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FEATURE ORGANIZATION AND THE STRONG DOMAIN HYPOTHESIS IN ZULU [LABIAL] PHONOLOGY*

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0. INTRODUCTION

The phenomenon of 'palatalization' in Southern Bantu languages (specifically languages of the Nguni and Sotho groups (Doke 1967:39-40)) has evoked considerable discussion in the generative phonological literature (O'Bryan 1974, Stahlke 1976, Herbert 1977, Ohala 1978, Khumalo 1987, Gorecka 1989). While individual languages within this group display variation in the details of the palatalization process, the phenomenon of interest here may be characterized as an alternation between labial and prepalatal segments which occurs in passive forms of verbs, and in locative derivatives of nouns. Although previous accounts of this phenomenon have treated this system of alternations as partially or entirely morphological in nature, I will argue in this paper that labial palatalization phenomena in Zulu, a language of the Nguni group spoken primarily in

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South Africa, are to be understood as the result of a phonological restriction on labial sequences in Zulu.[1]

1. BACKGROUND INFORMATION

Palatalization of labials in Zulu and related languages has been analyzed variously in the literature as a process of assimilation to or fusion with a following palatal glide (Stahlke 1976, Ohala 1978, Khumalo 1987), dissimilation from a following labial segment (Doke 1954, 1967; Gorecka 1989), or as a morphologically determined segment substitution not triggered by phonetic factors in the synchronic grammar (O'Bryan 1974, Herbert 1977). Before presenting the arguments for a dissimilation analysis of labial palatalization, it will be necessary to examine the data at issue, as well as various other aspects of Zulu phonology and morphology.

1.1 THE CONSONANT INVENTORY OF ZULU

For reference, the non-click consonant segments of Zulu are given in TABLE 1 below; click consonants are shown in TABLE 2.

[1]In nominal diminutives, both labial and coronal segments undergo palatalization, with some coronal segments (e.g. tʰ and n̄) displaying an alternation in place and others (l and ɬ) alternating only in manner of articulation. Alternations in the diminutive are subject to numerous exceptions. John McCarthy (p.c.) points out that palatalization is a well-documented property of the category 'diminutive' cross-linguistically; this fact, coupled with the sporadic applicability of palatalization here and the inclusion of coronal segments as targets suggests that palatalization in diminutives is a morphological, rather than phonological, phenomenon. No further discussion of palatalization in diminutives will be presented here.

Note that the labial alternations in question are not consistent with any phenomenon usually referred to as 'palatalization', such as the imposition of a secondary coronal articulation on a segment with primary labial constriction. For ease of discussion and consistency with the literature on Southern Bantu, however, I will continue to refer to the phenomenon under investigation here as 'palatalization'.

TABLE 1. ZULU CONSONANTS.

		Labial	Alveolar	Prepalatal	Velar	Laryngeal
Stops:	asp.	pʰ	tʰ		kʰ	
	ejec.	pʼ	tʼ		kʼ	
	dep.[2]	b	d		g	
	impl.	ɓ				
Fricatives:	vl.	f	s	š		h
	dep.	v	z			ɦ
Affricates:	vl.		tsʼ	čʼ	kxʼ	
	dep.			ǰ		
Nasals:		m	n	ñ	ŋ	
Laterals:			l			
	vl. fr.		ɬ			
	dep.fr.		ɮ			

TABLE 2. CLICK CONSONANTS.

	Dental	Palato-Alveolar	Lateral
plain	ʇ	ʗ	ʖ
asp.	ʇʰ	ʗʰ	ʖʰ
dep.	ʇᵍ	ʗᵍ	ʖᵍ

1.2 PALATALIZATION DATA

Consider the passive verb forms given in (1a), (b) and (c) below.[3] In (1a), the behavior of root-final bilabials in passive forms is contrasted with that of segments at other places of articulation. (1b) demonstrates that palatalization will apply to the rightmost labial in the verb stem. The target need not be root-final, but may be separated from the passive suffix by other root consonants or by segmental material in verbal extensions. In (1c), we see cases in which palatalization fails to apply; in each example, the segment which fails to undergo palatalization is the initial segment in the verb root.

[2]This consonant series, represented with the symbols traditionally used for (modal) voiced segments, is referred to in the Southern Bantu literature as the 'depressor' series, due to the lowering effect that these segments have on the tone of a following vowel. Doke (1969:50-1) reports that this series of stops is voiceless throughout the closure; 'the start of voicing is simultaneous with the explosion.'

[3]Unless otherwise noted, data presented in this paper are drawn from the author's field notes. Vowel length (occurring predictably on the penultimate syllable) and tone are not indicated. The consultant is a forty-two year-old female from Natal.

(1a)	ɓopʰa	'Tie!'	iyaɓoʂwa	'it is being tied'
	ɪupʰa	'Trap!'	iyaɪuʂwa	'it is being trapped'
	guba	'Dig!'	ayaguʃwa	'it is being dug'
	ɬeɓa	'Gossip!'	ᵘwiyaɬeč'wa	'she is being gossiped about'
	nɪoma	'Praise!'	iyanɪoñwa	'it is being praised'
	luma	'Bite!'	uwiyaluñwa	'he is being bitten'
	kʰetʰa	'Pick out!'	iyakʰetʰwa	'it is being picked out'
	ʗʰasa	'Slap!'	uyaʗʰaʂwa	'she is being slapped'
	ɪula	'Sing!'	iyaɪulwa	'it is being sung'
	gɛza	'Wash!'	iyagɛzwa	'it is being washed'
	bek'a	'Watch over!'	uyabek'wa	'he is being watched over'
(1b)	ɓopʰa	'Tie!'	uyaɓoʂiswa	'he is being made to tie'
			iyaɓoʂelwa	'it is being tied for s.o.'
	ɪᵍoboza	'Dip!'	iyaɪᵍoʃozwa	'it is being dipped'
	seɓɛnza	'Work!'	iyaseč'ɛnzwa	'it is being worked'
	ɬupʰek'a	'Suffer'	k'uɬuʂek'wa	'it is being suffered'
	šumayela	'Preach!'	iyašuñelelwa	'it is being preached'
	pʰupʰuma	'Boil!'	iyapʰupʰuñiswa	'it is being made to boil'
(1c)	bala	'Write!'	iyabalwa	'it is being written'
	ɓuta	'Collect!'	iyaɓutwa	'it is being collected'
	pʰuza	'Drink!'	iyapʰuzwa	'it is being drunk'
			*iyaʂuzwa	

These examples demonstrate that palatalization in passive verb forms applies to the rightmost bilabial segment[4] in the verb root (or stem, if the passive is formed on a base which has itself been derived by the addition of various suffixes), so long as that segment is not root-initial. Note also that this palatalization behavior is restricted to the stem domain; a bilabial segment in a prefix will not undergo this alternation. Thus, **ɓayaɪᵍonwa** 'they are being teased', not ***č'ayaɪᵍonwa**.

Palatalization of labials also occurs in locative adverbs (derived from nouns by suffixing /-ini/), provided that the final syllable of the noun root is composed of a labial consonant followed by a round vowel. Examples are provided in (2) below (Doke 1967(a,b,c), Khumalo 1987 (a,b)). (Alternations in the surface vowel quality of the locative suffix are predictable according to the height of the root-final vowel; [e] surfaces when the noun root ends in a [-high] vowel.) In the locative, only a bilabial in the root-final syllable undergoes palatalization; medial bilabials are impervious to palatalization, in contrast to their behavior in the passive. The failure of labial consonants to palatalize when followed by a non-round vowel is shown in (2b), and the failure of non-labial consonants to undergo palatalization is demonstrated in (2c).

[4]Labiodentals fail to undergo palatalization (e.g. **ɔova** 'Knead!', **iyaɔovwa** 'it is being kneaded'). More generally, [+continuant] obstruents do not display alternations in palatalization contexts.

(2a)	isiβopʰo	'grass rope'	esiβoʂeni	locative
	isigubu	'calabash'	esiguǰini	locative
	iŋguβo	'blanket'	eŋguʂ'eni	locative
	umlomo	'mouth'	emloɲeni	locative
	emβoβo	'hole'	emboč'eni	locative
	isipʰupʰupʰu	'frothing beer'	esipʰupʰuʂini	locative
(2b)	iñama	'meat'	eñameni	locative
	intaba	'hill'	entaβeni	locative
(2c)	izulu	'sky'	ezulwini	locative
	uβuso	'face'	eβusweni	locative
	utʰi	'stick'	otʰini	locative

The alternations which occur under palatalization in Zulu are summarized in TABLE 3 below.

TABLE 3. PALATALIZATION ALTERNATIONS.

Underlying	Palatalized
p'	č'
pʰ	š
b	ǰ
β	č'
m	ñ

2. PALATALIZATION IN ZULU

A careful review of the palatalization data provided in (1) and (2) above will suggest a number of important questions to be answered in an analysis of the phenomenon. First, why do only labials participate in the palatalization process, and why is the result of palatalization a prepalatal segment? Second, why is labial palatalization restricted to only two morphological contexts within the language, and how is this restriction to be characterized? (That is, is labial palatalization to be assigned to the morphological component of the grammar, or to the phonological component?) Third, why are there differences in the position of the labial target of palatalization in the locative and the passive (i.e. a root-final consonant vs. any non-root-initial consonant in the stem)? Finally, why doesn't a labial glide (w) (derived from a stem-final round vowel) in the locative surface when palatalization has occurred? Answers to these questions will be provided in the remainder of this paper.

2.1 THE ENVIRONMENTS FOR LABIAL PALATALIZATION

Given that labial palatalization is quite restricted in occurrence in Zulu, appearing in only two morphologically-circumscribed environments, one may rightly wonder whether a phonological analysis (i.e. one which assumes that

palatalization is conditioned by strictly phonetic factors) is possible or preferable to one which assigns these alternations to the morphological component of the grammar. The palatalization phenomena in question have repeatedly been described in the literature on Zulu as properties associated with specific morphological categories (primarily Doke 1954, 1967, with other writers drawing heavily on his descriptions), rather than with general phonological operations of Zulu. However, a closer examination of the candidate environments for palatalization reveals that the limited occurrence of these alternations may be ascribed not to the presence of a morphological restriction on rule application, but rather to generalizations about the phonological shapes of roots and suffixes in Zulu, and about the ways in which phonological constraints on syllables are violated and repaired under morpheme concatenation.

Let us consider the contexts in which palatalization occurs. First, we have palatalization of bilabial stem consonants in passive verb forms; the passive suffix in Zulu is /-w/[5]. Thus, palatalization occurs when a stem contains a (not necessarily contiguous) sequence of bilabial consonant+w. In an examination of commonly used verbal suffixes, Doke (1967:66-7) provides a list of seventeen synchronically productive verbal extensions, only one of which (the passive) contains the labial glide w. Further, none of the sixteen remaining suffixes contains a round vowel which can lose its moraic status (resulting in a w), as such suffixes are of the shape -VC or -VCVC, meaning that suffixal round vowels will always be 'protected' from contact with a following vowel by an intervening consonant, insuring that hiatus will never arise. Additionally, as all Zulu verb roots are consonant-final, we will find no instances of hiatus between a root-final round vowel and a vowel-initial verbal suffix (with a w resulting). Thus, all instances of labial palatalization in Zulu verbs occur in the sole phonological context in which a sequence of labial consonant+w may arise within verb stems.

Second, palatalization occurs in locative adverbs derived from nouns whose final syllable is composed of a bilabial consonant followed by a round vowel. As the locative suffix is vowel-initial, the environment for Glide Formation is met when a noun root ends in a round vowel; a w will be derived. Consider the locative data in (3) below; palatalization applies in (3a), but does not in (3b) or (3c) (Doke 1967 (a,b,c), Khumalo 1987 (b,c)).

(3a)	isiɓopʰo	'grass rope'	esiɓoʃ̲eni	locative
	isigubu	'calabash'	esiguʒ̲ini	locative
	iŋguɓo	'blanket'	eŋguʧ̲'eni	locative
	umlomo	'mouth'	emloɲ̲eni	locative

[5]With 'monosyllabic' (i.e. C- or VC-) verb stems, an epenthetic [i] appears before the [w]. Some analyses of Southern Bantu treat this vowel as an underlying segment, assuming that the passive suffix is /-iw/ (e.g. Louw 1975, Stahlke 1976, Khumalo 1987), with the vowel deleted following stems which are CVC- or larger. I assume that epenthesis occurs in order to satisfy prosodic minimality requirements imposed by the passive suffix; nothing in my analysis of palatalization hinges crucially on this assumption. For a detailed discussion of these issues, see Beckman 1992.

(3b)	iñama	'meat'	eñameni	locative
	intaβa	'hill'	entaβeni	locative
	utʰi	'stick'	otʰini	locative
(3c)	izulu	'sky; heaven'	ezulwini	locative
	uβuso	'face'	eβusweni	locative
	idolo	'knee'	edolweni	locative
	imot'o	'car'	emotweni	locative

In the examples in (3c) in which the noun ends in round vowel preceded by a non-labial consonant, we find that the stem-final vowel has lost its mora, yielding a surface **Cw** cluster. Thus, with no evidence to the contrary, we must assume that a non-moraic labial vocoid is derived from the stem-final round vowels in (3a) at some stage of the derivation. Further, it is important to note that palatalization never occurs when the final syllable of the noun stem is composed of a labial consonant plus a non-round vowel, as shown in (3b); therefore, labial palatalization is not obviously a property of locative denominal adverbs in general, but is dependent upon the segmental content of the noun stems in which it applies.

In Zulu, there are essentially two extensions which may be added to nominal roots: the locative and the diminutive (Doke 1967).[6] As noted earlier, we find palatalization of both bilabial and coronal consonants in the diminutive, and labial palatalization in the locative. Since there are apparently no other extensions which may be suffixed to noun stems (which are typically vowel-final), there are no additional contexts in which hiatus resolution would result in the creation of a **w**; thus, we cannot demonstrate unequivocally that labial palatalization in locative adverbs is a morphologically-determined alternation, rather than merely resulting from the juxtaposition of a bilabial consonant and a labial glide derived to resolve hiatus. That is, if other contexts were available (through morpheme concatenation) in which a **BU-V**[7] sequence were created, labial palatalization would be predicted to occur, as the crucial sequence of **B+w** would be derived. Labial palatalization in Zulu occurs in only the environments in which a sequence of labial consonant plus labial glide is possible within the domain of the stem (i.e. the root and any extensions which appear, excluding prefixes); thus, it is possible to characterize the conditioning environment for labial palatalization in strictly phonological terms, without reference to the morphosyntactic features of the forms in which the alternations occur. Further, as we have demonstrated that a sequence of two labial elements is essential in triggering labial palatalization, a dissimilation account of the phenomenon is indicated.

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[6]There is also a feminine suffix/-azana/. Neither the synchronic productivity of the feminine suffix (including applicability with stems ending in labial consonant-initial syllables) nor the palatalization behavior of noun stems in feminine forms is documented.

[7]The following abbreviations are used here and throughout: C = any consonant, V = any vowel, B = any bilabial consonant, F = any labiodental consonant, U = any round vowel, I = any front vowel.

2.2 LABIAL PALATALIZATION IN THE PASSIVE

Perhaps the most striking aspect of palatalization in passive forms of which we must provide an account is the long-distance nature of the interaction between labial segments. The rightmost bilabial consonant within the verb stem[8] is subject to palatalization, regardless of the number of intervening segments or syllables, so long as it is not root-initial. Furthermore, round vowels may intervene between the passive suffix and the bilabial consonant which undergoes palatalization. This is shown in (4) below.

(4)	ɓopʰa	'Tie!'	uyaɓoʃ̲iswa	'he is being made to tie'
			iyaɓoʃ̲elwa	'it is being tied for s.o.'
	seɓɛnza	'Work!'	iyaseʧ̲'ɛnzwa	'it is being worked'
	ɬupʰek'a	'Suffer'	k'uɬuʃ̲ek'wa	'it is being suffered'
	ʃumayela	'Preach!'	iyaʃuɲ̲elelwa	'it is being preached'
	ɟɡoboza	'Dip!'	iyaɟɡoʝ̲ozwa	'it is being dipped'
	kʰumula	'Undress!'	uyakʰuɲ̲ulelwa	'she is being undressed for'
	pʰupʰuma	'Boil!'	iyapʰupʰuɲ̲iswa	'it is being made to boil'

An account of this phenomenon must provide a principled explanation of the long-distance interaction between labial segments in the passive, and of the irrelevance of intervening round vowels.

Passives in Zulu are realized by suffixing /w/ to the verb stem. As a great deal of recent research in syllable structure and moraic theory (Kaye and Lowenstamm 1984, Clements and Keyser 1983, Levin 1985, Hayes 1989) has argued that high vowels and glides differ only in their prosodic properties, one might assume that the passive suffix is underlyingly /u/, with the glide surfacing by virtue of onset syllabification. Since there is never an alternation between [u] and [w] in surface forms of the passive, though, it can be argued that positing an underlying /u/ in this suffix would constitute the addition of an unmotivated degree of abstraction to the grammar of Zulu. However, since there is evidence elsewhere in the language that high back vowels alternate with labialization on the basis of syllable position, further arguments will be required in order to rule out the vocalic representation of the suffix.

The long-distance nature of labial dissimilation in the passive is exactly the sort of evidence which bears on this question. In order for two instances of a feature F to be involved in a rule of dissimilation, they must be adjacent to one another[9]; in most theories of adjacency (Archangeli and Pulleyblank 1987, Steriade 1987, Selkirk 1988, Odden 1991) this means that no additional instances of the

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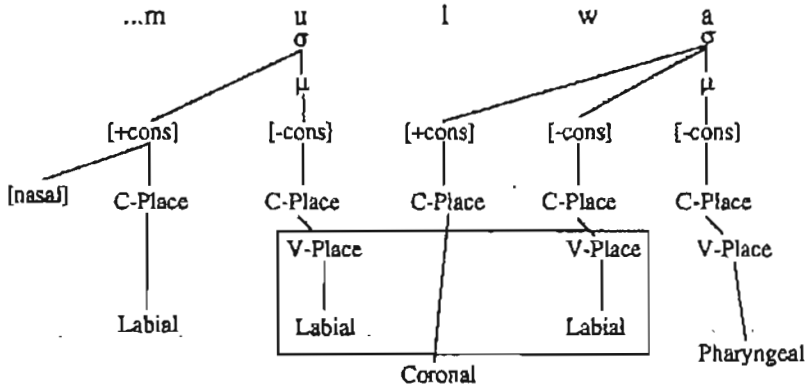
[8]'Stem' here refers to the constituent composed of the verb root, any verbal extensions, and the final vowel. Crucially, prefixes are not included in the stem.

[9]The following discussion assumes that feature adjacency is relevant for both assimilation and dissimilation, and that adjacency is formally defined in the same way for both types of processes. Pierrehumbert (1992) suggests that perceived similarity of segments may be of greater importance than adjacency in the application of dissimilation, but the means of implementing this idea formally have yet to be investigated.

feature F may intervene between the target and trigger. In order for the passive suffix to trigger dissimilation of a preceding labial consonant, its [Labial] specification must be in the same plane as the [Labial] specification of the target, with no [Labial] specifications intervening in that plane.[10] If the passive suffix had the same feature structure as a high round vowel, any round vowel intervening between the target and the trigger should block dissimilation, as shown in (5) below (adjacent [Labial] specifications are boxed in):

(5)

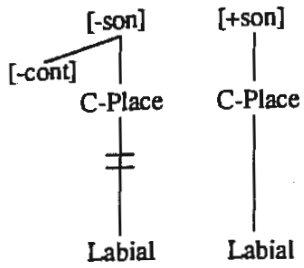


Crucially, in order for the passive suffix /-w/ to trigger dissimilation of a preceding consonantal [Labial] specification, the glide's [Labial] specification must be dominated by C-Place, rather than by V-Place. Intervening round vowels will thus fail to block dissimilation. The rule of Labial Dissimilation assumed is given in (6) below; the trigger must be specified as [+sonorant], reflecting the fact that only the labial glide triggers dissimilation.

[10]For arguments in favor of treating the root node as a complex of the features [consonantal] and [sonorant], see McCarthy 1988. The subsegmental organization assumed throughout is essentially that of Hume 1992 and Clements and Hume 1992, with irrelevant levels of structure not shown. Crucially, consonants and vowels are assumed to be characterized with a single set of place features, each of which defines a single tier of its own (in contrast to Clements 1991, where place features define different tiers depending on whether they are consonantal or vocalic). In consonants, place features are dominated by *place*, which is dominated by *oral cavity*, while in vowels the place features are dominated by *place* which is a dependent of *vocalic*; here these are shown as C-Place and V-Place.

In the geometry assumed here, adjacency must actually be defined on a plane, rather than a tier. Two place specifications are adjacent in this model only if they are dominated by a mother of the same type, and if no additional instance of that place feature dominated by the same type of mother intervenes. This notion of adjacency, applied to a rather different model of subsegmental organization, is spelled out in considerable detail in Selkirk 1991.

(6)

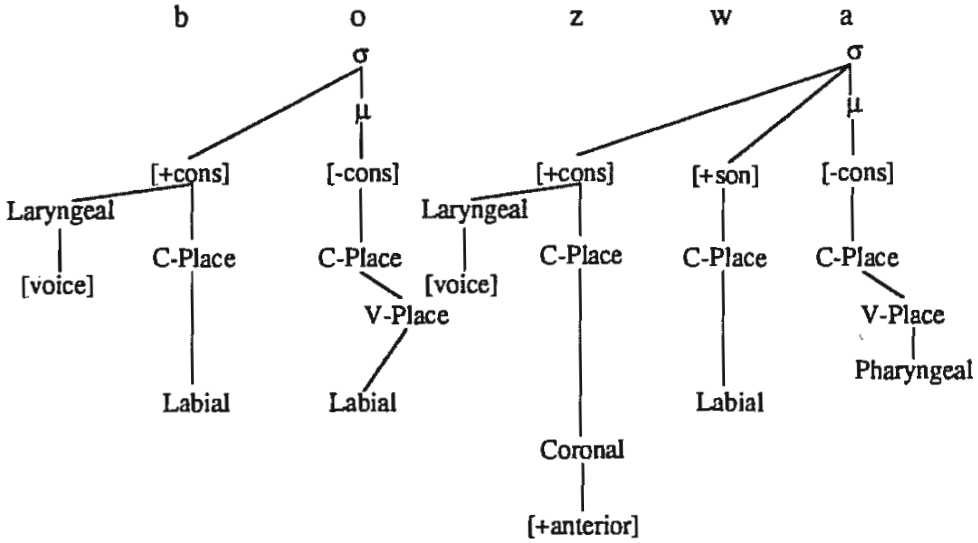


Domain: Stem

Following the application of Labial Dissimilation, a [Coronal] specification will be supplied by default.[11]

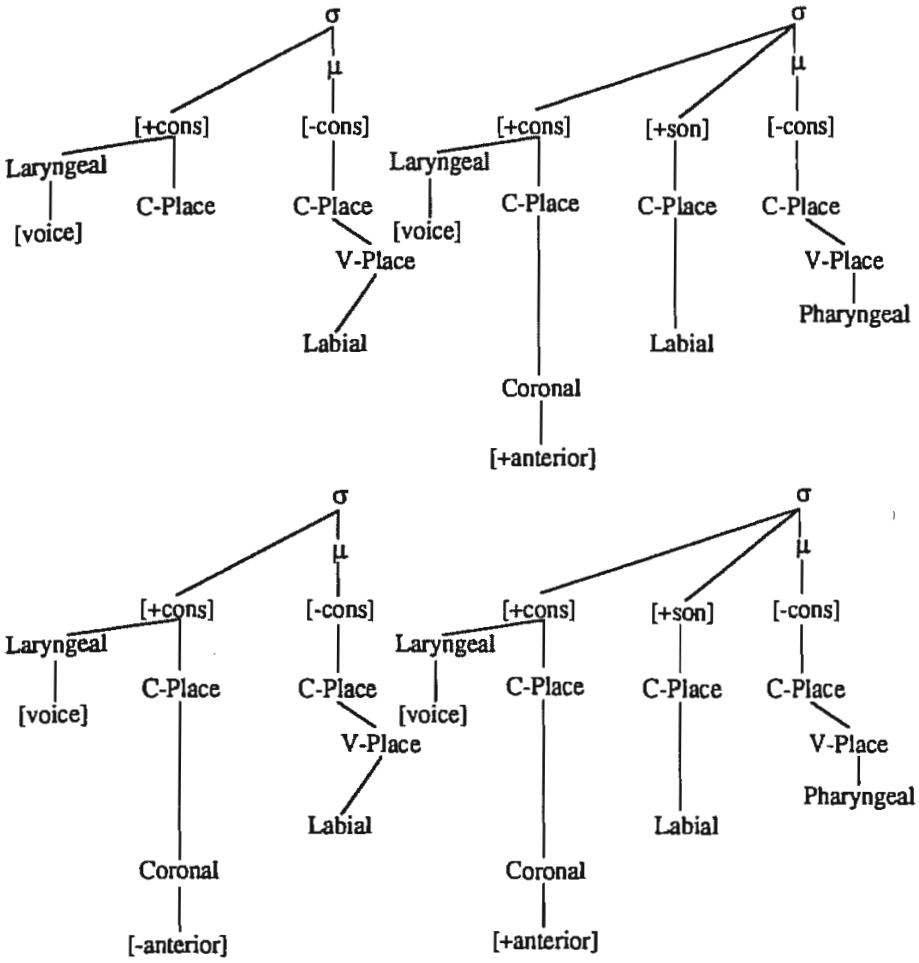
The derivation of the relevant portion of **iyaɪgo̯jozwa** 'it is being dipped' is shown in (7) below.

(7)



Underlyin

[11]A growing body of research (Avery and Rice 1989, Paradis and Prunet 1988, 1989; papers in Paradis and Prunet 1991) suggests that [Coronal] is the default place specification for consonants. However, we must also assume that [-anterior] is filled in by default, a position with little empirical support in the literature. This issue merits considerable further investigation. Note that it is not possible to assume that [Coronal, -anterior] is spread from a surrounding segment, as there are passive forms which contain no coronal segments in the stem domain. (For example, iyaɓošwa 'it is being tied' and ayagu̯jwa 'it is being dug'.) Further, assuming an underlying /i/ in the passive suffix which spreads the relevant feature complex will not provide the correct outputs, since intervening coronal consonants should block this spread in forms such as iyaɓošelwa 'it is being tied for someone' (on the assumption that [Coronal]$_{C\text{-}Place}$ will block the spread of [Coronal]$_{V\text{-}Place}$ to a C-Place node).



Because the [Labial] specification of a round vowel is contained in the plane defined by [Labial] and the immediately dominating V-Place, round vowels fail to trigger or block Labial Dissimilation, which is confined to the plane defined by [Labial] and C-Place.[12]

2.3 SYLLABLE-INTERNAL LABIAL INTERACTIONS

In §2.1 above, I argued that labial palatalization in Zulu is confined to the only two contexts in the language in which a derived sequence of labial consonant plus w is possible within the stem domain. A further examination of Zulu phonology reveals that sequences of labial segments have a marked status throughout the language. Doke (1967:34) notes that 'the use of the velar "glide" with bilabials [is] strictly avoided.' Consistent with this generalization, there are

[12]A labiodental intervening between the passive suffix and a stem bilabial is predicted to block Labial Dissimilation, as labiodentals do not undergo palatalization. This prediction is very difficult to test, as there are very few Zulu verb roots of the shape CVBCF, and my consultant was unfamiliar with those roots I was able to locate in Colenso 1967.

apparently no Zulu roots containing **Bw** onsets, although clusters such as **tw** and **kw** appear in underived nouns and verbs. Interestingly, Colenso 1967 (originally published in 1905) contains a number of lexical items containing **Bw** sequences, but my consultant rejected them as completely unacceptable forms (and expressed disbelief that such items would appear in a Zulu dictionary). An examination of the behavior of Zulu hiatus resolution strategies provides further evidence that the occurrence of labial sequences is restricted in the grammar of the language.

2.3.1 Syllable structure and hiatus resolution

Zulu, like other Bantu languages, does not permit closed syllables. Further, the only apparently permissible onset clusters are those composed of a consonant+glide sequence. Interestingly, there are no **Cy** clusters in Zulu. Where such a sequence is predicted to arise via the combination of **Ci** with a following onset-less syllable, we instead find a single consonant. Consider the following data (Khumalo 1987). In (8a), **/i/** surfaces as a glide when preceding a vowel-initial stem, but no glide surfaces in the parallel cases in (8b) when the **/i/** is preceded by an onset consonant.

(8a)	iʒa	'he (cl.4) eats'	yenza	'he (cl.4) does'	
	ip^ha	'he (cl.4) gives'	yak^ha	'he (cl.4) builds'	
	izwa	'he (cl.4) hears'	yosa	'he (cl.4) barbecues'	
(8b)	siʒa	'he (cl.7) eats'	senza	'he (cl.7) does'	*syenza
	lip^ha	'he (cl.7) gives'	lak^ha	'he (cl.7) builds'	*$lyak^ha$
	zizwa	'they (cl.8) hear'	zosa	'they (cl.8) barbecue'	*zyosa

Where we would expect to find the glide **y** surfacing in (8b), analogous to the data in (8a), it fails to appear. When hiatus resolution would result in a coronal glide in post-consonantal position, the coronal glide is systematically excluded from the surface forms.

More germane to the issue of labial palatalization is the behavior of **Cw** onset clusters in Zulu. While sequences of coronal consonant+**w** (e.g. **tw, sw, ʃw**) and velar consonant+**w** (e.g. **kw**) are permitted, no labial consonant+**w** onsets are possible.[13] Thus, we find glide~zero alternations parallel to those above involving the coronal glide **y**, but only when the onset consonant is bilabial (Khumalo 1987).

(9a)	uʒa	'he (cl.1) eats'	wenza	'he (cl.1) does'
	up^ha	'he (cl.1) gives'	wak^ha	'he (cl.1) builds'
(9b)	luʒa	'he (cl.11) eats'	lwenza	'he (cl.11) does'
	lup^ha	'he (cl.11) gives'	$lwak^ha$	'he (cl.11) builds'

[13]Labial-based restrictions on syllable structure are not unique to Zulu. For example, English (Fudge 1969, Selkirk 1982, Clements and Keyser 1983), Cantonese (Yip 1988), and Tashlhiyt Berber (Selkirk 1988, Clements 1991) all have labial cooccurrence restrictions similar to those discussed here.

(9c)	uyap^{h}a	'he gives'	uyona[14]	'he spoils'	
	uyamup^{h}a	'he gives him'	uyamona	'he spoils him'	*uyamwona

/uma e-ang-a/[15]	→	uma anga	'if he kisses'	
/uma e-mu-ang-a/	→	uma emanga	'if he kisses her'	*uma emwanga
/uma e-esab-a/	→	uma esaba	'if he is afraid'	
/uma e-mu-esab-a/	→	uma emesaba	'if he fears him'	*uma emwesaba

Unlike the cases in which the coronal glide y is predicted to occur, here we see that Cw onsets are permitted, unless the complex onset in question would be composed of two labial segments; in just these situations, exemplified in (9c), the w derived in order to resolve hiatus fails to be syllabified in surface forms.

A further complication in syllable structure arises in the behavior of labial glides derived from the juxtaposition of two round vowels. Consider the data in (10) below (Khumalo 1987).

(10a)	uʒa	'he (cl.1) eats'	wenza	'he (cl.1) does'
	luʒa	'he (cl.11) eats'	lwenza	'he (cl.11) does'
	ukuʒa iñama	'to eat meat'	ukwak^{h}a inʒu	'to build a house'
(10b)	uzwa	'he (cl.1) hears'	wosa	'he (cl.1) barbecues'
	luzwa	'he (cl.11) hears'	losa	'he (cl.11) barbecues'
	ukuʒa iñama	'to eat meat'	ukosa iñama	'to barbecue meat'

As the data in (10b) show, otherwise permissible Cw onsets fail to surface in the event that the syllable nucleus contains a round vowel.

TABLE 4 below summarizes, in schematic form, the permissible and impermissible syllable shapes of Zulu.

TABLE 4. ZULU SYLLABLE STRUCTURE.

Permitted	Forbidden
CV	CVC
yV	CyV
wV	BwV[16]
CwI	CwU

[14]The vowel of the present tense prefix /ya-/ does not surface here; non-high vowels delete under hiatus with a following vowel. Note that the prefix [a] is present in the form which contains a (consonant-initial) object prefix.

[15]The /e/ here is a 'participial subject prefix' (Khumalo 1987).

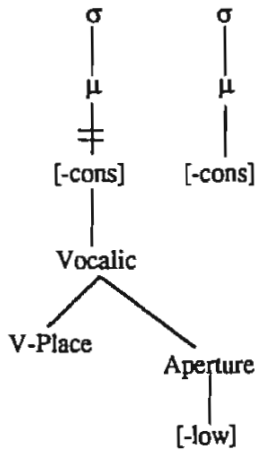
[16]The behavior of labiodental consonants with respect to this generalization is quite unclear. Labiodentals are rare in Zulu, and there are no prefixes of the form fu or vu which

As we will see in §2.3.2, labial interactions in the locative are closely connected with constraints on syllable structure, and an analysis of the locative facts will rely on an insightful account of syllable structure restrictions.

2.3.2 Labial palatalization in locatives

As noted in §2.1 above, the juxtaposition of a root-final syllable composed of a bilabial consonant and a round vocalic nucleus with the vowel-initial locative suffix /-ini/ is essential in triggering the occurrence of palatalization in denominal locative adverbs. Nouns whose final syllable contains a bilabial consonant followed by a non-round vowel do not exhibit palatalization of the bilabial in their locative forms. Thus, the existence of a labial glide w at some point in the derivation of locatives with palatalization is essential; we will assume that the following rule of Glide Formation applies.[17]

(11)



As a result of Glide Formation, locatives whose nominal roots end in **BU** syllables seem to contain the **Bw** sequence which is crucial in triggering Labial Dissimilation, suggesting that the rule should apply here. Note, however, that the [Labial] specification of this **w** should be assumed to be dominated by V-Place, as the segment in question is underlyingly a vowel. Thus, the structural description of

---

would be subject to Glide Formation. Doke (1969:118) notes that 'after denti-labials it is optional in all cases to employ or to leave out the w.' However, in my data, passive verb forms with a root-final labiodental always have **fwa** or **vwa** finally, suggesting that the restriction against **Bw** holds strongly only of bilabial onsets.

[17]For ease of explication, a rule-based format is assumed here. However, it is expected that a constraint-based theory of phonology, incorporating a set of ranked constraints, could also handle the facts accounted for here. At least the following constraints would be required: Onset (prohibiting vowel-initial syllables word-internally), Morify (requiring that all vocoids be morified), and Single Mora (prohibiting long vowels and complex nuclei); Onset has a higher ranking than Morify in the grammar. For a more comprehensive account of constraint-based phonology, see McCarthy 1992 and Rosenthall (in preparation).

the dissimilation rule is not met. One may suggest, following proposals made in Selkirk 1988, that instances of a feature which are contained in different planes may interact if and only if they are domainated by root-adjacent segments; this is consistent with the observation that consonant/vowel interactions are largely confined to strictly adjacent segments.

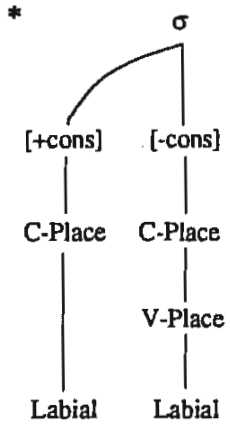
While allowing a disjunctive definition of adjacency for the application of Labial Dissimilation would permit all instances of labial palatalization to be achieved via the application of (6), followed by default [Coronal] specification, there is a crucial difference between the locative and passive instances of palatalization which cannot be adequately accounted for under such an analysis. While the w which triggers Labial Dissimilation in the passive is retained in surface forms, there is no labial glide surfacing in locatives in which an underlying labial has undergone palatalization. Recall the locative data given in (2a), repeated here as (12):

(12)	isiɓop^{h}o	'grass rope'	esiɓoʂeni	locative
	isigubu	'calabash'	esiguʄini	locative
	iŋguɓo	'blanket'	eŋguč'eni	locative
	umlomo	'mouth'	emloɲeni	locative
	emɓoɓo	'hole'	emboč'eni	locative
	isip^{h}up^{h}up^{h}u	'frothing beer'	esip^{h}up^{h}uʂini	locative

As demonstrated in (3c) above, a surface labial element is derived from a root-final round vowel in locatives whose final syllable onset is not labial; thus it is not possible to assume that non-moraic round vocoids are systematically deleted in locatives.

The absence of a w element in (12) is reminiscent of the vowel~glide alternations found in the prefix domain, where round vowels which have undergone Glide Formation fail to syllabify following labial consonants. (See (9c) above for examples.) Similarly, in just those cases in the locatives in which an underlying labial consonant is followed by a labial vocoid resulting from Glide Formation, we fail to find a surface vocoid. Suppose we assume that the w~zero alternations in the prefix domain are legislated by the following constraint, which also has dominion over the stem domain:

(13)



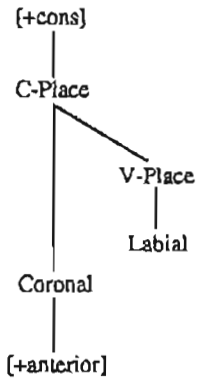
The absence of a surface w in the locative forms in (12) might be assumed to result from the application of (13); the labial vocoid which has been deprived of a syllabic affiliation by the application of Glide Formation would thus be prevented from being reaffiliated. Rather than being stray erased, however, the labial vocoid must be present in order to trigger Labial Dissimilation, as the surface forms contain prepalatal, rather than labial, consonants. Paradoxically, once Labial Dissimilation has applied, there is no further reason for the labial vocoid to resist syllabification, as the preceding onset consonant is no longer labial; the constraint in (13) should no longer apply. Given the rules and constraints sketched above, in addition to the assumption that non-moraic labial vocoids are syllabified as the second segment in a complex onset, it is not possible to explain why **esiβošeni** is the correct surface form, rather than ***esiβošweni** or ***esiβop^{h}eni**.

In providing an explanation for the behavior of palatalization and the labial glide in the locative, it will be necessary to revise a number of our assumptions about syllable structure and segmental representations in Zulu. Because palatalization in this context is intimately connected to Glide Formation and syllabic reorganization, it is reasonable to assume that our explanation should be closely tied to the constraints on syllable structure which forbid multiple labial elements in 'tripartite' syllables (discussed in §2.3.1 above). As we will see, it is possible to account for both the locative data and the prefix domain hiatus resolution data in a consistent fashion by adopting slightly different segmental representations than those assumed above.

Throughout the preceding discussion, it has been presumed that the result of demorifying a round vowel to resolve hiatus is a bisegmental sequence of C+w. Thus, the behavior of labials in locative forms has, up to this point, been treated as the interaction of two discrete labial segments. Let us suppose, however, that elements which are transcribed as Cw are actually single segments with a primary place of articulation and secondary labialization. That languages may exploit this possibility is suggested by Sagey (1986) and Steriade (1992). Tucker (1929) proposes exactly this analysis for the 'Suto-Chuana' Bantu languages, a related

Southern Bantu group, claiming that conventional sequential transcriptions mask the fact that labialization is actually a 'prosody of labialization that persists through the segment'. Assuming secondary labialization of consonants, all syllables in Zulu meet a CV template; restrictions on apparent sequences of onset consonants are actually constraints on possible complex segments.[18] Thus, the transcription tw would be phonologically represented in the following way:

(14)

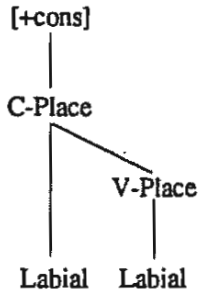


How does assuming the existence of complex, labialized single segments in Zulu aid in our understanding of Labial Dissimilation in the locative? Ohala (1978:380) suggests that labial consonants in Southern Bantu languages may not bear distinctive labialization because they are 'intrinsically labialized'. In current feature geometric terms, we would assume that labial consonants bear a specification for vocalic [Labial], in addition to their primary consonantal [Labial] specification.[19] That is, 'plain' labial consonants in Zulu (p^b, p', b, ɓ) have in common, at some stage in the phonological derivation, the following structure:

[18]This analysis is consistent with claims about syllabic complexity made in Kaye and Lowenstamm 1984, where it is proposed that the existence of branching onsets in a language implies the existence of branching nuclei. As Zulu does not permit branching nuclei, Kaye and Lowenstamm's proposals predict that it should also not permit branching onsets.

[19]Padgett (p.c.) suggests that all 'plain' consonants may have available, at some level of phonological representation, an inherent secondary articulation which is available for interaction with vocalic segments. Thus, coronal consonants are intrinsically 'coronalized', velars intrinsically 'dorsalized', etc. This notion is a central point of Ní Chiosáin and Padgett (1993).

(15)



We are now prepared to provide an account of labial interactions in the locative, and of hiatus resolution in the prefix domain. When a vowel's place features lose their prosodic licensing via the application of Glide Formation, they are re-licensed (whenever possible) by association to the preceding onset consonant.[20] Because there are no palatalized consonants in Zulu, the [Coronal] specification of a non-moraic front vowel may not be docked on a preceding consonant; the following constraint is assumed to hold:

(16)

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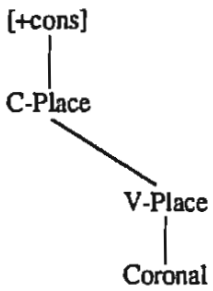

A non-moraic coronal vowel is ultimately stray erased when preceded by an onset consonant. However, because labialized consonants are permitted in Zulu, a constraint parallel to (16) may not be assumed to account for the absence of labialization on labials in the prefix domain; instead, the [Labial]$_{V\text{-}Place}$ of the labial vocoid is freely linked to the preceding onset consonant. When the preceding consonant is coronal or dorsal, the surface form contains a labialized consonant.[21] However, when the preceding consonant is a labial, survival of the derived labialized labial depends upon the extent to which representational constraints hold on the domain in which the structure was created. Because secondary labialization

[20]The stability of vowel place features in this circumstance may be accounted for by exploring the notion of a segmental HEAD, suggested by Itô and Mester (1991). If place features function as the HEAD of a segment, and the phonology of a language is constrained to preserve or license HEAD features whenever possible, then the place features of a non-moraic vowel may be reassociated, rather than stray erased (subject to other constraints in the language).

[21]Any remaining vowel features which are not associated to the preceding consonant are assumed to undergo Stray Erasure.

is not distinctive on labial consonants in Zulu, [Labial]$_{V\text{-}Place}$ is required by the principle of Structure Preservation to be underspecified in lexical representations; this restriction on the specification of secondary labiality will persist through at least part of the lexical phonology (Kiparsky 1985, Myers 1991, Padgett 1991). Adopting the modification of Strong Domain Hypothesis proposed in Myers 1991, which assumes that both phonological rules and constraints on segmental representation may be 'shut off' in the course of the derivation, it is assumed that the restriction against labialized labials is relaxed at some point in the derivation, making it possible to supply a [Labial]$_{V\text{-}Place}$ specification on a labial consonant (either by spreading or by default fill-in).

Given the fact that [Labial] sequences within the stem of a word (i.e. the root plus any suffixal elements and the final vowel) behave differently than they do in the prefix domain, as well as the fact that some prosodic minimality requirements in Zulu are sensitive only to stem material (Beckman 1992), we argue that the word stem corresponds to a discrete domain for the application of phonological rules and constraints. The differential behavior of labialized segments in the prefix and stem domains is thus attributed to the status of the Single [Labial] constraint, shown in (17) below.

(17)

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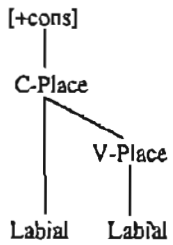

In the stem domain, which arguably exists as a phonological domain prior to the affixation of prefixes, Single [Labial] holds of all representations, requiring that labial consonants not bear redundant labialization. When the vowel in a root-final **BU** syllable loses its mora in the locative (via Glide Formation (11)), [Labial]$_{V\text{-}Place}$ is reassociated to the preceding labial consonant; however, the resulting structure violates Single [Labial] and must be repaired.[22] The following rule of [Labial] Pruning is assumed:

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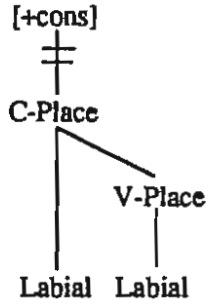
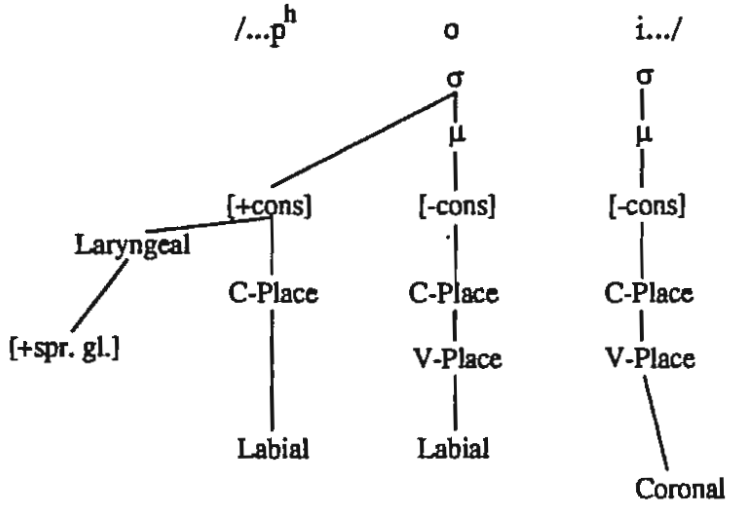
[22]In a constraint-based approach, the differential associability of [Coronal]$_{V\text{-}Place}$ and [Labial]$_{V\text{-}Place}$ might be attributed to constraint ordering. The constraint against secondary coronalization is ranked more highly than the requirement that all HEAD features be prosodically licensed, meaning that vocalic Coronal specifications may not be reassociated to a preceding consonant. However, the HEAD licensing constraint may be ranked higher than Single Labial, meaning that [Labial]$_{V\text{-}Place}$ is reassociated regardless of the preceding consonant.

(18)

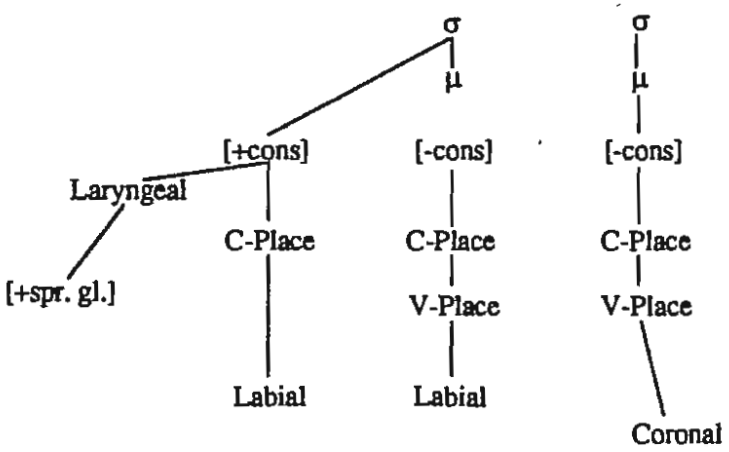


A partial derivation of the relevant portion of **esiɓošeni** 'grass rope (loc.)' is given in (19) below:

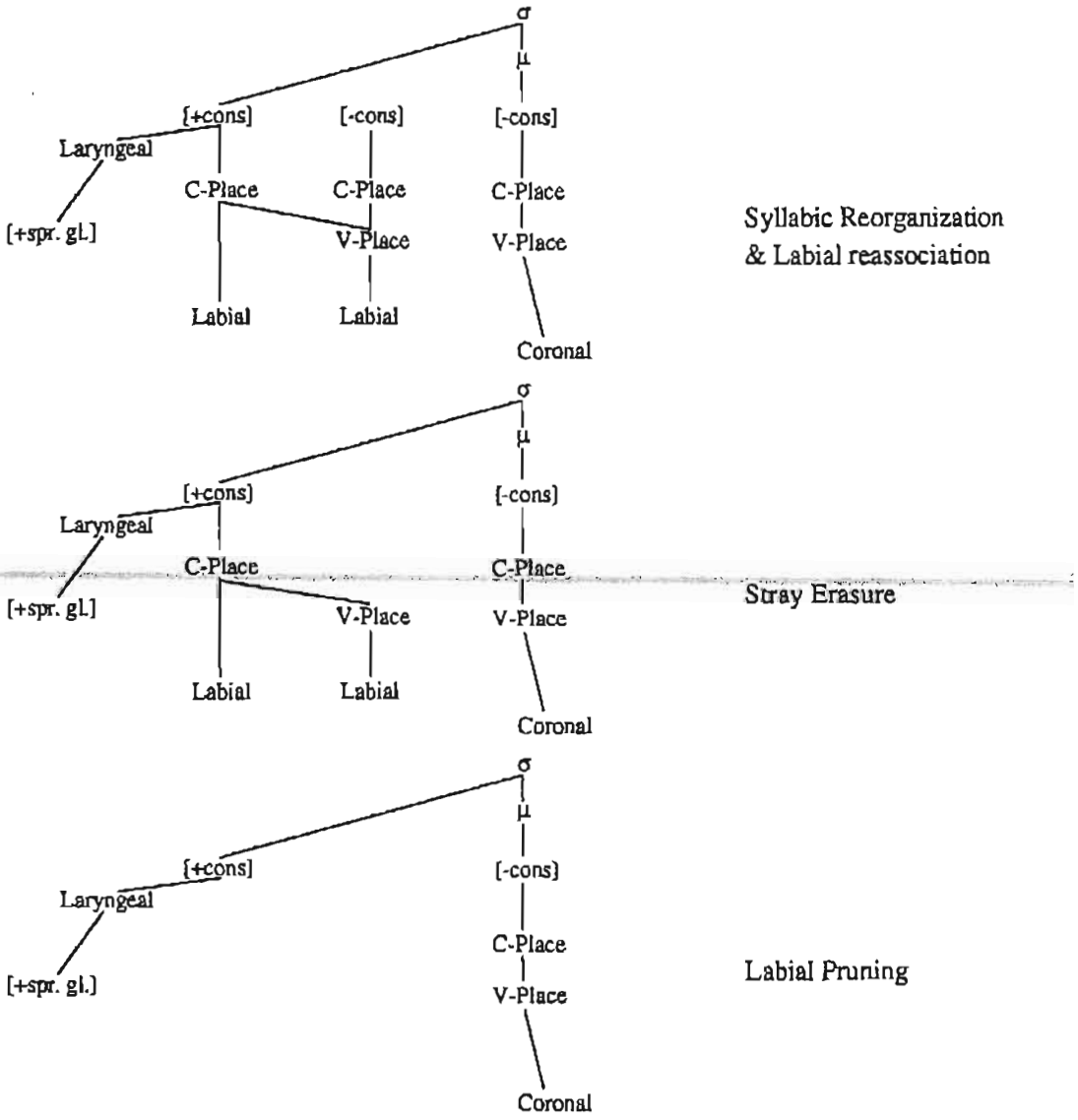
(19)



Underlying



Glide Formation



Following the application of [Labial] Pruning, a default [Coronal] specification is supplied to the onset consonant in order to derive the surface form.[23] Because all of the place features are delinked by pruning the C-Place node, neither the primary [Labial] specification of the root consonant nor the secondary labialization derived

[23]The variations in manner of articulation which accompany the labial palatalization phenomena are assumed to be derived by feature adjustment, in order to derive surface segments which fit in the Zulu segmental inventory. (For instance, there is no aspirated ([+spr.gl.]) prepalatal stop in Zulu, so underlying p^h surfaces as ʃ.)

from the root-final vowel is available in the surface form.

In order to account for the absence of palatalization phenomena in the prefix domain, it is necessary to assume that Single [Labial] has been relaxed at this later stage of the phonology. Redundant labiality may freely occur on labial consonants. Thus, when a labialized labial is derived in the prefix domain, this structure is indistinguishable from a plain labial and surfaces as such. We are claiming, then, that secondary labialization is not excluded from labials in the prefix domain; rather, it is present, but does not surface as a contrastive secondary articulation.

3. CONCLUSIONS

We have argued here that the phonological phenomena described as 'labial palatalization' in Zulu result from a pervasive dispreference for [Labial] sequences in the language; this very general constraint is satisfied in quite different ways. In passive verb forms, a rule of Labial Dissimilation applies to the leftmost of two $[\text{Labial}]_{\text{C-Place}}$ specifications when the trigger is a [+sonorant] segment (the passive suffix /-w/). However, in denominal locatives, surface prepalatals are derived by [Labial] Pruning, a rule which repairs the illicit labialized labials created in hiatus resolution. By assuming that the constraint against labialized labials is relaxed in prefix domain, in accordance with the version of the Strong Domain Hypothesis proposed in Myers 1991, we can account for the otherwise mysterious contrast in behavior of secondary labialization in Zulu.

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