a lexical rule. However, as such, the rule should fail to apply to a form such as /bint/: The cluster cannot share a set of place features since [+coronal] is disallowed in lexical representations, hence the structural description for Consonant Cluster Reduction is not met.

This inconsistency aside, we might assume that the default rule which supplies [+coronal] does in fact apply within the lexical component. Under such an analysis, the default specification of [+coronal] must be ordered *after* Nasal Assimilation and *before* Cluster Reduction:

(18)	<u>Lexical Level</u>:	/biNt/	/kaNp/ | LAB
	Nasal Assimilation	------	kamp V LAB
	Default [+coronal] specification	bint V COR	-----
	Cluster Reduction	bin	kam

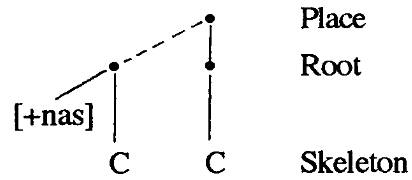
Thus we are forced to conclude that at the stage in the derivation at which Consonant Cluster Reduction applies, the default rules which provide coronals with their place features must have already applied, since the rule requires that the adjacent segments be multiply-linked to a single set of place features.

Kiparsky shows that Nasal Assimilation applies both lexically and post-lexically. The phrase used to demonstrate this fact is *venc vint pans* 'I sell twenty loaves of bread,' which surfaces as [béŋ bím páns]. Lexically, the rule applies to /beNk/, yielding [beŋ]. Postlexically, the rule applies to /biNt paNs/, yielding [bim pans]. The derivation provided by Kiparsky for this phrase is shown in (19). The output of nasal assimilation is indicated in boldface:

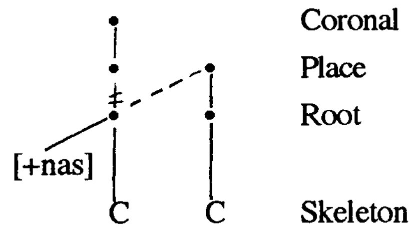
(19)		/beNk	biNt	paNs/
	LEXICAL			
	Nasal Assimilation	be**ŋ**k		
	Cluster Simplification	beŋ_	biN_	
	POSTLEXICAL			
	Nasal Assimilation		bi**m**	

Above we concluded that the default rule supplying [+coronal] must apply prior to the application of Cluster Reduction, since that rule targets a <u>consonant + stop</u> sequence multiply-linked to some set of place features. It must therefore be the case that in the *postlexical* application of Nasal Assimilation, the target of the rule is specified as [+coronal]. We therefore have two rules of Nasal Assimilation, one which applies lexically in a feature-filling manner, and the second which applies postlexically in a feature-changing manner, explicitly targeting coronals:

(20) Lexical Nasal Assimilation (feature-filling)



(21) Postlexical Nasal Assimilation (feature-changing)



The postlexical rule must stipulate that the rule specifically targets coronal nasals. Thus, we are forced to give up on the original explanation for why plain coronals are targeted by assimilation, since in the postlexical rule this fact must be stipulated. I conclude, therefore, that Catalan provides no argument to the effect that coronals are unspecified for place.

2.2. Sanskrit

Another assimilation rule which targets coronals is found in Sanskrit. In that language, a word-final dental consonant assimilates to a following retroflex, palatal or lateral (Whitney 1889). Cho (1991) argues that the plain coronals are targeted by this rule because they are underspecified for place of articulation features. The coronal consonants of Sanskrit are listed in (22):

(22) Sanskrit Coronal Consonants

Dental	Retroflex	Palatal	Lateral
t	ṭ	c	
th	ṭh	ch	
d	ḍ	j	
dh	ḍh	jh	
s	ṣ	š	
n	ṇ		
	ṛ		l

The dentals [t, n, s] assimilate in place of articulation (and sometimes other features as well) to a following retroflex, palatal or lateral consonant[5]. Cho discusses assimilation in the following contexts:

(23) Assimilation to a Retroflex

a.	tat ḍhaukate	→	taḍ ḍhaukate	'it approaches'
b.	ta:n ḍimbha:n	→	ta:ṇ ḍimbha:n	'those infants'
c.	pa:tas ṭalati	→	pa:taṣ ṭalati	'the foot is disturbed'

(24) Assimilation to a Palatal

a.	ut caṛati	→	uc caṛati	'rise'
b.	vudyut ja:yate	→	vudyuj ja:yate	'this dawn is born'
c.	ta:n jana:n	→	ta:ɲ jana:n	'those people'
d.	tatas ca	→	tataš ca	'and then'

(25) Assimilation to a Lateral

a.	tat labhate	→	tal labhate	'it takes'
b.	tri:n loka:n	→	tri:l loka:n	'three worlds'

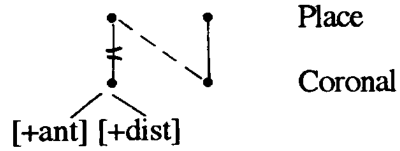
The rule might be stated as in (26), in which the target is explicitly represented as belonging to the dental series:

---

[5]There is some evidence that this rule applies progressively as well, though it seems to do so inconsistently. The following examples are taken from Whitney 1889)

a. ī̄ḍ-te -> īṭṭe (198b)
b. āiḍ-ta -> āiṭṭa (198b)
c. yāc-na -> yācña (201)
d. aj-nata -> ajñata (201)
e. indras çūraḥ -> indraç çūraḥ (172)
f. tās ṣaṭ -> tāṣ ṣaṭ (172)

(26) Coronal Assimilation



Cho argues that the rule need not stipulate the class of segments which undergo the rule, however, because the fact that the rule targets only plain coronals falls out from independent principles of underspecification: The plain coronals undergo the rule because they are underspecified for place features.

Cho (p. 166) assumes the following matrices for coronals (she does not include [lateral] among the features in this matrix, however she does indicate elsewhere that she assumes [lateral] to be a dependent of the Coronal Node):

(27) Fully Specified Matrix for Coronals

	Dental	Retroflex	Palatal
Anterior	+	-	-
Distributed	+	-	+

(28) Underspecified Matrix for Coronals

	Dental	Retroflex	Palatal
Anterior		-	-
Distributed		-	

Under Cho's underspecification analysis the retroflex, palatal and lateral consonants will all be underlyingly specified for one or more of the dependent features listed above. Members of these classes will therefore project a Coronal Node. The non-lateral dentals have no underlying specification for a marked value of a feature dependent on the Coronal Node. Therefore, they will fail to project a Coronal Node. The rule proposed by Cho is given in (29):

(29) Coronal Spread

Clearly this analysis provides an appealing account of why assimilation targets the dentals. One important fact remains unexplained, however: Why is it that the dentals assimilate only to other coronals? The fact that the assimilation obtains among consonants articulated with the tongue blade suggests that the phenomenon is related to the articulatory similarity of the trigger and target. If we adopt an analysis in which the target is completely lacking in articulatory specifications, we cannot explain why the rule only obtains when the trigger and target are articulatorily similar.

Furthermore, Cho's contention that assimilation is the result of underspecification is inconsistent with other phenomena of Sanskrit. Cho herself points out that Sanskrit has another rule which crucially relies on the presence of a Coronal Node in the representation of the dental series at the relevant stage in the derivation. The phenomenon in question is n-retroflexion and the relevant data are shown in (30). A coronal nasal becomes retroflex when preceded by a retroflex continuant. Crucially, no non-retroflex coronal consonant may intervene, even a dental. Triggers and targets are indicated in bold-face, blockers are underlined:

(30)

n-retroflexion applies		no n-retroflextion is blocked	
pṛ-ṇa:	'fill'	mṛd̲-na:	'be gracious'
vṛk-ṇa	'cut up'	maṛj̲-a:na	'wiping'
kṣubh-a:ṇa	'quake'	kṣved̲-a:na	'hum'
kṛp-a-ma:ṇa	'lament'	kṛt̲-a-ma:na	'cut'

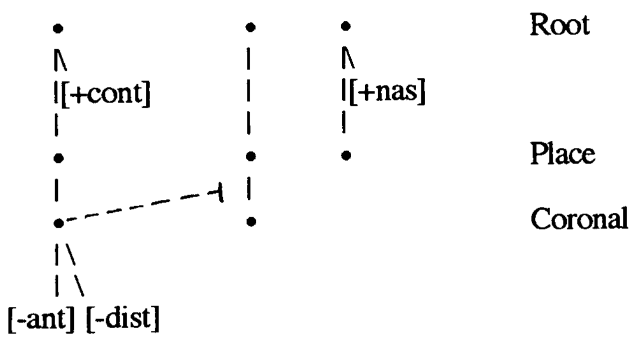
Cho follows Schein & Steriade (1986) in the view that n-retroflexion is derived by rightward spreading of the Coronal Node from a retroflex continuant onto the nasal /n/. Her formulation of the rule is as in (31):

(31) n-retroflexion

```
  •              •              Root
  |\             |\
  |[+cont]       |[+nas]
  |              |
  •        - - - •              Place
  |  - - -
  •-                            Coronal
  |\
  | \
[-ant] [-dist]
```

This statement of the rule correctly predicts that its application will be blocked if a coronal consonant intervenes between the trigger and the target. Application of the rule in such a configuration would result in a violation of the prohibition against Crossing Lines (Goldsmith 1976), as shown in (32):

(32) <u>Coronals Block n-retroflexion</u>



Thus, in order to characterize as a natural class those consonants which block the application of n-retroflexion, the blocking consonants must have featural content on the spreading tier, i.e. they must be specified with a Coronal Node.

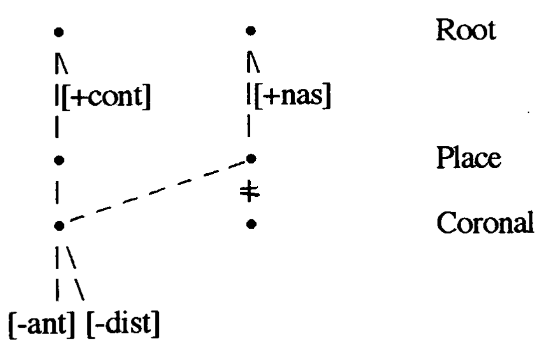
Cho suggests, following Paradis & Prunet (1989a), that while the dentals in Sanskrit lack a Coronal Node underlyingly, default rules forcing the projection of a Coronal Node apply *early* in the derivation. Presumably, the claim is that dentals lack place features at the stage in the derivation at which Coronal Assimilation applies, but that place features are filled in before the application of n-retroflexion. Presumably the derivations would work as follows:

(33) Derivations

Underlying Representations	/taːn janaːn/ COR	/vṛk-na/ COR	/mṛd-na/ COR
Coronal Assimilation	taːn janaːn COR	---------	----------
Default	taːn jaɲaːn COR COR COR COR	vṛk-na COR COR	mṛd-ɳa COR COR COR
n-retroflexion	---------	vṛk-na COR COR	-BLOCKED-

Cho's analysis, in which the rules are ordered as shown in (33), faces two problems. The first problem involves Cho's claim that the dental nasal /n/ is targeted by n-retroflexion because it lacks a Coronal Node. If this is so, we are forced to conclude that the default rules apply to all consonants except the nasal. I take this to be an unacceptable consequence of the underspecification analysis of n-retroflexion, and conclude that the correct formulation of n-retroflexion must be as shown in (34), where the trigger and target are both specified as coronal:

(34) n-retroflexion



The more serious problem with Cho's analysis is that n-retroflexion applies only word-internally, whereas Coronal Assimilation applies both within words and across word boundaries (Whitney 1889 p. 64-65). Based on the discussion above, we know that *all* coronals are specified for their point of articulation when n-retroflexion applies. Therefore, Cho's analysis involves an ordering paradox. Cases of Coronal Assimilation across a word boundary must therefore apply after n-retroflexion, i.e. at a stage in the derivation at which the dentals are specified with a coronal articulator. I conclude from this that an analysis of coronal assimilation which invokes coronal underspecification is incompatible with the facts of Sanskrit.

2.3 Summary: Assimilation

Catalan and Sanskrit are the two languages frequently cited in the literature on coronal underspecification as realizing the prediction that unmarked (and hence underspecified) coronal consonants will tend to be targeted by feature-filling point of articulation assimilation rules. I have demonstrated that an analysis invoking underspecification for place features is incompatible with independent phonological processes in both of these languages.

3. Transparency in Fused Vowel Structures

Paradis & Prunet (1989) present analyses of phenomena from three West African languages which they claim demonstrate that coronal consonants may intervene between a sequence of vowels which are multiply linked to a single Place Node. They argue that coronal consonants may occur in these positions because the Place Node is absent in the specification of coronal consonants. The languages discussed by Paradis & Prunet are Fula, Mau and Guéré. A rather different phenomenon, but one which appears also to involve multiple linking of vowel place features across intervening coronals is presented in Parkinson (1993). Parkinson argues for the transparency of coronal sonorants in Rwaili Arabic. I will review each of these analyses within the context of the predictions made by Radical versus Contrastive Underspecification, and will conclude that neither theory adequately predicts the class of consonants that will exhibit transparency in multiply-linked vowel structures.

3.1 Fula

Paradis & Prunet (1989) present three instances from Fula, a Niger-Congo language spoken in West Africa, in which coronal consonants surface flanked by identical vowels. They conclude that each case demonstrates that coronal consonants lack place specifications underlyingly. The arguments fail to establish that the behavior of coronal consonants is any different from that of the other consonants of the language, however, since non-coronal consonants do not occur in the relevant morphological environments. Similar criticisms of Paradis & Prunet's conclusions based on Fula are given in Parkinson (1993). Therefore, I will focus on their analyses of Mau and Guéré.

3.2 *Mau*

Mau is a language of the Niger-Congo family spoken in the Ivory Coast and Mali. Paradis & Prunet cite a case of transcoronal vowel fusion in Mau which is evidenced by the distribution of tones in this language. The fusion across a coronal is possible, they claim, because coronals lack a Place Node. The consonant inventory of Mau is given in (35).

(35) Mau Consonant Inventory

	labial	alveo	palatal	velar	complex
stops	p, b	t ,d	c, j	k, g	kp, gb
implos.	ɓ	ɗ			
nasals	m	n	ɲ	ŋ	ŋm, $ŋ^w$
fric.	f, v	s, z			
glides	w		y		
liquids		r, l			

The liquids [l] and [r] are in free variation intervocalically.

Paradis & Prunet show that Mau has a LH melody which is realized as a contour on monosyllables, and as a low tone on the initial syllable followed by a high tone on subsequent syllables in polysyllabic words. The forms they cite are given in (36) and (37):

(36) LH pattern: monosyllabic words

a. [yě] 'gourd'
b. [wŏ] 'hole'

(37) LH pattern: polysyllabic words

a. [sàfíná] 'soap' (< Fr. *savon*)
b. [màsúwá] 'misfortune'
c. [wòó] 'cola'
d. [tèé] 'popular bank'

To account for the distribution of tones in Mau, they provide a statement of Tone Association Conventions, with the requirement that all tones be associated (thus guaranteeing the realization of contour tones on the monosyllables):

(38) Tone Association Conventions

i. Associate L to the first syllable
ii. Associate H to the following syllable(s)

Paradis & Prunet cite two classes of cases in which the distribution of tones is different from the pattern observed above. If the first two vowels of the word are adjacent and identical (and another vowel follows), the identical vowels are both L-toned. If the first two vowels of the word are identical and separated by a liquid, those two vowels are also L-toned:

(39) V_1 and V_2 are adjacent and identical

a. [gĩ̀ĩ̀wĩ́ĩ́] 'sulphur'
b. [tĩ̀ĩ̀wĩ́] 'road'
c. [dèèké] 'shirt'
d. [hèèyábú] 'protection'

(40) V_1 and V_2 are separated by a liquid

a. [màràká] or ([màlàká]) 'Marka (ethnic group)'
b. [màràsí] or ([màlàsí]) 'card game (< Fr. *mariage*)'
c. [yɔ̀rɔ̀kó] or ([yɔ̀rɔ̀kó]) 'chain'
d. [bɔ̀rɔ̀tí] or ([bɔ̀lɔ̀tí]) 'thread'

Paradis & Prunet argue that it would be incorrect to assume that the melody for these cases is LLH, as opposed to LH, since the former melody would constitute a violation of the Obligatory Contour Principle. On the other hand, to assume that clause (i) of the Tonal Association Convention applies twice for cases like those in (39) and (40) would be unsatisfying, since it is not clear why the sequences CVV and CVrV should pattern together to the exclusion of other CVCV sequences.

To account for the LLH pattern, Paradis & Prunet propose that the forms in (39) and (40) contain fused structures. That is, identical vowels are represented as sequences of two Root Nodes multiply linked to a single Place Node. A coronal may intervene because it lacks a Place Node. A Place Node is present in the representation of all other consonants, and therefore, in a word like [tɔ̀ɲɔ́ɔ́] 'worm' the first two vowels of the word are not represented with a multiply-linked structure, and each is assigned its own tone.

Paradis & Prunet's analysis works as follows. They claim that the tone-bearing unit in Mau is the Root Node.[6] Thus, for cases in which the first two vowels are identical and adjacent, the structure will contain a single Root Node linked to two timing slots:

(41) <u>Identical Adjacent Vowels</u>

```
Skeletal Tier        X  X
                      \ /
Root Tier              •
                       |
Place Tier             •
                       |
                       •
Dorsal Tier           / \
               [αhigh] [βback]
```

A similar analysis is proposed for the fact that $\{CV_irV_i\}$ sequences yield only one tone-bearing unit. Paradis & Prunet suggest that the sequences in question are underlyingly {CrV}. Such a consonant + liquid sequence is an unacceptable surface onset in Mau, and thus a vowel is inserted to break up the unsyllabifiable cluster. That epenthetic vowel inherits the quality of the following vowel by spreading. Therefore, tones are associated prior to syllabification, and at that stage in the derivation, only one tone-bearing unit is available: the Root Node of the *second* of the two identical surface vowels.

Although Paradis & Prunet do not do so, I will try to demonstrate how all of this works by way of derivations. Consider the word [sàràbá] 'wick ' (RN = Root Node, PN = Place Node):

(42) <u>Underlying Representations</u>

```
s   r   a   b   a
X   X   X   X   X
|   |   |   |   |
RN  RN  RN  RN  RN
```

[6]Their analysis will work equally well under the assumption that the tone-bearing unit in Mau is the syllable, provided that long vowels are tautosyllabic. Paradis & Prunet do not make an explicit statement on this point.

Tone Association

```
s   r   a   b   a
X   X   X   X   X
|   |   |   |   |
RN  RN  RN  RN  RN
         :       :
         L       H
```

Syllabification

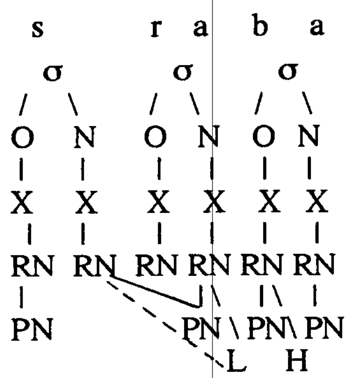
```
s       r   a   b   a
  σ       σ       σ
 / \     / \     / \
O   N   O   N   O   N
|   |   |   |   |   |
X   X   X   X   X   X
|       |   |   |   |
RN      RN  RN  RN  RN
            |       |
            L       H
```

Vowel Spreading

```
 s          r   a   b   a
  σ           σ       σ
 / \         / \     / \
O   N       O   N   O   N
|   |       |   |   |   |
X   X       X   X   X   X
|   |       |   |   |   |
RN  RN_     RN  RN  RN  RN
|      `-----. |\   |\   |
PN             PN \ PN\ PN
                  L    H
```

Under Paradis & Prunet's analysis, the tone-bearing unit in Mau is the Root Node. Thus, leftward spread of the Place Node as shown above does not in itself entail leftward spread of the L tone. Paradis & Prunet do not address this point, however we can assume that the epenthetic vowel receives its tonal specification via leftward spread:

(43) Leftward Tonal Spreading



Paradis & Prunet's claim that the LLH forms with a medial liquid contain an underlying [Cr-] sequence appears to be correct. That the quality of the epenthetic vowel is always identical with that of the following vowel suggests that the epenthetic vowel is specified via leftward spreading. Let us assume that Paradis & Prunet are correct: The Place Node spreads across an intervening placeless liquid.[7] Given the consonant inventory of Mau, both theories of underspecification predict [r/l] to be underspecified for place features. Since no other consonant occurs in the relevant environment, the distinct predictions of Contrastive versus Radical Underspecification cannot be evaluated. I conclude from this that the facts of Mau are compatible with both theories, and do not support the theory of Radical Underspecification over that of Contrastive Underspecification.

3.3 Guéré

Guéré is a Kru language spoken in the Ivory Coast. The data discussed by Paradis & Prunet are from Paradis (1983). Guéré has the following underlying consonant inventory:

[7] Paradis & Prunet assume that the intervening consonant must lack a Place Node in order to allow the leftward spread of the vocalic features onto the empty V-slot. It is not clear that this assumption is justified, however. Heather Morrison informs me that in Winnebago, an epenthetic vowel surfaces as a copy of the vowel to its right. The intervening consonant may be either a labial or coronal sonorant.

(44) Guéré Underlying Consonant Inventory

	labial	alveolar[8]	palatal	velar	complex
stops	p, b	t ,d	c, j	k, g	kp, gb, k^w, g^w
nasals	m	n	ɲ		ŋm, $ŋ^w$
fric.	f, v	s, z			
glides	w		y		
oral son.	ɓ	l			

According to Paradis (1983), [n], [r] and [ɗ] appear as surface variants of /l/. /ɓ/ surfaces as [m] in certain contexts. Guéré has nine basic vowel phonemes, all of which may be underlyingly nasal or oral:

(45) Guéré Vowel Inventory

[+ATR]		[-ATR]	
i	u	ɪ	ʊ
e	o	ɛ	ɔ
		a	

Paradis & Prunet's argument is based on what they term transcoronal fusion. They claim that with the exception of compounds, native words cannot contain two non-high vowels in Guéré.[9] That is, if a bisyllabic word contains a non-high vowel, it must also contain a high vowel. Thus, words of the types shown schematically in (46) are well-formed in Guéré, but words of the types shown in (47) are are claimed to be ill-formed:

---

[8]This column is labeled "Coronal" in Paradis & Prunet (1989), but Paradis (1983) indicates that this series is alveolar.

[9]I have found several exceptions to this generalization in Paradis (1983) (Tones are omitted):

nɛna	mae	nmae	gwɛe	yɔo	taõ
'tale'	'to forget'	'to repair'	'to sting'	'viper'	'mouse'

(46) <u>Well-formed Structures</u>

(a)
```
    C   V   (C)   V
        |         |
   [+high]     [+high]
```
(Both vowels are [+high])

<u>Examples</u> [bũi] 'ashes'[10]
[nimi] 'animal'

(b)
```
    C   V   (C)   V
        |         |
   [+high]     [-high]
```
(The first vowel is [+high])

<u>Examples</u> [jie] 'road'
[biɗe] 'swim'
[nimɛ] 'bird'

(c)
```
    C   V   (C)   V
        |         |
   [-high]     [+high]
```
(The second vowel is [+high])

<u>Examples</u> [bɔʊ] 'frog'
[zegʊ] 'chameleon'

(47) <u>Ill-formed Structures</u>

```
*C      V   (C)   V
        |         |
   [-high]     [-high]
```

To account for the distribution of non-high vowels in Guéré, Paradis & Prunet propose a Height Constraint, which refers to the Dorsal Node, and disallows two adjacent Dorsal Nodes which both dominate [-high]:

(48) <u>Height Constraint</u>

```
 Dorsal        Dorsal
   |             |
*[-high]      [-high]
```

Sequences of identical non-high vowels are also allowed in Guéré. The forms cited in Paradis & Prunet are listed in (49):

---

[10] I have been unable to find examples of CVV roots where the vowels are identical high vowels, such as Cii. Similarly, I have found no CVCV roots where the vowels are high and distinct, such as CiCu.

(49) <u>Sequences of identical non-high vowels</u>

a. [baa] 'manioc' b. [ɗɔɔ] 'week' c. [yɛɛ] 'to dry'

Paradis & Prunet provide no examples of CV_iV_i roots containing [+high] vowels, and I have been unable to find any such forms in Paradis (1983). Thus, in addition to the well-formed structures listed in (46), we can conclude that a word may be of the form shown in (50):

(50)

```
C  V  V
    \ /
     •        Place
     |
     •        Dorsal
     |
  [-high]
```

So far we have seen that the Height Constraint given in (28) holds of most tautomorphemic sequences of non-like vowels, though the absence of roots of the form CVV in which both vowels are [+high] is not explained. Sequences of identical vowels are argued by Paradis & Prunet to satisfy the constraint because they are represented as a single Place Node linked to two Root Nodes, and thus contain only one [-high] specification.

It turns out that CVCV roots containing identical non-high vowels are also allowed in Guéré, provided that the intervening consonant is /l/. Such forms are in apparent violation of the Height Constraint. (Note that intervocalic /l/ is in free variation with [ɗ] and Ø):

(51)	a.	[wɔlɔ], [wɔɗɔ] or [wɔɔ]	'to wash'
	b.	[sɔlɔ], [sɔɗɔ] or [sɔɔ]	'lose weight!'
	c.	[bele], [beɗe] or [bee]	'to hang'
	d.	[dulu], [duɗu] or [duu]	'chest'

Paradis & Prunet's analysis of the forms in (49) is as follows: Sequences of identical vowels are represented as fused structures, in which two Root Nodes are multiply-linked to a single Place Node. A sequence of identical vowels will thus have the structure shown in (52):[11]

[11]Paradis & Prunet do not provide an argument for why it is the Place Node rather than the Root Node which is multiply linked. In fact, it can be argued that words containing adjacent identical vowels involve a multiply linked Root Node, since words like *bãa and *baã are absent from the Guéré lexicon.

```
(52)  Skeletal Tier      X     X
                         |     |
      Root Tier          •     •
                          \   /
      Place Tier            •
                            |
      Dorsal Tier           •
                           / \
                   [αhigh] [βback]
```

They claim that the possibility of an intervening coronal in forms like those in (51) is due to the fact that coronals lack a Place Node, while all other consonants are specified for place. A sequence of two like (nonround) vowels with an intervening coronal will have the representation in (53), whereas an intervening non-coronal will have a Place Node, and fusion will be impossible, as shown in (54):

```
(53)  Intervening Coronal

      Skeletal Tier      X  X  X
                         |  |  |
      Root Tier          •  •  •
                          \   /
      Place Tier            •
                            |
      Dorsal Tier           •
                           / \
                   [αhigh] [βback]
```

```
(54)  Intervening Non-Coronal

      Skeletal Tier      X              X              X
                         |              |              |
      Root Tier          •              •              •
                         |              |              |
      Place Tier         •              •              •
                         |                             |
      Dorsal Tier        •                             •
                        / \                           / \
                 [αhigh][βback]                [αhigh][βback]
```

Paradis and Prunet state that the only coronal consonants which occur intervocalically are /n/ and /l/, yet Guéré lacks words containing /n/ flanked by identical non-high vowels. The principles of Radical Underspecification, however, dictate that the *entire* series of unmarked coronals must lack place specifications underlyingly. Thus, if it is correct to analyze the well-formedness of the words in (51) as resulting from the possibility of a multiply-linked vocalic matrix across a placeless coronal, then Radical Underspecification incorrectly predicts that /n/ will also be allowed in this configuration. The predictions of Contrastive Underspecification in this case are less clear, given the unusual inventory of oral sonorants. Contrastive Underspecification correctly predicts the opacity of the nasal /n/, since place is contrastive within the class of nasals. With respect to the class of underlying oral sonorants, consisting of /l/ and /ɓ/, Contrastive Underspecification could make two separate predictions, both of them incorrect. If the two phonemes in fact belong to separate categories and are distinguished independently of place, say by the feature [continuant], then both should be be in the R-class for place features, and thus both should be underlyingly placeless. This prediction is incorrect, since sequences of identical non-high vowels are disallowed across /ɓ/. If the two phonemes do belong to the same category and are distinguished by place features, they will both belong to the D-class for place features and neither is predicted to be underlyingly underspecified for place features. This result is incorrect as well.

3.4 Rwaili Arabic

Parkinson (1993) presents data from a language in which the coronal sonorants are transparent in a context in which the coronal obstruents are not. He discusses a rule of Rwaili Arabic which raises [a] to [i] when it is in an open syllable and the following vowel is [a]. Parkinson shows that this rule fails to apply when a coronal sonorant intervenes.[12] Examples are shown in (55):

(55) Examples of Raising (from Parkinson 1993)

Raising Applies		Raising Does Not Apply	
katab → kitab	'he wrote'	wzanat → wzanat	'she weighed'
ʕzamat → ʕzimat	'she invited'	ǵsalat → ǵsalat	'she caught'
ḥlabat → ḥlibat	'she milked'	nxalat → nxalat	'she sifted'
ðabaḥ → ðibaḥ	'he killed'	ð̣arab → ð̣arab	'he hit'
nazal → nizal	'he got down'	ḥfarat → ḥfarat	'she dug'
gadar → gidar	'he was able'	ṣbarat → ṣbarat	'she waited'

[12]The rule is blocked in another context, namely when the potential target is adjacent to a guttural consonant. Parkinson analyzes blocking in this context as a Linking Constraint effect, where the low vowel [a] and the guttural consonant are multiply linked.

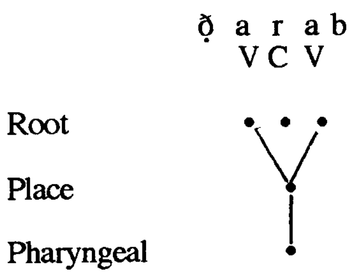
Parkinson's analysis works as follows. He assumes, following McCarthy (1986), that at the earliest stages of the derivation, vowels and consonants are represented on separate tiers. Later, these independent tiers are conflated, as shown in (56):

(56) <u>Tier Conflation</u>

```
 a
 |\
 | \
 |  \
CVCVC     →     CVCVC
|  |  |         | | | | |
k  t  b         k a t a b
```

Parkinson proposes that the coronal sonorants lack a Place Node. As a result, the non-adjacent skeletal V positions remain multiply-linked to a single Place Node after Tier Conflation:

(57) <u>Medial Coronal Sonorant after Tier Conflation (modified from Parkinson, p. 19)</u>[13]

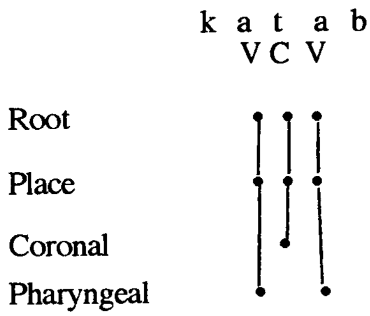


This structure may be compared to the structure of /katab/ after Tier Conflation, given in (58), in which each vowel is independently specified as pharyngeal:

---

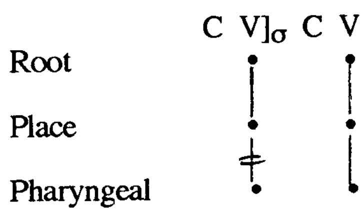
[13]In order to explain other patterns observed in Rwaili, Parkinson assumes a more articulated feature geometry than that shown here. In particular, he adopts the model prosed by Clements & Hume (forthcoming), in which vowels and consonants are specified with the same articulator nodes, vowels articulations being differentiated from consonant articulations by the presence of a V-Place node dominated by the C-place node. This structure has been simplified here for consistency with the other analyses given in the present paper. Parkinson's argument is not affected by this simplification.

(58) Medial Obstruent after Tier Conflation



Parkinson argues that Raising in Rwaili is a dissimilation rule deleting the first in a sequence of two pharyngeal specifications. The rule is motivated by the OCP, in this case operating on the Pharyngeal tier:

(59) Raising (modified from Parkinson, p. 8):



Default rules later supply the specifications for [i].[14] Since forms containing an intervening coronal sonorant are represented with a single Pharyngeal specification, there is no OCP violation on the Pharyngeal tier. This explains the failure of Raising to apply to forms containing a medial coronal sonorant. Parkinson concludes from the Rwaili data that Paradis & Prunet's claim that *all* unmarked coronal consonants are underlyingly placeless is too strong. In Rwaili, only coronal *sonorants* are underspecified for place features.[15] The consonant inventory of Rwaili is listed in (60):

[14]That [i] is the default vowel is motivated elsewhere by epenthesis facts (see Parkinson, p. 9-10).
[15]As mentioned above, Parkinson also discusses Paradis & Prunet's (1989) paper on coronal transparency and concludes that the convincing arguments from those languages also involve only coronal sonorants.

(60) Inventory (from Parkinson, p. 1)

	Labial	Interdent.	Dental	Alveolar	Velar	Uvular	Pharyng.	Laryng.
stops	b		ṭ t d		k g			ʔ
fricatives	f v	ð̣ ð	ṣ s z			x g̊	ḥ ʕ	h
nasals	m		n					
liquids			l	r				

Assuming that Parkinson's analysis of Rwaili raising is correct, Radical Underspecification makes the wrong prediction for Rwaili. The Feature Minimization Principle forces underspecification of the entire series of unmarked coronals and thus predicts that the sonorants and obstruents will all exhibit transparency effects in this language, which they do not. Contrastive Underspecification theory predicts that the liquids will be underspecified for place features, since place is non-distinctive within the class of liquids. However, this theory dictates that the dental nasal be specified for coronality, since place of articulation is contrastive within the class of nasals. Nonetheless, the dental nasal also appears to be placeless at the relevant stage in the derivation. Here, Contrastive Underspecification fails as well.

3.5 *Summary: Transparency in Fused Vowel Structures*

We have seen in this section that while the facts of Fula and Mau are consistent with the Coronal Underspecification Hypothesis, they do not prove that it is correct. In neither language can the behavior of the coronal consonants be shown to contrast with the behavior of the non-coronal consonants. Guéré and Rwaili are somewhat more conclusive. If it is correct to anayze these language as involving fused vowel structures, then we must explain why it is that a single set of vocalic features spanning two syllabic nuclei may be interrupted only by a consonants from the class of coronal *sonorants*. If the Coronal Underspecification Hypothesis were correct, all plain coronals would be allowed in the relevant configurations.

4. Coronal Harmony Systems

Shaw (1991) discusses two languages which exhibit place harmony among coronals. The argument for coronal underspecification works as follows. If these harmony systems involve spreading the Coronal Node, then coronal consonants which neither undergo nor block the proccess must lack a Coronal Node. The languages discussed by

Shaw are Chumash and Tahltan. Navaho (Sapir & Hoijer 1967) also has an anterior harmony rule essentially identical to the rule in Chumash.

4.1 Chumash[16]

Anterior harmony in Chumash involves only the sibilants of the language. The consonant inventory of Chumash is given in (61):

(61) Chumash Consonant Inventory

p	t	c	č	k	q	
p^h	t^h	c^h	$č^h$	k^h	q^h	
p'	t'	c'	č'	k'	q'	ʔ
		s	š	x		
		s^h	$š^h$	(x^h)		
		s'	(š')	x'		
m	n					
m'	n'					
w	l		y			
w'	l'		y'			

In Chumash, all coronal sibilants within a word agree with respect to the feature [anterior]: The rightmost sibilant in the word determines the anteriority of all sibilants to its left. Certain coronal consonants, namely the non-sibilant dentals, are transparent to this process. Some examples are shown in (62):

(62) a. k-$\underline{s}$unon-u$\underline{s}$ 'I obey him'
k-$\underline{š}$unan-$\underline{š}$ 'I am obedient'

b. u$\underline{š}$la 'with the hand'
u$\underline{s}$la-$\underline{s}$iq 'to press firmly by hand'

c. uq$\underline{s}$ti 'of throwing'
$\underline{š}$-ux$\underline{š}$ti-me$\underline{š}$ 'throw over to'

d. $\underline{š}$-api-$\underline{č}$o-it 'I have good luck'
$\underline{s}$-api-$\underline{c}$o-u$\underline{s}$ 'he has good luck'

Shaw assumes, following Poser (1982) and Steriade (1987b), that Chumash sibilant harmony involves the leftward spread of the feature [anterior]. To account for the

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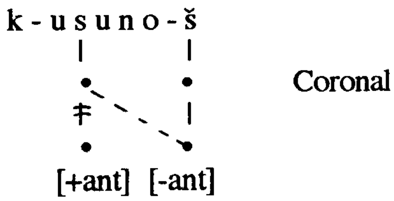
[16]For the Chumash data and generalizations Shaw cites Beeler (1970, 1976), Applegate (1972, 1976) and Harrington (1974).

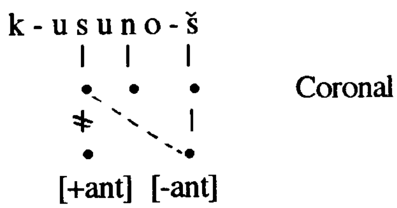
fact that non-sibilant coronals are transparent to the rule, she proposes two possible analyses. In the first, non-sibilant coronals are transparent to the rule because they lack a Coronal Node and thus are not possible targets:

(63) <u>Non-sibilant transparency, Version 1 (From Shaw, p. 143)</u>



The second analysis of non-sibilant transparency which Shaw proposes is that given in Steriade (1987b): The rule only targets segments specified for anteriority. Since anteriority is only contrastive among the class of sibilants, only the sibilants will be specified on the [anterior] tier:

(64) <u>Non-sibilant transparency, Version 2 (From Shaw, p. 143)</u>



Shaw concludes that either analysis of non-sibilant transparency is plausible.

The analysis in (64) applies the principles of Contrastive Underspecification, and is unproblematic. Let us consider Chumash Anterior Harmony within the framework of Radical Underspecification. Clearly both values of the feature [anterior] are active in this process. The Feature Minimization Principle requires one value of this feature to be absent in underlying structure, and without language-specific evidence to the contrary, that value will be [+anterior]. Now, in order to explain the transparency of the non-sibilants, it must be the case the the default rule supplying [+anterior] applies twice: The first time to the sibilants, and the second time, after harmony has applied, to the non-sibilants. This consequence has two major problems, the first of which is theory-internal. Since the harmony rule explicitly mentions the feature [anterior], and both values of [anterior] are active, the RROC requires that all default rules supplying [anterior] should apply prior to the application of the rule. Enforcement of the RROC would render the coronal nonsibilants opaque. Even if it were possible to get around the RROC, it is plainly the case that attributing to the grammar of Chumash two distinct default rules supplying [+anterior] entails the admission of considerable redundancy into the system. The more serious flaw, however is that the Radical Underspecification analysis treats as accidental the fact that the class of transparent segments in Chumash harmony is precisely that class for which the spreading feature is irrelevant: the coronal non-sibilants and all non-coronals. We can conclude that Radical Underspecification theory does not provide an adequate account of the Chumash pattern.

4.2 *Tahltan Coronal Harmony*

Tahltan contains five series of coronals: (i) alveolar non-sibilant (ii) lateral (iii) interdental (iv) alveolar sibilant and (v) palatal sibilant. The full consonant inventory is listed in (65):

(65) <u>Tahltan Consonant Inventory</u> (from Shaw 1991, p. 144)

b	d	dl	dð	dz	dž	g	gʷ	ɢ	
	t	tɬ	tθ	ts	tš	k	kʷ	q	
	t'	tɬ'	tθ'	ts'	tš'	k'	kʷ'	q'	ʔ
		ɬ	θ	s	š	x	xʷ	χ	h
		l	ð	z	ž	ɣ	ɣʷ	ʁ	
m	n				y		w		
	n'								

Tahltan has a coronal harmony process in which three of the five coronal series participate (interdental, alveolar sibilant, palatal sibilant), while the other two do not (alveolar non-sibilant, lateral). Members of the former category are capable of both undergoing and triggering the rule, whereas members of the latter category neither undergo, trigger, nor block the rule. Examples are shown in (66) and (67). The underlying form of the agreement morpheme which means 'first person singular subject' is /-s-/, and its surface form is underlined in the data in (66). The underlying form of the agreement morpheme which means 'second person singular subject' is /-θ-/, and its surface form is underlined in the data in (67):

(66) Coronal Harmony: The Pronominal Morpheme /s/ (from Shaw, p. 144)

a.	ɛs̱k'a:	'I'm gutting fish'
b.	sɛs̱xɛɬ	'I'm going to kill it'
c.	θɛθ̱ðɛɬ	'I'm hot'
d.	mɛθ̱ɛθɛθ	'I'm wearing (on feet)'
e.	eš̱džɪni	'I'm singing'
f.	neš̱yɛɬ	'I'm growing'

(67) Coronal Harmony: The Pronominal Morpheme /θ/ (from Shaw, p. 145)

a.	naθ̱iba:tɬ	'we hung it'
b.	θ̱i:tθædi	'we ate it'
c.	des̱idzɛl	'we shouted'
d.	xas̱i:dɛts	'we plucked it'
e.	ĩš̱itšotɬ	'we blew it up'
f.	uš̱idžɛ	'we are called'

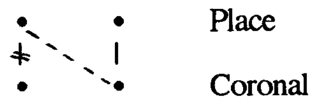
Shaw makes the following observations: Spreading is from right-to-left. The triggers and targets of the rule are the members of the dð, dz, and dž series, and only place features spread, not [voice], [cont], etc. Crucially, members of the non-participating series (the alveolar non-sibilants and the laterals) do not block the harmony process, as shown by the forms in (68). The triggers and targets are underlined, and the transparent coronal segments are in bold-face:

(68) Transparency (from Shaw p. 145)

a.	ɛθ̱**d**u:θ̱	'I whipped him'
b.	yaš̱**tɬ**'ɛṯš̱	'I splashed it'
c.	mɛʔɛš̱i**t**'oṯš̱	'We are breast-feeding'

Shaw analyzes the process as involving leftward spreading of the Coronal Node onto another Coronal Node, with concomitant delinking, as formalized in (69). She argues that since all features dependent on the Coronal Node spread, it must be the case that the rule spreads the entire node, and not independent features:

(69) Coronal Spread (from Shaw, p. 146)



Shaw proposes that the transparent coronals are underlyingly specified as shown in (70) and that those which participate in the harmony process are underlyingly specified as shown in (71) (RN = Root Node, PN = Place Node):

(70) Series which are Transparent to Coronal Harmony

a. [d]

RN
[-cont]

b. [dl][17]

RN
[-cont]
[+lat]

(71) Series which Participate in Coronal Harmony

a. [dð]

RN [-cont]
PN
COR
[+distributed]

b. [dz]

RN [-cont]
PN
COR
[+strident]

c. [dž]

RN [-cont]
PN
COR
[-anterior]

Under this analysis the Coronal Node is absent for those segments which can be uniquely specified without reference to any of the dependent features of the Coronal Node. These are the transparent coronals.

We begin by evaluating Radical Underspecification in light of the facts from Tahltan. In order to do so efficiently, we will consider the non-lateral alveolars of the language, listed in (72):

[17]Shaw assumes that [lateral] is a dependent of the root node.

(72) Tahltan non-lateral Alveolars

Alveolar Stops	Alveolar Fricatives	Alveolar Affricates
d	z	dz
t	s	ts
t'		ts'

Now, crucial to Shaw's analysis is that both the fricative series and the affricate series are both specified for a feature dependent on the Coronal Node. Members of the stop series, by contrast, are not underlyingly specified for a coronal dependent, and thus fail to project a Coronal Node prior to the application of the spreading rule. Therefore, the fricative series and the affricate series must be underlyingly specified as [+strident] in order to maintain Shaw's analysis.

Furthermore, the fricative series must be kept distinct from the affricate series underlyingly. The feature relevant for this contrast is [continuant]. We may either say that the value present underlyingly is [+continuant], as shown in (73), or [-continuant], as shown in (74):

(73)	Alveolar Stops	Alveolar Fricatives	Alveolar Affricates
		[+strident]	[+strident]
		[+continuant]	

(74)	Alveolar Stops	Alveolar Fricatives	Alveolar Affricates
	[-continuant]		[-continuant]
		[+strident]	[+strident]

Note that both of these systems are redundant. In (73) the alveolar fricative is distinct from the alveolar stop both by the feature [+continuant] and by the feature [+strident]. In (74) the alveolar fricative is distinct from the alveolar stop both by the feature [-continuant] and by the feature [+strident].

I submit that if the Feature Minimization Principle is to be taken seriously, this redundancy must be excluded. The only way that the redundancy can be removed while still keeping the three sets of alveolars underlyingly distinct is to remove the value [+strident] from the underlying matrix of the alveolar fricatives as in either (75) or (76):

(75)	Alveolar Stops	Alveolar Fricatives	Alveolar Affricates
		[+continuant]	[+strident]

(76)

Alveolar Stops	Alveolar Fricatives	Alveolar Affricates
		[+strident]
[-continuant]		[-continuant]

Either way, the alveolar fricative series cannot be represented as [+strident] underlyingly. Therefore, this series is predicted by Radical Underspecification *not* to project a Coronal Node, and thus *not* participate in the harmony process. This prediction is incorrect.

If it is indeed the Coronal Node which spreads in Tahltan coronal harmony, Contrastive Underspecification will also make the wrong predictions. Since place is contrastive among the stops and the nasals (except [n']), Contrastive Underspecification dictates that members of these classes will be underlyingly specified for point of articulation features.

4.3 *An Alternative Analysis of Tahltan*

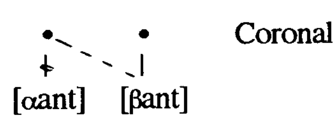
An analysis along the lines of that proposed by Steriade (1987b) for Chumash may also be appropriate for Tahltan. Notice that among the class of coronal affricates and fricatives there is a 3-way distinction with respect to point of contact, the furthest front being the interdentals, the furthest back being the alveopalatals, with the alveolars in between. Suppose that a single three-way feature characterizes this frontness continuum in Tahltan. We can label this feature [anterior] and assign it the values shown in (77):

(77) Values of Three-way [anterior]

[1 anterior] = interdental
[2 anterior] = alveolar
[3 anterior] = alveopalatal

Given that [anterior] as defined in (77) is contrastive only among the fricatives and affricates, the formulation of Tahltan rule is identical to that of the Chumash and Navaho rules:

(78) Universal [anterior] Harmony



(iterative)

Of course, in order to make this analysis convincing, evidence for a three-way [anterior] feature in other languages must be found.

4.4 *Summary: Coronal Harmony Systems*

The Chumash and Navaho patterns have been shown to be incompatible with the theory of Radical Underspecification. When the Feature Minimization Principle is applied rigorously, we see that the Tahltan pattern is incompatible with Radical Underspecification as well. Contrastive Underspecification is more promising in light of the facts from the harmony systems explored in this section. This theory correctly predicts the patterns observed in Chumash and Navaho. Furthermore, if the place of articulation distinctions among the coronal consonants of Tahltan can be shown to involve a three-valued frontness feature, the principles of Contrastive Underspecification will correctly predict the Tahltan pattern as well.

5. Summary and Conclusions

The principles of Radical Underspecification predict that unmarked coronal consonants are underlyingly underspecified for point of articulation features. This prediction has given rise to what I have labeled the Coronal Underspecification Hypothesis, and a good deal of research has been carried out which either assumes that this hypothesis is correct, or sets out to prove its validity. In this paper I have surveyed three types of phenomena which have been cited as support for the Coronal Underspecification Hypothesis, and we have seen that in all cases for which an underspecification analysis maybe appropriate, the hypothesis fails to predict the range of underspecified segments. The cases of assimilation typically cited are Catalan and Sanskrit, and we saw that the fact that plain coronals are targeted by assimilation rules cannot be explained by appealing to their lack of place specifications in either of these languages. The convincing cases of transcoronal fusion, i.e. those cases in which a single set of vowel place features is multiply linked to two skeletal slots and interrupted by a coronal consonant, consistently allow only coronal sonorants (and not necessarily *all* coronal sonorants) in the relevant position. If it is appropriate to analyze these phenomena as resulting from underspecification of place features, the Coronal Underspecification Hypothesis fails to explain why only the sonorants are underspecified. I have tried to show that the theory of Radical Underspecification does not predict the patterns of coronal harmony discussed by Shaw (1991). I have instead adopted the theory of Contrastive Underspecification, arguing that coronal consonants which do not participate in coronal harmony systems are those for which the spreading feature is not contrastive. Thus, the non-participating coronals are transparent because they are not specified for the relevant feature, not because they lack place features entirely.

The Coronal Underspecification Hypothesis attributes the special behavior of coronals to their status as the universally unmarked consonants. As the unmarked consonants, they are assumed to be underspecified for place features. Although the Coronal Underspecification Hypothesis is typically adopted by those authors who have written on coronal underspecification, the data discussed in the literature on this subject fail to support this hypothesis. Therefore, I conclude that the Coronal Underspecification Hypothesis must be abandoned as a means of explaining the phonology of coronal consonants.

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LABIALITY IN MIXTECAN -- A UNIFIED TREATMENT[1]

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0. Introduction

In this paper I analyze data from Mixtecan, a group of Otomanguean languages spoken in the states of Oaxaca, Guerrero, and Puebla, Mexico (Hollenbach 1977, Longacre 1957, Longacre and Millon 1961), concluding that labiality is limited to one autosegment per word. Mixtecan will be shown problematic for theories positing distinct labial features for consonants and vowels (Archangeli and Pulleyblank 1986, Selkirk 1988,1993, Clements 1991, Odden 1992). Instead, this analysis supports a theory of feature geometry which does not distinguish between consonantal and vocalic labiality (Clements 1985, Sagey 1986, McCarthy 1989).

In Section 1 I discuss the patterning of labiality in Proto-Mixtecan (Longacre 1957, Longacre 1962, Longacre and Millon 1961, Rensch 1976, Rensch 1977), concluding that labiality is strictly limited in its distribution. In Section 2 I present data from Trique (Longacre 1957, Hollenbach 1977), concluding that labiality is limited to one instance per word. I reach a similar conclusion regarding the patterning of labiality in Mixtec and Proto-Mixtec (Mak and Longacre 1960). I further conclude that constraints on the distribution of labiality in Trique and Mixtec have their origins in Proto-Mixtecan. In Section 3 I consider the theoretic implications of these findings with respect to the feature-geometric location of the feature [labial].

1 Proto-Mixtecan

Longacre (1957) argues that modern Trique, Mixtec, Cuicatec, and perhaps Amuzgo, are historically derived from Proto-Mixtecan (PMx). His reconstructed segment inventory for PMx is in (1).

[1]Thanks to Abby Kaun for her helpful comments.

(1)		*t		*k	*k^w	*ʔ	*i	*i	*u
		*^{n}d		*^{n}g	*^{n}g^w		*e	(*O)	*o
		*θ		*x	*x^w			*a	
	*m	*n	*n						
		*l							
	*w		*y						

*i is a high, close, back, unrounded vocoid. *O is "some sort of low, back rounded vowel"(p.27) whose presence is questionable, as it does not survive in modern reflexes. Longacre (1962) revises the vowel inventory to exclude *O. Rensch (1976,1977) simplifies the system further in his discussion of PMx in the context of Proto-Otomanguean, eliminating *o as well.

The word in PMx normally consisted of a stress-initial bisyllabic root and non-syllabic inflectional material (consisting of tone, length, ablaut, and/or consonantism). This morphological complex is called a "couplet" by Longacre.[2] A couplet's first and second syllables are referred to as "penultima" and "ultima," respectively. Ultimas may have possessed nasal codas.

Longacre reconstructs PMx as possessing a constraint which disallows the co-occurrence of a labial consonant (*m,*w,*k^w,*^{n}g^w,*x^w) and a labial vowel (*u,*o) within the syllable. This constraint is formalized in (2).

(2) $*[[\text{lab}][\text{lab}]]_\sigma$

A further constraint disallows labial onsets in penultimas.

(3) $*[[\text{lab}]\text{V}\sigma]_{\text{couplet}}$

His list of reconstructed PMx ultimas possesses no instances of syllables with multiple labial specifications, while his list of PMx penultimas possesses no instances of labial onsets. Ultima-final nasals in PMx are reconstructed as *m, although this segment survives in modern reflexes as vowel nasalization, possessing no independent strictural component. Longacre reconstructs a dissimilatory process in which labial and labialized

[2]Employing more modern terminology, it might be possible to replace "couplet" with "foot".

onsets lose their labiality in the presence of a nasal coda (*k^{w}i - *kim, *x^{w}a - *xam, *?mV - *?Vm), thus obeying a reconstructed constraint limiting labial consonants to one per couplet.

(4) *[[lab C][lab C]]$_{\text{couplet}}$

In Mak and Longacre's (1960) discussion of Proto-Mixtec (PM) phonology (derived from PMx), a specifically bilabial nasal coda is reconstructed to account for the presence of intervocalic [m] in certain modern Mixtec dialects within cognate sets having nasalized vowels in other dialects. Note that these intervocalic bilabial nasals are currently present only when the preceding vowel is itself labial (reconstructed as PM u). Thus we get *kumi* (four) (< PM *kųų*), *tumi* (feather) (< PM *tųų*), but *kan* (to dig) (< PM *kąą*).[3] As we will see in the next section, such superficial sequences of labial segments may be analyzed as deriving from a single labial autosegment.

Given the syllable-internal constraints already discussed (cf.2,3,4), we may conclude that the following couplets were disallowed in PMx:

(5) Disallowed couplets involving labiality in PMx

	C	V	C	V	N
a.	[lab]	X	X	X	
b.	X	X	[lab]	[lab]	
c.	X	X	[lab]	X	[lab]

(where [lab] = any labial, X = any segment)

That is, PMx disallowed couplets with labial onsets in the penultima (5a), as well as couplets with two labials in the ultima, one of which is in onset position (5b,c).

With these constraints holding of PMx, let us consider the possible instances of multiple labial specifications within the PMx couplet.

[3]Mak and Longacre report that Chigmecatitlan Mixtec possesses *kam* for PM *kąą*, but question the accuracy of the transcription. Post-nasal [i] in these modern forms is assumed "added to a few forms in certain dialects"(1960:p.38).

(6) Possible multiple labial specifications in PMx couplets

	C	V	C	V	N
a.	X	[lab]	X	[lab]	
b.	X	[lab]	[lab]	X	
c.	X	[lab]	X	[lab]	[lab]
d.	X	[lab]	X	X	[lab]
e.	X	X	X	[lab]	[lab]

(where [lab] = any labial segment, X = any non-labial segment)

Given (6), our tentative conclusion regarding the distribution of labiality in PMx couplets is the following: couplets which possess two labial vowels with or without a labial ultima nasal coda (6a,c), or a labial penultima vowel followed by a labial onset (6b), or a labial penultima vowel with a labial ultima nasal coda (6d), or a labial ultima vowel with a labial ultima nasal coda (6e), were all acceptable.[4] In the next section, we will see how a more general constraint may have been operating in PMx, by investigating labiality constraints in modern Trique.

2. Labiality Constraints in Trique

In this section, I investigate labiality constraints in the modern Trique dialects of San Andres Chicahuaxtla, San Martin Itunyoso (Longacre 1957), and San Juan Copala (Hollenbach 1977). The patterning of labiality here will show that the superficial instances of multiple labial specifications that were seemingly allowable in PMx may be illusory, and that Longacre's two distinct syllable-based constraints, and one consonant-based constraint on labial co-occurrence may possibly be superseded by a single constraint limiting labiality to one instance per couplet.

In Trique, couplets are stress-final, indicated by lengthening of open ultimas, with a freer distribution of segments in ultimas than in penultimas. Only the laryngeals /ʔ,h/ may close syllables. The Trique segment inventory is listed in (7).

[4]See the appendix for a list of reconstructed PMx couplets.

(7)

p	t			k	i:	u:
b	d			g	e(:)	o(:)
	s	š	ṣ̌		a(:)	
	z	ž	r			
	c	č	č̣			
m	n					
	l					
		y	w			

ʔ, h

(/p/ and/b/ occur only in loans. Labiovelars ([k^w], [g^w]) are treated as clusters by Hollenbach (/kw/,/gw/))

Vowels may be constrastively nasalized, and ultima vowels may be laryngeally interrupted, in which /h/ or /ʔ/ intrude on the vowel (i.e., [VhV], [VʔV]). Interrupted vowels are distinguished from true sequences of vowel-laryngeal-vowel (often displaying translaryngeal harmony), in that interrupted forms occur in otherwise bisyllabic words, and do not undergo final lengthening. Thus [weʔe^3] (/weʔe^3/)(house) is monosyllabic, while [we^{3}ʔe:^{2}] (/we^{3}ʔe^2/)(beautiful) is bisyllabic.

The following relevant facts and generalizations regarding labiality in Trique are presented in Hollenbach (throughout, tones are excluded):

(8) a. Labiovelars may occur word-medially.

nukwah	(strong)
dugwah	(to twist)

b. Sequences of [uw] are attested. (Syllable boundaries are indicated by ".".)

yu.wi	(people)
zu.we	(dog)
ru.wa	(squash seed)

c. Only one labial consonant is permitted per couplet, excluding homorganic labial nasal-stop clusters and their free variants. These clusters are limited in their lexical distribution to the loan and mimetic vocabularies:

*[lab] [lab]
[+cons]...[+cons]

but kamba? (furrowed green squash)

(-ma?, -mwa? are also reported as acceptable ultimas, i.e., there is free variation among these forms.)

d. Multiple [labial] specifications are very rarely attested.

i.	roko	(custard apple)
	guku	(Inca dove)
ii.	guno	(to hear)
	uno	(to sow)
	kohnu	(tobacco)

e. No syllable consists of a labial followed by a round vowel.

*mu *mo *wo *wu

(recall that /m/ is the only native labial contoid)

The data in (8di) are harmonic forms. In (8dii) is an exhaustive list of forms from both Hollenbach's list (of approximately 150 items) and Longacre's list (of approximately 500 items) which possess sequences of non-identical round vowels. Regarding (8e), Longacre (1957) indicates that this constraint is active in the synchronic grammar, writing that "the semivowel w does not occur before o or u...When morphological combinations would bring together these restricted combinations the semivowel is lost"(no examples given)(p.16).

Although the data in (8) indicate that multiple labial segments may be present within the couplet, I will now argue that nearly all forms which superficially possess multiple labial segments may be reducible to a single labial specification.

Consider first the forms in (8a). A generalization that eluded Hollenbach is that medial labiovelars occur with other labials only in very limited circumstances. Specifically, these segments are present only when immediately preceded by /u/, and immediately followed by a non-labial vowel. Moreover, such sequences seemingly never constrast with non-labialized counterparts, thus, for example, *[uka] is impossible.[5] A sample list of these forms, from both Hollenbach and Longacre, is presented in (9).

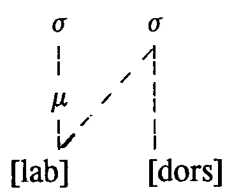
[5]The sole exception to this generalization in Longacre's list is *guki* (yesterday).

(9)

nukwah	(strong)	
dugwah	(to twist)	
dugwane	(to bathe someone)	
rugwah	(hearth stones)	(-ruwah)
dugwe	(to weep)	
dugwi	(together with, companion)	
dukwa	(jail)	
nugwa	(word)	
nukwa	(to stretch (something))	
rugwi	(peach)	
zugwe?ehe	(mattery eyes)	
zugwi	(name)	
zukwa	(snake)	

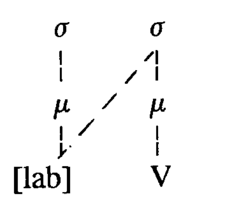
Labiality is thus never contrastive in this environment. I conclude that medial labiovelars acquire their labiality from the preceding labial vowel, and thus these surface forms may derive from a single [labial] autosegment. This is shown in (10).

(10) /uka/ -> [ukwa]



Similarly, [uwV] sequences never constrast with [uV] sequences, and thus involve hiatus resolution in which the labial vowel spreads rightward to provide an onset for the bare vowel syllable (cf.8b)

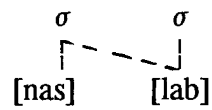
(11) /ua/ -> [uwa]



Hiatus resolution is not present for /iV/ sequences (*nia* (dinner), *rio* (trough): *[iyV]).

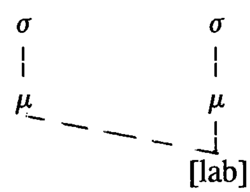
Homorganic labial nasal-stop clusters in the loan and mimetic vocabularies may uncontroversially be analyzed as possessing a single [labial] autosegment which is associated to both the stop and the immediately preceding nasal (cf.8c).

(12) /VNbV/ -> [VmbV]



Finally, couplets with identical vowels may be multiply linked for place features (cf.8d).

(13) [$CV_{[lab]}CV_{[lab]}$]



In Longacre's list, when discounting vocalic tonal, laryngeal, and nasal contrasts, there are approximately 210 segmentally distinct couplets. That is, 210 couplets possess distinct combinations of segments, apart from tonal, laryngeal, and nasal contrasts. 33% of these forms (70 in all) are fully harmonic, i.e., consist of vowels of identical quality. Given the six vowel qualities present in the San Andres Chicahuaxtla and San Martin Itunyoso dialects, we would expect only one couplet in thirty-six to display vocalic identity (2.8%) if there were no tendency toward vowel harmony. Hollenbach, in her discussion of the San Juan Copala dialect states "Although all five long vowels occur in nonultimas, it is almost possible to reduce the number of constrasts in this position to three. In words of native origin, the occurrence of /i u/ or /e o/ respectively, is to a large degree predictable from the ultima vowel..."(p.42). It is for these reasons that positing harmonically derived vocalism in penultimas becomes tenable.

With these representations in mind, the overall generalizations to be made regarding the patterning of labiality in Trique are in (14).

(14) a. All instances of adjacent labial segments are reducible to a single [labial] autosegment (cf. 8b,c,d).

b. Labial contoids never co-occur with labial vocoids (cf.8d,e), and only co-occur with other labial contoids if both derive from a single [labial] specification.

c. Multiple labial specifications in vocoids which are non-string-adjacent are extremely rare (cf.8dii).

Now the distribution of labiality in Trique becomes apparent: assuming the exceptionality of the forms in (8dii), couplets are limited to a single [labial] specification.

(15) <u>Modern Trique labiality constraint</u>

$*[[\text{lab}](\ldots)[\text{lab}]]_{\text{couplet}}$

There are two further exceptions to this constraint in Hollenbach's data. The first, *ru?mi* (charcoal), is in free variation with *ru?wi*, and is thus not a true counter-example. Longacre and Millon reconstruct glottal stop - consonant sequences for PMx, but write that "glottal stop ... offered insufficient consonantal barrier and functioned in a sort of quasi-prosodic function [sic]"(1961:p.5). Thus sequences of glottal stop - consonant are best considered laryngealized consonants in PMx. I will assume the same holds of modern reflexes.

The second counter-example, *zume* (barn owl), seemingly does not possess a free variant *zume*, but may be derived historically from PM *zuu*.

Longacre's wordlist for Trique contains only two more forms which unambiguously possess more than one labial specification.

(16)	a.	maru	(black)
	b.	zumigwi	(world)

Note that in (16b) the domain of multiple labiality exceeds bisyllabicity, and thus does not constitute a true counter-example.

Of Longacre's list of approximately 500 words, 234 may be argued to contain only one instance of labiality (cf.10-13). If one instance of labiality is present in approximately 50% of all items, we would expect, all else being equal, that two instances of labiality should be present in 25% of all items, or 125 forms. The fact that only two forms, or .4% of the total, contain multiple labial specifications strongly suggests a constraint of the form in (15) limiting the distribution of labiality.

Now observe that similar constraints hold elsewhere in modern Mixtecan languages. In modern Mixtec, while Longacre shows that vowels of identical quality are oft-attested within the couplet, he quotes Pike's (1947) observation that "no combinations of o with u are found"(cited in 1957:p.23). Vocalic labiality in Modern Mixtec thus nearly parallels the pattern in modern Trique. Given the modern cross-dialectal co-occurrence constraint on the distribution of labiality in vowels, we may rather safely assume its origins are from PMx.

Now recall the conclusions of Section 1 regarding multiple labial specifications in PMx couplets (repeated here as (17)).

(17) Possible multiple labial specifications in PMx couplets

	C	V	C	V	N
a.	X	[lab]	X	[lab]	
b.	X	[lab]	[lab]	X	
c.	X	[lab]	X	[lab]	[lab]
d.	X	[lab]	X	X	[lab]
e.	X	X	X	[lab]	[lab]

(where [lab] = any labial segment, X = any non-labial segment)

Consider first pattern (17a), which allows two labial vowels within the couplet. But we have just concluded that constraints in modern reflexes forbidding such forms is most likely derived from PMx itself. Therefore, pattern (17a) turns out to be unacceptable. This still allows pattern (17b-e), however. Concerning (17b), note that we have already seen that such sequences are in most instances readily derivable from a single labial specification which spreads rightward from the penultima. Therefore, pattern (17b) is not acceptable either. We are thus left with instances of multiple labial specifications involving reconstructed bilabial nasal ultima codas. Mak and Longacre themselves seem far from comfortable with this reconstructed segment, considering evidence for bilabiality here "scanty" (1960:p.30,fn.16). It is also important to recall that these reconstructed bilabials are present in modern Mixtecan only when following labial vowels, and thus their labiality is predictable. Elsewhere, these nasals survive only as either coronals or vowel nasalization.

It is quite possible then, that the various labiality constraints argued by Longacre, Pike, and Hollenbach to hold of PMx and certain of its modern reflexes may be subsumed under a single, general constraint on the distribution of labiality.

(18) Possible Mixtecan labiality constraint

$$*[[\text{lab}](\ldots)[\text{lab}]]_{\text{couplet}}$$

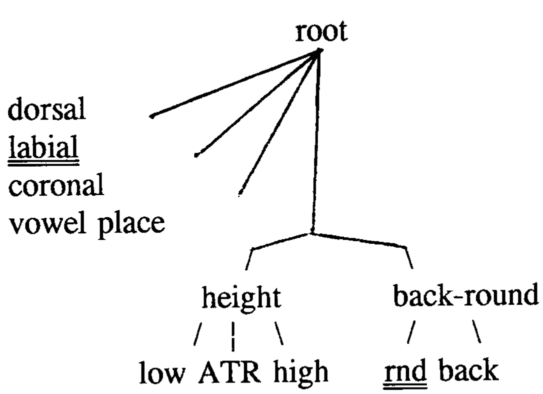
Specifically, [labial] is limited to one instance per couplet.

3. Theoretic Implications

Various theories of feature geometry posit distinct place features for consonants and vowels. Certain of these theories allow for the interaction of labial consonants and labial vowels via "cross-tier assimilations" and "cross-tier dissimilations" (Selkirk 1988, Clements 1991), while another (Odden 1992) predicts the complete independence of consonantal and vocalic labiality.

The labiality constraint present in certain Mixtecan languages limits labiality to one instance per couplet, regardless of the stricture specifications of the segment(s) to which labiality is associated. Mixtecan thus poses an immediate problem for Odden's geometry (shown in (19)).

(19)



(19) shows that labiality in consonants is represented as an articulator, sister to [corona] and [dorsal]. Labiality in vowels is represented underneath the Vowel Place node, sister to [back].

Clements (1991) proposes a "consonant-place - vowel-place" geometry (20), that, while still segregating consonantal labiality from vocalic labiality, nonetheless allows their interaction via "cross-tier assimilations" and "cross-tier dissimilations".

(20)

```
                  root
                   |
                  C-place
                  /     \
          articulators  vocalic
          /              /     \
   [labial]         V-place  aperture
          etc.        /
                  [labial]       etc.
```

In this geometry, Clements allows labial consonants and labial vowels to interact in terms of assimilatory and dissimilatory processes despite their being on distinct autosegmental tiers.

Clements' approach would seem to be an attempt at geometrically capturing the distinct phonetic manifestations of labial vowels and labial consonants: while labial vowels are always round, this entailment does not hold for labial consonants. Nonetheless, labial vowels and labial consonants *do* seem to interact (contra Odden 1992). It is apparently for this reason that Clements allows for these distinct features' cross-tier interaction.[6] Yet Clements avoids the problems encountered in Odden's geometry by stipulation only: within Clements' model, despite their phonetic similarity (though non-identity), the only property common to labial consonants and labial vowels is the label [labial]. By extension, we expect interactions between any two features, should they bear like-sounding names. Surely, we do not want such rampant arbitrariness to be allowed into the grammar, and yet Clements' approach would seem to be lifting the curtain on just such a scenario.

The Mixtecan data show no asymmetry between labiality in consonants and labiality in vowels: only one labial specification is allowable per couplet, regardless of whether it is manifested on a consonant, on a vowel, or on both. One geometry which reflects this unification of consonantal and vocalic labiality is presented in Sagey (1986), the relevant components of which are shown in (21).

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[6]In most cases stricture alone can determine whether a labial segment will be round or not: labial vocoids are rounded, while labial contoids are not rounded. See Selkirk (1993) for a variant of this approach.

(21)

```
                 Place
              /    |    \
      [labial][coronal][dorsal]
```

The Mixtecan data may be accounted for by this unified approach to labiality.

4. Conclusion

The constraint on the distribution of labiality in Mixtecan requires reference to both consonants and vowels. This favors a unified approach to consonant-vowel labiality, eschewing the problems associated with positing their segregation.

Appendix

Longacre and Millon (1961) present a brief list of reconstructed PMx forms. All couplets are presented here (monsyllabic forms are omitted).

*^{n}du^{n}di	(bean)
*θo?wa	(cacao)
*kO^{n}g^{w}i/	
*xO^{n}g^{w}i/	
*^{n}dO^{n}g^{w}i/	
*tO^{n}g^{w}i	(day)
*yawe/	
*θawe	(maguey)
*ya(m)xi(m)	(maize dough)
*ya?we	(market place)
*yOθo	(metate)
*xitam?/	
*yitam?	(earth oven)
*yuwe?/	
*θuwe?	(earth mat)
*k^{w}ano(m)/	
*xino(m)/	
*^{n}dano(m)/	
*kanom/	
*nano(m)	(to plant)
*yami/	
*θami/	
*θa?mi	(potato)
*^{n}diθi	(pulque)
*k^{w}ande/	
*xinde/	

*kande/	
*^{n}dande	(to ripen)
*yOkim?/	
*yOk^{w}i?/	
*ΘOkim?	(squash)
*yunO(m)/	
*xanOm	(tobacco)
*yiko/	
*Θiko/	
*^{n}diko	(twenty)
*k^{w}anO(m)/	
*xinO(m)/	
*kanO(m)/	
*danO(m)	(to weave)

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ERRATA

The following corrections should be made in UCLA OPL 13:

1. p.114, fn.5 should read:
   "The sole exception to this generalization in Longacre's list is *gukī* (yesterday).

2. p.116, 9 lines from bottom should read:
   "...we would expect only six couplets in thirty-six (16.66%)..."

3. p.117, 10 lines from bottom should read:
   "...variant *zuwe*, but may be derived historically from PM *zʉʉ*."