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Place Feature Geometry

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PLACE FEATURE GEOMETRY

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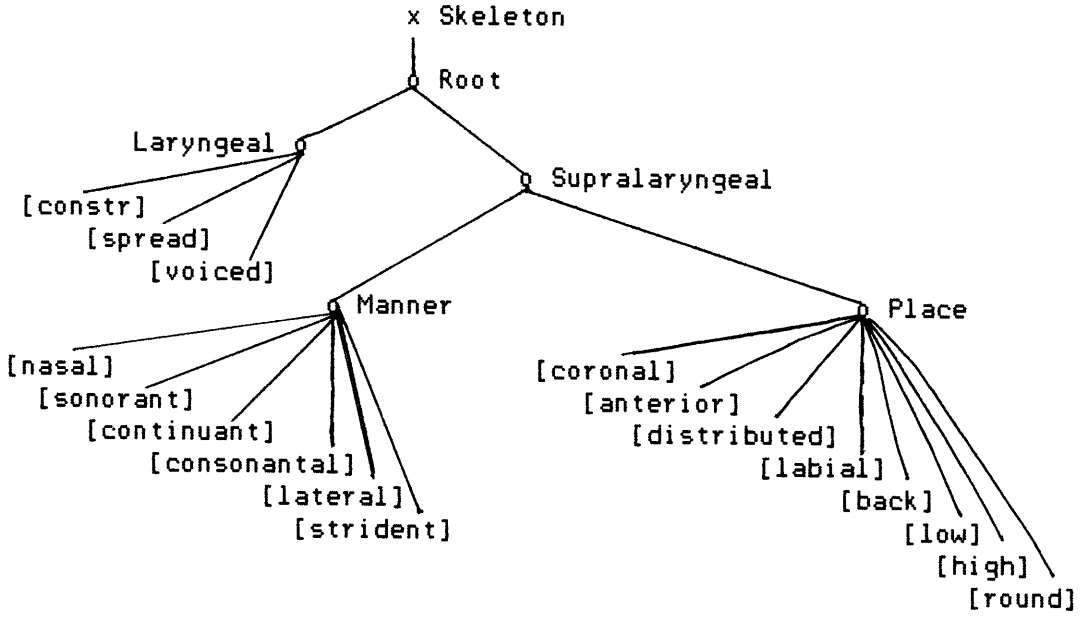
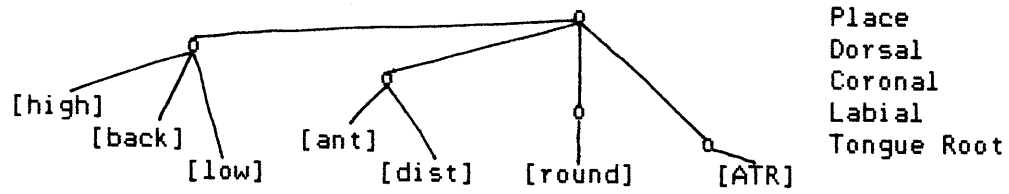
The feature hierarchy in (1) was proposed by Clements (1985) and Mohanan (1983) as a representation for certain natural classes of phonological features. The hierarchy includes constituents for place, manner, and laryngeal features, with the place and manner constituents united into a supralaryngeal constituent, and the laryngeal and supralaryngeal constituents united into a root constituent.[1]

(1) Feature Hierarchy (Clements 1985)



I will argue here for an elaboration of this hierarchy within the place node. The place feature hierarchy I propose groups place features into constituents based on the articulator they are executed by. These constituents, or "articulator-nodes," are shown in (2), where features are grouped under Dorsal, Coronal, Labial, and Tongue Root articulator nodes.

(2) Articulator Nodes:



Similar organizations of place features have been proposed by Halle (1986) and by Ladefoged and Maddieson (1986).

My primary evidence for the hierarchy of place features in (2) derives from complex, or multiply-articulated, segments such as labiovelars and clicks. Complex segments provide good evidence for the organization of place features because they require specification for more than one place of articulation within a single place node. In addition, independent support for the articulator nodes hierarchy is provided by harmony systems in languages without complex segments.

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The four articulator nodes in (2) represent the four active articulators in the mouth: the tongue body, tongue front, lips, and tongue root. Multiple articulations (in complex segments) are possible only when each articulation is formed with a different active articulator, as noted by Halle (1982). Complex segments are NOT possible which combine, for example, bilabial and labiodental articulations which are both formed with the lips, or dental and alveolar articulations both formed with the tongue front. Thus, the first argument for the articulator nodes structure in (2) is that it characterizes the possible complex segments that may occur in human language: Complex segments are possible only for combinations of two or more articulator nodes.

In this paper, I will discuss complex segments combining labial, coronal, and dorsal articulations. Some examples of complex segments combining these articulations are shown in (3).

(3)

Labial+Coronal	Labial+Dorsal	Coronal+Dorsal	Labial+Coronal+Dorsal
Margi [p͡t]	Loko [k͡p]	!Xu [t͡x]	Kinyarwanda [t͡kw]
Margi [t͡w]	Kiny. [k͡w]	Nama [|]	
	Shona [p͡x]	Czech [c]	
	!Xoo [0]		
	Nupe [p͡y]		

In (3), Margi [t͡w] combines labial and coronal articulations, !Xóõ [0] is a click combining labial and dorsal articulations, Nama [|] is a click combining coronal and dorsal articulations, and Kinyarwanda [t͡kw] combines all three articulations--labial, coronal, and dorsal.

Several types of evidence show that complex segments must be analyzed as single segments rather than consonant clusters. First, complex segments syllabify as single segments. The second column in (4) shows the syllabification in Kinyarwanda of loan words containing consonant clusters.

(4) Syllabification -- Kinyarwanda

u.b͡goo.ko	'race'	Republik	>	re.pu.bu.ri.ka
t͡kwee.se	'all of us'	Präsident	>	pe.re.zi.da
u.mu.s͡kwa	'ant'	Patrizia	>	paa.ti.ri.si.ya
k͡waa.k͡wa	'to ask'	Petroleum	>	pee.te.roo.ri

All clusters in the loan words are eliminated, usually by epenthesis, in order to make the words fit the CV syllable structure of Kinyarwanda. For example, Rebublik becomes [re.pu.bu.ri.ka]. The first column in (4), on the other hand, shows the syllabification of native words containing complex segments. These words fit the CV syllable structure of

Kinyarwanda only if the complex segments, such as [t͡kw] in [t͡kweese], are analyzed as single segments rather than consonant clusters.

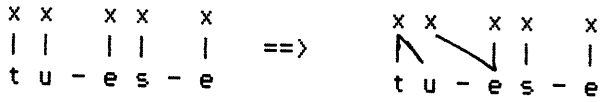
Second, in certain cases where a complex segment is derived from an underlying sequence of two segments, compensatory lengthening of an adjacent vowel occurs. For example, in Kinyarwanda, a consonant and an /u/ may combine to form a labiovelarized complex segment. As shown in (5), when this occurs, the following vowel is lengthened.

(5) Compensatory Lengthening -- Kinyarwanda

/mu-i-genda/	[m͡niigeenda]	'don't go'
/tu-es-e/	[t͡kweese]	'all of us'
/ku-gu-ir-a/	[kug͡wiira]	'to fall on'

The analysis is as follows: complex segment formation merges the original sequence of two segments into a single segment, as shown in (6), where the features for /u/ merge onto /t/. This creates an empty skeletal slot, and compensatory lengthening then results from the adjacent vowel features spreading onto the empty slot.

(6)



The third argument that complex segments are single segments is that they have the phonetic length of single segments, not of consonant clusters. For example, as shown in (7), the complex labiovelar stop in Igbo, at 112 milliseconds, is almost exactly the same length as the simple labial stop, at 110 milliseconds.

(7) Phonetic Timing -- Igbo

agadi	'elderly person'	[g]	90 msec.
iba	'malaria'	[b]	110 msec.
ag͡ba	'jaw'	[g͡b]	112 msec.

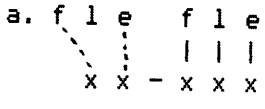
Because the units on the skeletal tier represent phonological timing, the length of the labiovelar stop is evidence for it being represented on a single skeletal slot.

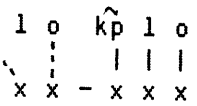
Finally, complex segments behave in reduplication as single segments rather than as sequences of two segments. In the Ewe reduplication process shown in (8), the first consonant and vowel of the stem associate to the reduplicative prefix.

(8) Reduplication -- Ewe

fle	'to buy'	feflee	'bought'
k͡plo	'to lead'	k͡pok͡plo	'leading'
g͡bla	'to exert oneself'	g͡bag͡blam	'exerting oneself'
n͡yra	'to rave'	n͡yan͡yrala	'a raver'

If the stem begins with a consonant cluster, as in /fle/ 'to buy', only the first consonant is associated, as shown in (9a). This reduplication treats labiovelar complex segments as single consonants, not as clusters like /fl/. As shown in (9b), the entire labiovelar is associated to the first slot of the reduplicative prefix. This shows that the labiovelar is not a consonant cluster, for if it were, only half of it would survive the reduplication.

(9) a.


b.


The evidence I have discussed so far shows that complex segments must be analyzed as single segments rather than consonant clusters. I will now discuss evidence that the two articulations of a complex segment must be represented not only within a single segment, but within a single place node.

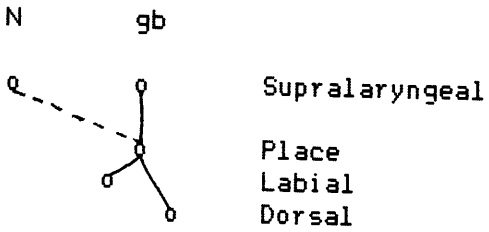
First, both articulations in a complex segment are spread in place assimilations. Examples from Yoruba and from Kpelle of a nasal assimilating to a complex segment are given in (10).

(10)

Yoruba			Kpelle		
/mo m bo/	[mo m bo]	'I am coming'	/N-polu/	[m̀bolu]	'my back'
/o m lo/	[o n lo]	'he is going'	/N-tia/	[ǹdia]	'my taboo'
/o m ke/	[o ŋ ke]	'he is crying'	/N-kɔɔ/	[ŋ̀gɔɔ]	'my foot'
/o m g͡bo/	[o ŋ͡m g͡bo]	'he is hearing'	/N-k͡piŋ/	[m̀ŋg͡biŋ]	'myself'

Notice that the nasal becomes doubly-articulated, labiovelar, before a labiovelar stop, as in the Yoruba phrase [o ŋ͡m g͡bo] 'he is hearing'. Under the standard assumption that place assimilation is a spreading of the place node, the assimilations shown in (10) must involve spreading a place node which dominates specifications for both the articulations in the complex segment, in order for both articulations to be assimilated. This spreading is shown in (11), where a place node dominating both labial and dorsal is spread onto the preceding nasal.

(11)



Second, representing the two articulations of a complex segment by articulator nodes within a single place node captures the fact that they are phonologically unordered.

There are two ways that articulations may be phonologically ordered. First, they may be ordered by the features which specify them being ordered on the same tier, as A and B are in (12a). Second, they may be ordered by the features which specify them being linked to elements which are ordered. Thus, in (12b) the articulations which A and B specify are ordered by virtue of A and B being linked to skeletal slots which are ordered.

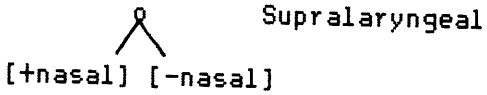
(12) Two articulations A and B are phonologically ordered only if specified by features which are:

a) on the same tier, or b) linked to elements which are ordered.

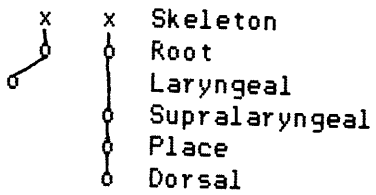
An example of the first type of ordering, by a sequence of features on a single tier, is given in (13a): a prenasalized stop containing the ordered sequence [+nasal] [-nasal]. An example of the second type of ordering, by being linked to elements which are ordered, is given in (13b).

(13)

a. [nd]



b. [ʔə]

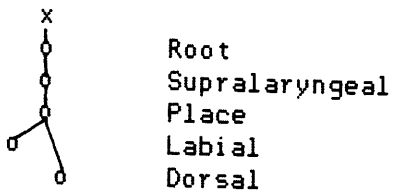


In (13b), the laryngeal node specifying the glottal stop is not ordered on the laryngeal tier with respect to the following vowel, which lacks a laryngeal node; however, the glottal stop as a whole is ordered with respect to the vowel by virtue of the features for

both being linked to root nodes and skeletal slots which are ordered.

Given the articulator nodes representation, though, the articulations in a complex segment are not ordered in either of these ways. As shown in (14), different articulator nodes are on different tiers. Therefore, the representation predicts that the articulations in a complex segment are not phonologically ordered. Furthermore, the articulations in a complex segment are specified within a single segment and a single place node, so they are not linked to elements which are ordered. Thus, articulator nodes are unordered in the same way that the laryngeal and supralaryngeal nodes are.

(14) [gb]



That the articulations in complex segments are in fact phonologically unordered is shown by free variation in phonetic order in some cases. For example, the word for "dog" in Kru, shown in (15), may be pronounced as [b͡we], with the order labial-velar, [gb͡we], with the order velar-labial-velar, or [g͡be], with the order velar-labial.[2]

(15) Kru: b͡we ~ gb͡we: ~ g͡be 'dog'

Similarly, the word for "be bitten" in Venda, shown in (16), may be pronounced as [luŋ͡wa], with the order velar-labial, or [lum͡ŋa], with the order labial-velar.

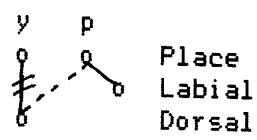
(16) Venda: luŋ͡wa ~ lum͡ŋa 'be bitten'

This free variation in phonetic order is natural and expected if no order between the articulations is specified phonologically.

Phonological lack of order is evidenced in other cases by apparent metathesis. In Zoque, shown in (17), palatalization by a preceding /y/ results in a palatal offglide.

(17) Zoque:

/poy-pa/	[po͡pya]	'he runs'
/tey-tih/	[te͡cyih]	'right there'
/ƛay-kʌsi/	[ƛa͡kyʌsi]	'on the vine'



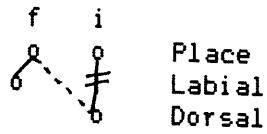
The analysis of this is shown in (17). Once the dorsal node

specifying the features of /y/ has spread onto the place node of the /p/ in [pop͡ya], there is no order between the /y/ articulation and the /p/ articulation. Thus, the /y/ may surface phonetically as an offglide without any process of phonological metathesis being required.

Similarly, in Tswana, shown in (18), the labial-palatal sequence /fi/ in the word meaning 'palm of hand' is merged to yield a palatal-labial sequence [x͡ʃw]. Again, once the labial and dorsal nodes are linked to a single place node, there is no phonological order between them.

(18) Tswana:

/lemati-ana/ [lemax͡ʧana] 'door' (dim.)
/lehofi-ana/ [lexox͡ʃwana] 'palm of hand' (dim.)
/selEpE-ana/ [selEcx͡wana] 'axe' (dim.)



Finally, lack of phonological order is shown by cases where both articulations in a complex segment characterize both sides of the segment in satisfying the structural description of a phonological rule. For example, there is a Morpheme Structure Condition in !Xóõ which disallows sequences of dorsal consonants and front vowels in Underlying Representation. This Morpheme Structure Condition is stated in (19).

(19) !Xóõ Morpheme Structure Condition:

$$*\text{dorsal } \overset{\vee}{[-\text{back}]}$$

Clicks in this language, which involve both coronal and dorsal closure, are subject to the Morpheme Structure Condition in (19). No clicks are followed by front vowels in Underlying Representation. Thus, clicks behave as dorsal with respect to this rule which is sensitive to their right edge.

On the other hand, clicks with [+anterior] coronal articulations may be followed by surface front vowels due to a process which raises and fronts /a/ between a [+anterior] coronal consonant and /i/, as stated in (20).

(20) !Xóõ a-Raising: /a/ --> /i/ / [+anterior] ___ /i/

That clicks trigger the process in (20) shows that they also behave as coronal on their right edge.

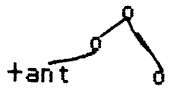
Data showing both of these processes at work are given in (21). The underlying forms in column A show that clicks are followed only by back vowels in underlying representation; thus, they obey the Morpheme Structure Condition in (19). In column B are the surface forms. (21a) shows that the vowel /a/ after

[-anterior] coronal clicks remains unchanged, because a-Raising applies only after [+anterior] coronals. (21b) shows that the vowel /a/ after a [+anterior] coronal click but not before /i/ remains unchanged. (21c) shows that /a/ between a [+anterior] coronal click and /i/ is raised to /i/.

(21)	A	B	
a.	/!xa - i/	[!xai]	'clothings'
	/ǁgai/	[ǁgai]	'clod, lump'
b.	/ǀ?a - ba - te/	[ǀ?abate]	'lovers'
	/ǂa - ba - te/	[ǂabate]	'steenbucks'
c.	/ǀ?a - i/	[ǀ?ii]	'lover'
	/ǂa - i/	[ǂii]	'steenbuck'

Thus, these clicks behave as both coronal and dorsal in rules sensitive to their right edge, which supports their place of articulation being represented by unordered coronal and dorsal articulator nodes, as in (22).

(22)



Place
Coronal
Dorsal

This behavior contrasts with that of segments containing a phonologically ordered sequence of articulations, such as prenasalized stops. A prenasalized stop, represented as in (23), will behave as [+nasal] in rules sensitive to its left edge, and as [-nasal] in rules sensitive to its right edge. It will not behave like the clicks, that is as both [+nasal] and [-nasal] in rules sensitive to its right edge.

(23) [nd]

Supralaryngeal

The evidence for articulator nodes I have presented so far has been drawn from the behavior of complex segments. Further, independent, evidence for articulator nodes is found in languages without complex segments.

For example, the structure of the labial articulator node dominating the feature [round] unites labial consonants and rounded vowels under a single feature, the labial node. This satisfies the many arguments of Campbell (1974) and Hyman (1975) (among others) regarding the need for such a feature. In addition, however, the articulator nodes structure requires a labial node in vowels that are [-round]. That this relationship between the feature [round] and the labial node is correct is

suggested by a set of two harmony processes in Warlpiri which involve the feature [round].

First, progressive Labial Harmony in Warlpiri, shown in (24), is blocked by intervening labial consonants (/p/ and /w/).

(24) Warlpiri Labial Harmony

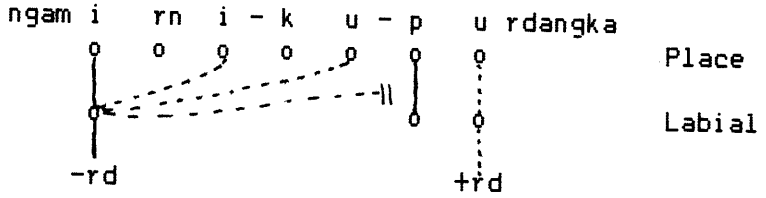
/maliki-kurlu-rlu-lku-ju-lu/ [maliki-kirli-rli-lki-ji-li]
dog-Prop-Erg-then-me-they

/ngamirni-ku-purdangka/ [ngamirni-ki-purdangka]
MoBr-Dat-same gen. kinsman

/ngali-wurru/ [ngali-wurru]
1 2-Emphatic

As noted by Cole and Trigo (1986), this blocking is accounted for by analyzing Labial Harmony as spreading a labial node which dominates [-round] from left to right, as shown in (25).

(25)



If instead just the feature [round] were spread, the blocking by labial consonants unspecified for [round] would be unexplained. (The default value of [+round] is inserted on the final /u/.)

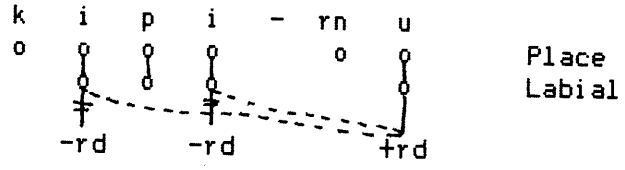
Second, regressive Round Harmony, shown in (26), is not blocked by labial consonants (/p/ and /w/).

(26) Warlpiri Round Harmony

/kipi-rni/	[kipi-rni]	winnow-NPast
/kipi-rnu/	[kupu-rnu]	winnow-Past

Therefore, this process spreads just the feature [+round] from right to left, as shown in (27). Because only [+round] is spread, the spreading is not blocked by the labial node of /p/.

(27)



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This analysis of the two harmony processes, which attributes their different patterns of blocking to their spreading at different levels in the hierarchy, is possible only if there is a hierarchical structure of labial dominating [round].

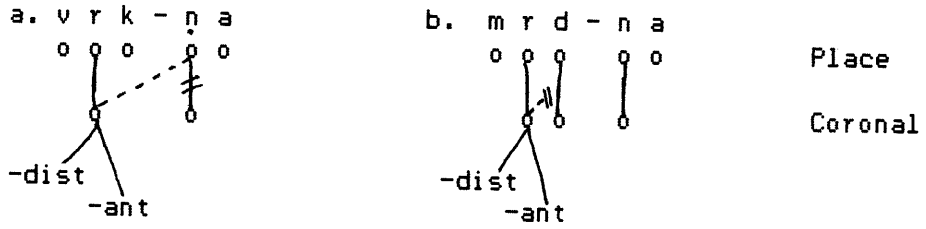
Another harmony process in a language without complex segments that supports the articulator nodes structure is long-distance N-Retroflexion in Sanskrit. This process provides support for the coronal node, as noted by Steriade (1986). N-Retroflexion assimilates an /n/ to a preceding retroflex consonant, across intervening vowels and non-coronal consonants, as shown in (28a). Intervening coronal consonants block retroflexion, as shown in (28b).

(28) Sanskrit N-Retroflexion (Steriade 1986)

		a. Applies		b. Blocked	
-na-	'present'			mrd-na-	
-na-	'pass. part.'	vrk-ṇa-	'cut up'		
-ana-	'middle part.'	pur-aṇa-	'fill'	marj-ana-	'wipe'
-mana-	'middle participle'	krp-a-maṇa-	'lament'	krt-a-mana-	'cut'

Analyzing N-Retroflexion as spreading the coronal node explains its being blocked only by coronal consonants, because only coronal consonants will be specified with a node on the relevant tier. In (29a) is shown N-Retroflexion spreading a coronal node across an intervening dorsal consonant, /k/. In (29b) is shown spreading of the coronal node being blocked by an intervening coronal consonant, /d/.

(29)



Some consequences of the articulator nodes hierarchy within the place node are as follows. First, articulator nodes are privative features. That is, they are either present or absent in the structure. Because of this, it is impossible to assimilate or spread a minus value for these features. I believe it to be a correct prediction that such assimilations (for example of [-coronal]) do not occur. Nevertheless, although [-coronal] cannot be spread, the class of noncoronal consonants can be specified, for example as a condition on the target or trigger of a rule, as those consonants lacking a coronal node (analogously to

unsyllabified or unstressed segments lacking those structures).

Second, specification of a place feature entails the specification of the articulator that dominates it. Sounds not involving a particular articulator are not specified for the features that that articulator node dominates, even redundantly. For example, only dorsal consonants are [-back]. Labial and coronal consonants are unspecified for [back] and have no dorsal node; they are not "redundantly" [-back]. Therefore, spreading [-back] onto a labial or a coronal, as in palatalization, changes the segment by adding a dorsal articulation. This explains why labials and coronals are affected by the spreading of [-back] in palatalization. If labials and coronals were redundantly [-back], and if [-back] did not imply dorsal articulation, then there would be no explanation for why adding [-back] in palatalization would have any effect. It would be simply adding a feature specification that was already there.

In summary, the place feature hierarchy I have proposed accounts for the possible complex segments that may occur in language, and for their behavior. It accounts for the patterns of blocking in certain harmony systems, and it makes predictions about possible and impossible place assimilations. Furthermore, it accounts for these phenomena in an explanatory way, because the hierarchy is based on vocal tract anatomy.

NOTES

This paper is excerpted from my 1986 MIT doctoral dissertation. More complete discussion of the issues and analyses presented here, as well as discussion of related phenomena and issues, can be found in that work. I would like to thank the following people for their invaluable help with the dissertation: Morris Halle, the chair of the thesis committee; Donca Steriade; Jim Harris; Tova Rapoport; and Robert Sagey.

1. A discussion of the representation of manner features in the hierarchy is beyond the scope of this paper. Therefore, I use the representation in (1), which was proposed by Mohanan (1983) and Clements (1985). However, it is likely that manner features would be better represented as linking directly to either the supralaryngeal node or the root node. See Sagey (1986b) for further discussion.

2. See Sagey (1986b) for discussion of degree of closure in complex segments. Briefly, I propose there that there is only one distinctive degree of closure in each segment and that each articulation in a complex segment either receives that degree of closure or is unspecified for degree of closure. Thus, for example, the variation in dorsal degree of closure in the Kru word for "dog" would be explained by there being no phonological

specification of degree of closure for the dorsal articulation in that segment.

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