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Prenasalization and feature geometry

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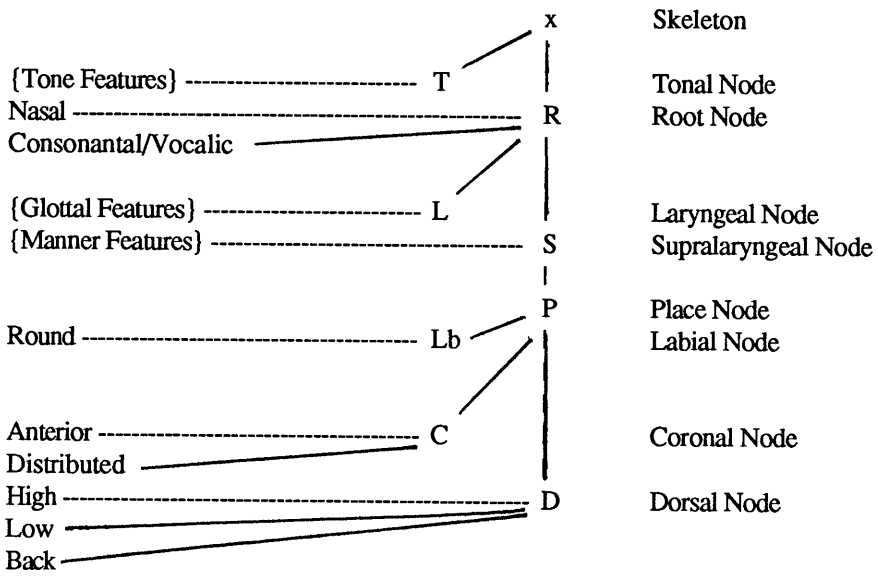
1. Introduction

The fundamental feature of non-linear phonological theory is the emphasis on the role of representations over rules to account for a number of phenomena. To paraphrase a recent statement by McCarthy (1988), if the representations are right, the need to appeal to language-particular rules would be minimized. An important contribution to a theory of representations is the proposal by Clements (1985) that distinctive features are organized into a hierarchical structure. One version of this hierarchy, incorporating modifications by Sagey (1986) and Piggott (1987, 1988), is presented in (1).

1.

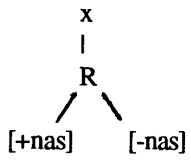


In this paper, I investigate aspects of the internal structure of prenasalized segments in terms of a hierarchy such as (1). It is now generally accepted that such a consonant must be represented as a single segment with two components, the first specified [+nasal] and the second [-nasal]. Assuming a standard view that feature values are binary, I defend a representatation of prenasalized segments in which the distinct specifications for nasality are associated with different nodes. This representation leads to an explanation of the way in which nasal harmony processes are instantiated in a number of languages.

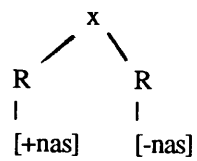
2. The representation of prenasalized segments

Prenasalized consonants together with affricates are members of a class segments, called contours, which, characteristically, contain both values for a given feature. A theory of phonology that incorporates a hierarchy such as (1) must address the issue of how opposite specifications of the same feature are represented in the structure of a single segment. Assuming the organization of features in (1), there appear to be only the two possibilities for representing the surface structure of prenasalized consonants; these are given below.

2. (a)



(b)



The representation in (2a) is equivalent to that proposed by Sagey (1986); it requires that the opposing values for nasality be immediately dominated by the same class node.[1] The alternative (2b) is proposed by Piggott (1988). It is important to note that the choice between (2a) and (2b) cannot be derived from independent properties of the feature hierarchy. Sagey, recognizing this fact, proposes a condition on representation which would eliminate (2b). This condition is stated in (3).

3. Contour segments may branch for terminal features only. No branching class nodes are allowed.

A different condition is recognized by Piggott (1988) and has the effect of making (2a) ill-formed; it is formulated as follows.

4. A node may immediately dominate no more than one value for a given feature.

Since these conditions and the representations they permit are clearly stipulative in that they cannot be derived from independent properties of the theory of phonology in which they are embedded, the choice between them can be made only on empirical grounds. From this perspective, I argue below that patterns associated with prenasalized segments cannot be satisfactorily explained, if (2a) is the appropriate representation of these segments. I, then, show how the problems can be resolved, if (2b) is adopted. Finally, I propose an alternative to both (2a) and (2b) that is consistent with the principle in (4) but completely eliminates the need to refer to language-particular processes that account for the specification of feature values.

2.1 Nasal spreading and prenasalization

If the representation in (2a) reflects the structure of prenasalized segments, one would

expect such segments to be formed by spreading the feature nasal. However, in the clearest cases of nasal spreading, there is no evidence that prenasalized segments can be derived just by the process of spreading. Data from four typical cases are produced below.

5.

(i)	Malay			(ii)	Warao		
	(a)	mãỹãn	'stalk'		(a)	inãw̃ãhã	'summer'
	(b)	mẽw̃ãh	'be luxurious		(b)	mõỹõ	'cormorant
	(c)	mã?ãp	'pardon'		(c)	mẽhõkohi	'shadow
	(d)	mãkan	'eat'		(d)	mõãũ	'give it to him'
(iii)	Sundanese			(iv)	Capanahua		
	(a)	ɲãĩãn	'wet'		(a)	põỹã(n)	'arm'
	(b)	mĩ?ãsih	'love'		(b)	hãmã?õna	'coming stepping'
	(c)	ŋãtur	'arrange'		(c)	bãnawi	'plant it'
	(d)	ŋũdag	'pursue'		(d)	cipõŋki	'down river'

In all the languages in (5), nasality clearly spreads from an underlying nasal consonant. In Malay, Sundanese and Warao, rightward spreading is arrested by supralaryngeal consonants, but none of the arresting segments becomes prenasalized. Capanahua, on the other hand, shows leftward spreading. The result is that nasal consonants may be followed by oral vowels, and oral consonants may be followed by nasal vowels. But, again, neither prenasalized nor post-nasalized segments are derived. If the supralaryngeal consonants in the languages cited above are specified for nasality, the failure of nasal spreading to produce prenasalized segments should not be surprising. Given the theory of spreading proposed in Piggott (1988), nasality could not spread to a position already specified for this feature. The relevant clauses of this theory are reproduced below.

6. Spreading Theory
   (a) A node (x) may spread only to a position not specified for (x).
   (b) The spreading of a node (x) may be arrested only by a position specified for (x).

In the discussion to follow, I will assume this theory to be correct.

One language often cited as providing support for the representation in (2a) is Guarani. According to the data given by Rivas(1974) and van der Hulst and Smith (1982), Guarani morphemes fall into three types: (a) completely oral morphemes (7)); (b) completely nasal morphemes (8); (c) morphemes that combine a nasal part followed by an oral part (9).

7.

(a)	tupa	'bed'
(b)	piri	'rush'
(c)	haihu	'to love'
(d)	puru?a	'to be pregnant'

8.

(a)	tũpã	'god'
(b)	pĩr̃ĩ	'to shiver'

	(c)	mã?ẽ	'to see'
	(d)	nũpã	'to beat'
9.	(a)	^{m}ba?e	'thing'
	(b)	hẽ^{n}du	'to hear'
	(c)	kũmã^{n}da	'bean'

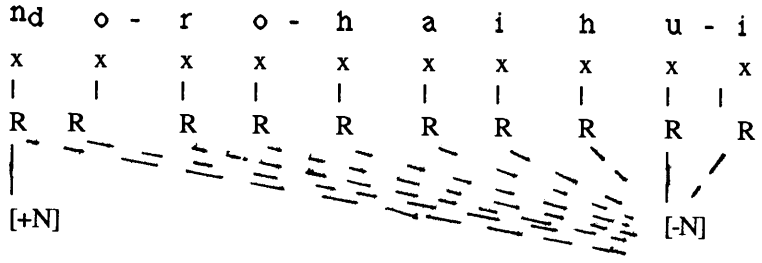
The data in (9) reflect the fact that morphemes which are partly nasal and partly oral always contain a prenasalized consonant followed by a sequence of oral segments. Simple nasal consonants, which must always be followed by a nasal sequence, alternate and are in complementary distribution with prenasalized consonants. The alternation is illustrated by the following data.

10.	(a)	^{n}do-ro-haihu-i	'I don't love you'
	(b)	nõ-r̃õ-hẽ^{n}du-i	'I don't hear you'
	(c)	nõ-r̃õĩ-nũpã-ĩ	'I don't beat you'

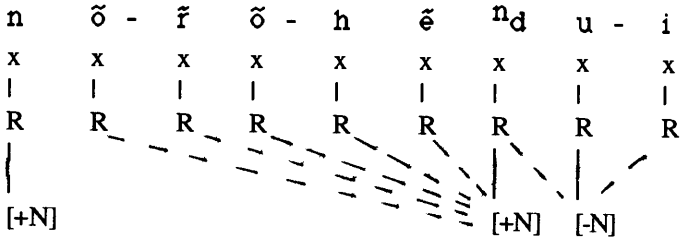
The words in (10) show clearly that nasality is transferred from a stem to both prefixes and suffixes. Notice that the prefix marking negation appears as [^{n}do] in (10a) or as [nõ] in (10b,c). On the other hand, the suffix /i/ is realized as oral in (10a,b), but as nasal in (10c).

Since prenasalized segments in Guarani are always followed by an oral span, Sagey (1986) and others take the position that these segments are derived by spreading [-nasal] leftward to a segment already specified [+nasal]. Spreading of just the feature nasal would, obviously, result in a derived structure in which both values for nasality are directly associated with the same node, thus apparently justifying the representation in (2a). The derivations of (10a) and (10b), respectively, are illustrated below.

11. (a)



(b)



Another language that seems to form prenasalized segments by spreading nasality is the Arawakan language, Terena. In this language, according to Bendor-Samuel (1960), 1st Person is marked by a nasal prosody which they describe as spreading rightward over a word until arrested by

a voiceless obstruent. The arresting obstruent becomes voiced, and the combination of the nasal prosody and the obstruent forms a prenasalized segment. Words in which all segments are nasalized are illustrated in (12), and those in which the process is arrested are shown in (13).

12.	(a)	emoʔu	'his word'	ẽmõʔũ	'my word'
	(b)	ayo	'his brother'	ãỹõ	'my brother'
	(c)	ano	'his neck'	ãnũ	'my neck'
13.	(a)	owoku	'his house'	õw̃õŋgu	'my house'
	(b)	nokone	'his need'	nõŋgone	'my need'
	(c)	piho	'he went'	mbiho	'I went'
	(d)	tuti	'his head'	nduti	'my head'
	(e)	šeʔeša	'his son'	nžeʔeša	'my son'

If it is assumed that the 1st Person prefix has the specification [+nasal] and this element spreads, the derivation of the prenasalized segment in a form such as [õwõŋgu] 'my house' would be as in (14).

14. (a)

o	w	o	k	u
x	x	x	x	x
|	|	|	|	|
R	R	R	R	R
			|	
			|	
[+N] +			[-N]	

⇒ (b)

õ	w̃	õ	ŋg	u
x	x	x	x	x
|	|	|	|	|
R	R	R	R	R
			|	
			|	
[+N] +			[-N]	

The analyses of Guarani and Terena that appear to offer support for representing prenasalized segments as in (2a) are actually seriously flawed. Consider, first, the case of Guarani. The derivation of prenasalized consonants depends, crucially, on the assumption that both values for nasality spread. However, within current approaches to feature specification (e.g. Archangeli and Pulleyblank 1986, Steriade 1987), it is doubtful whether both values for a feature could be available for spreading in the same grammar. Certainly, the most restrictive theory would be one that permitted the spreading of only one value for a given feature. But even if the theory of phonology did allow for the spreading of both [+nasal] and [-nasal], the distribution of nasality in Guarani indicates that the specification [-nasal] is not available to spread. Recall that Guarani morphemes and words are either fully oral (7, 10a), fully nasal (8, 10c), or part nasal and part oral (9, 10b). In the last type, prenasalized segments always mark the boundary between the nasal and oral parts. To derive the prenasalized segment, the specification [-nasal] must be to the right of the specification [+nasal] as in (15a) below. But if [-nasal] can appear to the right of [+nasal] in an underlying representation, it should also be possible for [-nasal] to appear to the left of [+nasal] as in (15b).

15. (a)

x	x
|	|
[+N]	[-N]

(b)

x	x
|	|
[-N]	[+N]

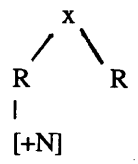
Two pieces of evidence show clearly that (15b) is not possible in Guarani. The first is the restriction on the distribution of nasality; oral spans cannot precede nasal segments in the language. The second piece of evidence is the absence of post-nasalized segments. Since the spreading of nasality is considered to be bidirectional, rightward spreading of [-nasal] in (15b) would produce a post-nasalized segment. If [-nasal] were present in the underlying representation of Guarani morphemes and words, the representation in (15b) and its consequences could only be eliminated by ad hoc stipulations.

Consider, now, some of the consequences of an analysis that derives prenasalized consonants in Terena by spreading nasality. A major shortcoming is the failure to explain how obstruents can be both targets for nasal spreading and also block the process. To see the problem more clearly, we must focus on the source of nasal spreading. There is compelling evidence that spreading must be associated with a feature of the 1st Person morpheme. First, it should be noted that there is no spreading in 3rd Person forms, even when nasal consonants are present. The second bit of evidence is embedded in a 1st Person form such as (13b) [nõŋgone] 'my need'. Notice that the vowel following the last nasal consonant in the word is not nasalized. The source of nasality on the first vowel must, therefore, be the 1st Person prefix. This entails that the nasal consonant at the beginning of this word is transparent to nasal spreading. In contrast, non-nasals must be opaque. The blocking effect of the latter must be attributed to their [-nasal] specification. By itself,this is not surprising. What is surprising is that the [+nasal] specification of nasal consonants does not block spreading. The problem posed by the apparent transparency of nasal consonants to nasal spreading can be resolved by stipulating that nasals are not specifed as [+nasal], as is proposed in Piggott (1988). However, such a proposal is clearly ad hoc. The consonant system of Terena is not significantly different from that in Warao, for example, and nasal consonants must be underlyingly [+nasal] in the latter.

2.2 The internal structure of prenasalized segments

Most of the problems that follow from recognizing (2a) as the appropriate representation of prenasalized segments can be resolved, if the nasal and non-nasal components of these segments are considered to be associated with distinct nodes of the feature hierarchy, as is reflected in (2b). For example, we would be able to explain why the simple spreading of nasality does not produce prenasalized and/or post-nasalized consonants in languages like Warao, Sundanese, Malay and Capanahua; the appropriate representation could not be produced by such a process. The problem of accounting for the alternation between prenasalized segments and simple nasals in Guarani can also be resolved. The appropriate explanation follows, straightforwardly, from the following underlying representation of the nasal-prenasalized alternants in Guarani.

16.

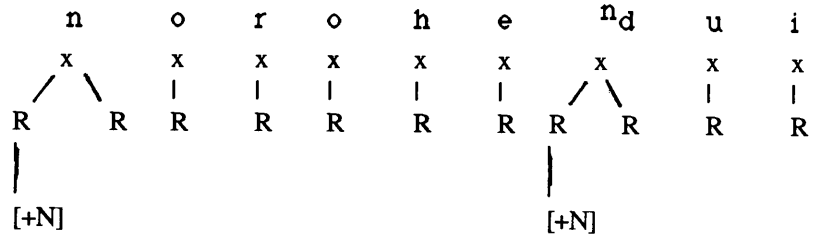


The structure in (16) is not specific to Guarani. It must be part of the underlying representation of prenasalized segments in any language, if it is assumed that the redundant [-nasal] specification of consonants cannot be lexically specified.

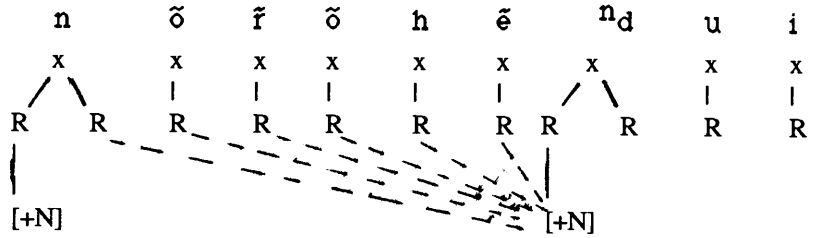
Let us see how (16) contributes to an explanation of the distribution of nasality in Guarani. It is argued in Piggott (1988) that nasal spreading in this language is uniformly leftward.

When this process is triggered, nasality would spread to all available positions to the left of a segment with the properties of (16). Consequently, from underlying (17a) the derived representation (17b) would follow.

17. (a)



(b)



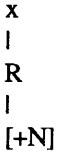
The surface nasal at the beginning of this word is clearly derived from a representation like that in (16) by spreading nasality to the right root node. This would result in both root nodes being specified as [+nasal]. They would, then, be fused, so that the surface representation of the simple nasal would contain a single root node. When nasal spreading does not affect the right root node, it would be specified [-nasal] by the universal redundancy rule (18).

18. [ ] → [-nasal]

This account of the derivation of simple nasal consonants in Guarani explains why these segments are always followed by a nasal span. This analysis also explains why prenasalized segments must be preceded by a nasal sequence and followed by an oral sequence. Notice also that postnasalized segments could not be derived in Guarani, since only [+nasal] spreads and no segment is underlyingly specified as [-nasal].

Unlike the situation in Guarani, the structure in (16) is not part of the underlying representation of any Terena consonant. The representation of an underlying nasal contains only one root node dominating the feature nasal as in (19a), while the single root node of an obstruent is not specified for nasality (19b).[2]

19. (a)



(b)

The structure appropriate to prenasalized segments must,therefore, be derived. Since these segments arise only in forms containing the 1st Person affix, the combination of this morpheme and the stem must provide directly for the formation of prenasalized segments. To account for the data in (13), this affix must contain more than the specification [+nasal]. I propose that it must

have the following structural properties.

20. Terena 1st Person Prefix

R
|
[+N]

Given such a representation, the prenasalized segment in a form such as [ⁿduti] 'my head' can be straightforwardly derived by associating the root node of the 1st Person morpheme to the skeletal position associated with the first obstruent in the word as is shown in (21).

21. (a)

	t	u	t	i
	x	x	x	x
	|	|	|	|
R +	R	R	R	R
|				
[+N]				

(b)

	ⁿd	u	t	i
	x	x	x	x
	|	|	|	|
R +	R	R	R	R
|				
[+N]				

The mechanism by which the floating root node in Terena is linked to a skeletal position is the Mapping Parameter proposed in Piggott (1988).

22. The Mapping Parameter
A floating autosegment links to the rightmost/leftmost available position.

In a previous analysis of Terena nasalization (Piggott 1988), I claimed, incorrectly, that a floating autosegment is linked in to the rightmost available position. I now support an alternative analysis in which the parameter setting in Terena requires that the floating root node be linked to the leftmost available position. Independent evidence in favour of this analysis comes from the manifestation of the process that marks 2nd Person. Bendor-Samuel (1960) points out that the 2nd Person is marked by a [+high, -back] segment which appears as the semivowel [y] before stems beginning with one of the vowels [e, a, o, u]. In other cases, the segment combines with the leftmost of these vowels to yield the following vowel changes: [e, u] > [i], [a, o] > [e]. Crucially, the [+high, -back] segment cannot combine with the high front vowel [i]. This type of restriction on the mapping process is also reflected in the realization of the 1st Person morpheme; the floating root node specified [+nasal] cannot be combined with a position associated with a nasal consonant, as is shown by a form such as (13b) [nõᵑgone] 'my need'. In (13b) the mapping process skips over the nasal consonant and finds the leftmost non-nasal consonant.[3] After the 1st Person morpheme is phonologically linked to the stem by the Mapping Parameter, the nasal feature of this morpheme spreads. I assume that this morphologically triggered process of nasal spreading in Terena is bidirectional, but rightward spreading from a prenasalized consonant is blocked by an obstruent in the same way as the spreading process is blocked in languages such as Warao and Sundanese.

One other example of a language with prenasalized segments may be considered here. The description by Pike and Small (1974) indicates that in Mixtec there a contrast between a set of oral voiceless stops e.g. [p t k kʷ] and a set of prenasalized stops e.g. [ᵐb ⁿd ᵑg ᵑgʷ]. In addition, there is a distinct set of nasals [m n ɲ]. There are also voiceless and voiced fricatives; the latter are not prenasalized.[4] Two pieces of evidence indicate that the language has a progressive

harmony process that spreads nasality rightward from a nasal consonant. First, vowels following nasal consonants must be nasalized. Secondly, prenasalized stops and other voiced obstruents cannot be followed by nasal vowels, except when the special regressive harmony process, discussed below, is triggered. These patterns are illustrated by the following data.

23. Progressive Nasal Harmony in Mixtec

(a)	nũʔũ	'tooth'
(b)	nãʔã	'people'
(c)	mãũ	'aide'
(d)	dusnũũ	'eye'
(e)	nũti	'sand'
(f)	mĩʔⁿde	'prickly pear'

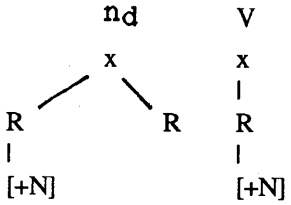
From the data in (23), the obligatory presence of nasalized vowels after nasal consonants can be attributed to the rightward spreading of nasality from a nasal consonant. The fact that nasality cannot spread rightward from prenasalized segments is not unusual; we have seen that a similar restriction holds in Terena. However, this restriction on nasal spreading is not sufficient to account for the absence of nasal vowels after prenasalized segments, since there are underlying nasal vowels in Mixtec. This is confirmed by forms such as the following.

24.

(a)	tũũ	'charcoal'
(b)	kʷẽʔẽ	'to go'
(c)	sẽũ	'other one'

We must, therefore, explain not only why derived nasal vowels cannot occur after prenasalized consonants, but also why underlying nasal vowels cannot appear in such a position. If underlying prenasalized segments in Mixtec are represented as in (16), a possible explanation would emerge. To see this, consider the combination of a sequence consisting of a prenasalized consonant and an underlying nasal vowel in (25).

25.



The impossibility of underlying nasal vowels after prenasalized consonants can, readily, be attributed to the Obligatory Contour Principle (OCP). This principle blocks a sequence of [+nasal] specifications on the nasal tier.

This explanation of the absence of nasal vowels after prenasalized segments by appealing to the OCP is only tenable if the initial representation of the latter does not include the specification [-nasal]. This possibility can be permitted if there are two root nodes to which nasality may be linked. Of course, the fact that nasality cannot spread rightward from a prenasalized segment should also follow from the representation. If the presence of the

specification [-nasal] is assumed to be responsible for the blocking of nasal spreading, this value would have to be inserted prior to spreading.

In addition to the progressive nasal harmony, Mixtec also has a regressive nasal harmony triggered by the 2nd Person (familiar) morpheme. In this case, nasality spreads from the end of a word and may be arrested only by a voiceless obstruent. Some of the data appear in (26) below.

26. Regressive Harmony in Mixtec

(i)	(a)	kũžũ	'you are diligent'
	(b)	kĩʔvĩ	'you will be drunk'
	(c)	kĩʔðĩĩ	'you will get angry'
	(d)	kõʔõ	'you will drink'
	(e)	nd^{z}õʔõ	'you are a hummingbird'
	(f)	kĩʔĩ	'you take it'
(ii)	(a)	kũnũ	'you will run'
	(b)	kãmã	'you will hurry'
	(c)	kãʔnĩ	'you will kill'
	(d)	nãngãvã	'you will let it loose'
	(e)	kãʔndẽ	'you will cut'
	(f)	išãmbãʔã	'you are a good child'
(iii)	(a)	kaʔtã	'you will sing'
	(b)	kotõndẽẽ	'you will examine'
	(c)	cikweʔcĩ	'you will complain'
	(d)	koʔšõ	'you will fall'

The major issue raised by the data in (26) is the apparent transparency of prenasalized stops and other voiced obstruents to the harmony. In Piggott (1988), I show that this problem can be resolved if we assume that all voiced obstruents in Mixtec are underlyingly prenasalized segments and that regressive harmony can spread nasality leftward from the left root node of such a segment.

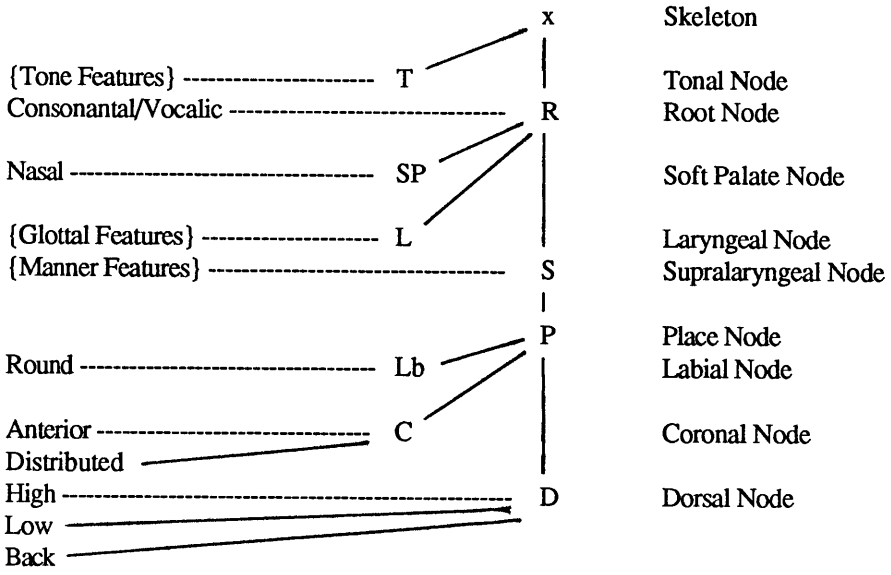
3. Conclusion

I have argued in this paper that the internal structure of prenasalized segments must contain two root nodes, dominating different specifications for nasality. Such a representation is necessary to account for the fact that typical processes of nasal spreading do not create prenasalized segments. Given this representation, it is also possible to allow a rule such as (18) to introduce the [-nasal] specification for consonants and still maintain a difference between simple nasal and oral segments, on the one hand, and prenasalized segments on the other. I have also shown that the presence of two root nodes in the internal structure of prenasalized segments contributes to the explanation of restrictions on the destribution of nasality in Guarani, Terena and Mixtec. However, my analysis raises a number of issues which must be addressed, if it is to be accepted as superior to the alternative considered here.

One problem is derived from the assumption that phonological theory permits a representation like (16) in which the left node is specified [+nasal] and the right node is unspecified. This would seem to entail that postnasalized segments in which the right node is specified [+nasal] should be just as likely to occur as prenasalized ones. This is clearly not the case. I know of no language with underlying postnasalized segments. This problem can be solved by adding to phonological theory a condition requiring that the specification [+nasal], the only value present in underlying representations, be associated with the left node of a contour segment. Perhaps, the appropriate mechanism is actually the Universal Association Convention, operating to map features to nodes. But the second problem is not so easily handled. It arises as a consequence of adopting a theory of underspecification according to which the redundant feature value [-nasal] is not specified in underlying representations. Given such a conception of feature specification, it appears to be impossible to determine, in a principled manner, when redundant values are inserted in a derivation. For example, in Guarani, the specification [-nasal] cannot be inserted before nasal spreading, if nasals may be derived from a representation like (16). On the other hand, it is clear that, in Mixtec, prenasalized segments must be specified for both values of nasality before nasal spreading, since [+nasal] can spread rightward from a nasal consonant but not from a prenasalized one. The problem also surfaces in the analysis of nasal spreading in languages such as Capanahua, Warao, Malay and Sundanese. If segments specified [-nasal] block the spread of nasality in these languages, how does phonological theory provide for the insertion of this value?

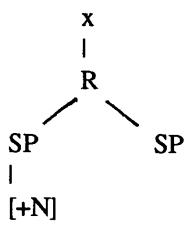
A possible answer to the question of how the specification of the value [-nasal] is incorporated into grammar can be provided by the alternative feature hierarchy in (27) below.

27.



This alternative is based on a proposal by Sagey (1986) according to which the feature nasal is dominated directly by an articulator node, the Soft Palate Node. This hierarchy would provide for the representation of prenasalized segments in (28) as an alternative to (16).[5]

28.



If (28) is appropriate for prenasalized segments, the structure of a simple nasal would contain a single SP node dominating the specification [+nasal] and oral segments would contain this node with no specification for nasality. Given that nasal is the only terminal feature of the Soft Palate node, I propose that nasal spreading is accomplished by the spreading of this node. Of course, given the theory of spreading in (6), nasal spreading would be blocked not by the feature nasal itself but by the presence of a Soft Palate node. This would entail that the specification [-nasal] never has to be present in any grammar prior to the spreading of nasality.

The adoption of the hierarchy in (27) has other implications for the specification of [-nasal]. It would no longer be necessary to maintain the standard view that nasality is a bivalent feature. It could be considered to be monovalent. This would directly capture the fact that the specification [-nasal] plays no role in the grammar of any language. It would also eliminate the need for a redundancy rule such as (18).

Notes

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1. Sagey actually requires that nasality be immediately dominated by a Soft Palate node rather than by the Root node. The two specifications for the feature would, therefore, be linked to the Soft Palate node.
2. This representation of underlying nasals in Terena differs from that proposed in Piggott (1988). There, it was assumed that nasals are not specified for nasality. On reconsideration, I have determined that such a proposal cannot be reconciled with any principled theory of feature specification.
3. This conception of how the process of mapping is accomplished leads to a rejection of the constraint formulated in Piggott (1988) as the The Mapping Constraint, which assumed that mapping cannot cross a position specified for the features involved in the particular process.
4. In Piggott (1988), I proposed that all voiced obstruents in Mixtec are underlyingly prenasalized segments.
5. The representation in (28) is appropriate for only one type of prenasalized segment. There is some evidence that prenasalization is the instantiation of spontaneous voicing in some languages; Guarani may be one of these.

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