On the Interaction between Sonorancy and Voicing*

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In this paper we present an analysis of the relationship between sonorancy and voicing based on a theory of segmental structure which recognizes the possibility that voice may not be a unitary phenomenon. We propose that voicing has two distinct realizations. One is through the activation of laryngeal features and the other is spontaneous voicing. We propose that sonorants involve a node which represents spontaneous voicing and that this may also be present in obstruents. We adopt the term SV for this node (see also Piggott 1989). We thus view spontaneous voice as distinct from laryngeal features, sharing the general position of Stevens & Keyser (1989) who state that "voice might be classed as a manner feature" separate from the laryngeal features which deal with laryngeal configurations.

An advantage of the feature geometry that we propose in this paper is that it allows an account of sonorant-sonorant interactions, as sonorant features such as [nasal] and [lateral] are both dominated by the SV node.

A further advantage is that we are able to shift the burden of explanation from the rule component to the representational component. By recognizing two types of voicing, we eliminate the use of redundancy rules in the specification of voice for sonorants as a method of accounting for phonological processes.

The paper is divided into four sections: in section 1, we set out our background assumptions. In section 2 we provide evidence for SV as a node dominating sonorant features and in section 3 we extend our analysis to the distinction between sonorant and laryngeal voicing in obstruents. In section 4, we discuss the implications of our analysis for rule formalism.

1. Assumptions
1.1 Feature Geometry

Following Clements (1985), Sagey (1986), Archangeli & Pulleyblank (1986), McCarthy (1988), and others, we assume that segments are not merely unordered feature bundles but that they have hierarchical structure. The model of segment structure that we adopt is shown in (1).

(1)

```
Root
   /   \
Laryngeal  Continuant
   /       /
Supralaryngeal  SV (Spontaneous Voice)
   /     \     
Place  
   /   \
Nasal  Lateral
   /   \
Labial  Coronal  Dorsal
```

We distinguish two major node types, organizing nodes and content nodes. Organizing nodes (roughly equivalent to Clements' 1985 class nodes) serve to define major organizational units such as Supralaryngeal, Place and Spontaneous Voice. The content nodes are actual articulatory instructions.
The absence of plus and minus values on the nodes should be noted. Their absence follows from our assumption that all features are monovalent in nature, with presence versus absence giving the appearance of binarity. This assumption is a natural extension of the move made in Sagey (1986) to monovalent articulator nodes, and leads potentially, we believe, to a more highly constrained theory. See Anderson & Ewen (1987) and van der Hulst (forthcoming a, b) for work which argues for monovalency.

1.2 Underspecification

What we call underspecification differs in some respects from the usual use of this term (e.g. Archangel 1984, 1988, Steriade 1987, and many others). Given binary features, two types of underspecification can be distinguished, redundant feature underspecification and redundant value underspecification. With single valued features, only redundant feature underspecification is relevant. We assume that redundant, or unmarked, content nodes are absent from underlying representation. Which content nodes are unmarked is determined by a universal markedness theory, with the least marked of the content nodes at any particular organizing node normally being absent from underlying representation. Markedness can be overridden by contrasts within an inventory (see Avery & Rice forthcoming for details). Thus, underspecification is inventory-driven in the sense of Steriade (1987).

The role of default rules in our framework is less elaborate than that found in other work on underspecification theory (e.g. Archangel & Pulleyblank 1986, Kiparsky 1982). We see default rules as being restricted to the phonetic implementation component. Thus, if a feature or node is underspecified in the phonology of a language, then that feature cannot play a role in the phonology of the language. Default rules merely supply articulatory instructions; for example, such rules specify whether a /t/ is dental or alveolar in a particular language.

1.3 Rules

We assume that the phonology is restricted to at most three operations, spreading, delinking, and OCP-based fusion (although we shall see some reason to revise this later).

Spreading is a language-particular operation which may include trigger and target conditions as well as a directionality parameter. The theory of spreading that we adopt is summarized in (2).

(2)  a. Spreading can occur only if a structural target is present.
     b. A feature or node can spread only to an empty position.

(2a) disallows node generation through spreading and (2b) rules out cases of spreading triggering delinking. See Mascaro (1987a) and Piggott (1988) for similar views and Avery & Rice (forthcoming) for further details.

Delinking is a neutralization process which delinks content nodes in neutralizing positions such as morpheme-final or syllable-final. A crucial assumption that we make is that laryngeal distinctions are universally neutralized syllable-finally, as shown in (3).\(^1\)

(3)

\[
\begin{array}{c}
\text{Root} \\
/ \\
\text{Laryngeal} \\
\dagger \\
x
\end{array}
\]
Fusion takes identical locally adjacent content nodes and fuses them. Fusion is not further relevant to this paper. See Avery & Rice (forthcoming) for discussion of the differences between fusion and spreading.

2. The SV node

Frequent place assimilation across languages has been taken as strong evidence for Place as an organizing node (see Clements 1985, McCarthy 1988). We will present arguments parallel to those presented for the Place node for an organizing node dominating the sonorant features, [nasal], [lateral], and [r-features]². We argue that a node is necessary based on assimilations found within the sonorant consonants. In addition, we present evidence that the node itself can spread and delink.

2.1 English assimilation

Sonorant-sonorant assimilations are found in English level 1 phonology, with the prefix /in-/ This prefix assimilates to a following consonant in terms of place of articulation as in (4a). More importantly, it assimilates totally to a following sonorant consonant as in (4b), with subsequent independently necessary degemination (see Schein & Steriade 1986, Borowsky 1986, etc. for a discussion of degemination in English).

\[
\begin{array}{lll}
\text{a.} & \text{[m]balance} & \text{[n]dentured} & \text{[g]rown} \\
\text{[m]possible} & \text{[n]tangible} & \text{[t]edible} \\
\text{b.} & \text{[r]ational} & \text{[l]egible} & \text{[n]umerable} & \text{[m]easurable}^3
\end{array}
\]

Borowsky (1986) argues that the /n/ of the prefix /in-/ is specified merely as [sonorant], with [nasal] supplied by default. We agree with the spirit of this analysis, but for us the nasal is simply the organizing node SV. Thus, the unmarked sonorant consonant is nasal and [nasal] is predictable from SV.⁴

The rule of spreading in English can now be formulated as in (5). In this rule, we show [lateral] and [r-features] as dependents of the organizing node SV, while the nasal is simply SV. The conditions for spreading are met (there is an empty structural target), and [lateral] and [r-features] spread leftward to the empty SV node.

\[
\begin{array}{llll}
\text{SV} & \text{SV} & \text{(illegible)} & \text{SV} & \text{SV} & \text{(irregular)} \\
& & \text{lateral} & & \text{r-features}
\end{array}
\]

2.2 Klamath n-l assimilation

In Klamath, as in English level 1, /n-l/ becomes [l-l], as illustrated in (6). See Barker (1964) for discussion.

\[
\begin{array}{llll}
\text{honlina} & \rightarrow & \text{hollina} & \text{'flies along the bank'} \\
\text{w'inl'ga} & \rightarrow & \text{w'llga} & \text{'lies down on the stomach'}^5
\end{array}
\]

Clements (1985) proposes that n-l assimilation in Klamath be analyzed as the spreading of lateral, with spreading formalized as in (7).
The rule in (7) spreads a supralaryngeal feature on the right that dominates [lateral] to a supralaryngeal node on the left that is realized as a coronal sonorant, delinking the supralaryngeal node on the left. While Clements' rule is descriptively adequate, it offers no account of why such target conditions are found: a rule that spread [lateral] to a target with any random set of supralaryngeal features could just as easily be formulated. In addition, Clements' formulation of the rule is problematic given the theory of spreading outlined in (2) as this theory allows spreading to occur only if an empty structural target is present. In our terms, the [lateral] dependent of the SV node on the right spreads to the empty SV node on the left. The rule is shown in (8).

2.3 Ponapean assimilation

Ponapean is another language that exhibits assimilation within the sonorants. We illustrate the Ponapean assimilations with the n/l alternation.\(^6\) In rapid speech, Ponapean exhibits the same assimilation found in Klamath and English, /l/ assimilates to /l/, as illustrated in (9).

This assimilation can be accounted for in the same way as the Klamath and English level 1 assimilations, with the daughter of the righthand node spreading to the lefthand node.

2.4 Toba Batak assimilation

Toba Batak is another language with numerous sonorant-sonorant assimilations. These are shown in (10). Data is from Hayes (1986).

We assume the representations in (11) for the Toba Batak sonorants.\(^7,\,8\)
/n/ is represented as a bare SV node. /l/ is an SV node with [lateral] as a dependent and the feature [continuant] as a daughter of the root node. Finally, /r/ is a bare SV node with the feature [continuant] as daughter of the root node.

Assimilation in the n-n, r-r and l-l sequences in Toba Batak is straightforward, being the result of either fusion of identical sonorant features (l-l) or the fill-in of default rules (n-n, r-r). The n-l sequences are analyzed in the same way as the n-l sequences in Klamath, English level 1, and Ponapean, with spreading of [lateral] onto the lefthand unspecified SV node. In the n-r case [continuant] spreads from the /r/ onto the /n/ and the entire sequence is realized as [r-r] as the nasal default rule will not insert [nasal] onto a continuant. Assimilation in l-n is blocked since /n/ has no specified features to spread to /l/ and /l/ has a dependent. In r-l, [lateral] spreads from the /l/ to the /r/, yielding [l-l]. Assimilation in l-r is blocked for the same reason that there is no assimilation in l-n: the left-hand SV node has specified features ([lateral]) and therefore spreading cannot apply.

2.5 Korean SV spreading

So far, we have argued for the SV node based on spreading, as is found in Klamath, level 1 English, Ponapean and Toba Batak. In all these cases, the SV node organizes sonorant features and acts as a target for spreading. If SV is truly a node, one should find other node-like patterning, namely spreading and delinking. We will first consider spreading.

An example of spreading of the SV node is found in Korean. Stops assimilate in nasality to a following segment (12a-d) and t's assimilate to a following lateral (12e). This can be analyzed as the spreading of SV leftwards to a preceding consonant. (Data from Cho 1988 and from Iverson and Kim 1987)

(12) a. kukmul → kuŋmul 'soup'
b. kakmok → kaŋmok 'wood'
c. nappita → namnita 'to sprout'
d. kakʰni → kanni 'to be the same'
e. tikitiil → tikiliil 'the letters t and l'

Assuming that the nasals are characterized as SV and the lateral as SV dominating [lateral], the Korean process can be analyzed as spreading of an SV node on the right to an adjacent segment on the left which has no SV node. This assimilatory process is illustrated in (13).

(13) Root Root ~ ~ ~
    ~ ~ ~
    SV

Note that Korean cannot simply have supralaryngeal spreading since sonorant features spread independently of place features.

2.6 Yagaria SV delinking

Delinking provides a third argument type for node status. As discussed by McCarthy (1988), debuccalization can be viewed as delinking of the Place node. If SV is a node, one might expect to find desonorantization processes, where the SV node delinks. There is some evidence for desonorantization. In the Move dialect of Yagaria, a language of the Kamano-Yagaria-Keigana subfamily of the East-Central family of the East New Guinea Highlands stock, there are alternations between sonorants and obstruents: /l/ alternates with /ʔ/, /w/ with /p/, /j/ with /g/, and /m/ with /b/. Basically, the sonorant form occurs following a vowel and the obstruent form is found after a glottal stop, which is subsequently lost. See Levin (1987) for details. As discussed by Levin, these processes
can be viewed as strengthening, with a sonorant becoming an obstruent of the same place of articulation. We suggest that these alternations arise from a delinking of the SV node, which automatically yields the stops. (Notice that we are abstracting away from the voice properties of the output; Levin offers no account of this either).

2.7 Kuman SV delinking

Kuman, a Papuan language discussed in Levin (1988) and McCarthy (1988) offers additional evidence for SV sonorantization. In Kuman, the lateral becomes a [t] before an [n], as illustrated in (14).

(14) yabul-na → yobutna 'bone 1st sing.'
yal-nga → yatnga 'plant 2nd sing.'

We analyze this as delinking of the SV node, motivated by the presence of a following SV node. Once SV is delinked, the consonant is realized as the default coronal, [t].

2.8 Summary

To summarize, we propose that sonorants are best characterized as having an SV node dominating sonorant features. We have attempted to show that this node displays typical node-like behaviour: it serves as a target of spreading (Klamath, English level 1, Ponapean, Toba Batak), it spreads (Korean), and it delinks (Yagaria, Kuman). In addition, we have suggested that [nasal] is the unmarked sonorant and is not present in the underlying representations of the languages discussed so far, but arises through phonetic default rules.

3. The representation of sonorants and obstruents

Sometimes sonorants pattern with voiced obstruents, behaving as though the feature [voice] were present and other times sonorants do not pattern with voiced obstruents, behaving as though the feature [voice] were not present. When sonorants do not pattern with voiced obstruents, the standard analysis is that [voice] is redundant for sonorants and is not visible in the phonology (see, for instance, lô & Mester 1986, Hayes 1982, Kiparsky 1985, Mascaro 1987a). When sonorants do pattern with the voiced obstruents it is assumed that the process involved takes place after the specification of the redundant values for [voice] (see Mascaro 1987a). We propose that the difference between languages in which voiced obstruents and sonorants pattern separately and those in which they pattern together follows from the different representations of voiced obstruents in these languages. When voiced obstruents and sonorants pattern as a natural class, these sounds are characterized by the presence of the SV node. When voiced obstruents and sonorants do not form a natural class, the SV node is present only for sonorants; the voiced obstruents are distinguished from the voiceless obstruents solely by laryngeal features. This allows us to account for those languages in which voiced obstruents and sonorants pattern together without recourse to the ordering of redundancy rules.

We will propose a typology of languages where the classification of a language depends on the behaviour of nasals and voiced obstruents. We suggest two broad classes of languages. In class I languages, [nasal] is absent from underlying representation and we find sonorants and laryngeal obstruents, but no sonorant-obstruent interactions. When the language has voiced obstruents, voicing distinctions are neutralized in syllable-final position. In class II languages, [nasal] is present underlingly and we find sonorants and laryngeal obstruents, but voiced obstruents and sonorants interact. In these languages we claim that the voiced obstruents and sonorants are distinguished at the SV node.
One assumption which is crucial to this section is that final laryngeal neutralization is universal. We do not present arguments for this position, and must leave such arguments to a later paper. Should this prove to be untenable, it would require that we rethink the conclusions reached in this paper.

3.1 Class I languages

We distinguish two types of class I languages, those without laryngeal distinctions (section 3.1.1) and those with such distinctions (section 3.1.2).

3.1.1 Class 1a - no laryngeal distinctions
3.1.1.1 Ponapean

Ponapean has voiceless obstruents and sonorants, as shown in (15) (from Rehg & Sohl 1981).\(^{11}\)

\[
\begin{array}{ccc}
\text{Labial} & \text{Coronal} & \text{Velar} \\
\text{p} & \text{d} & \text{k} \\
\text{pw} & \text{t} & \text{g} \\
\text{m} & \text{n} & \text{ŋ} \\
\text{mw} & \text{l} & \text{ɾ} \\
\end{array}
\]

Rehg and Sohl (1981) characterize the non-sonorants in Ponapean as voiceless and the sonorants as voiced. There are no voicing contrasts within either the obstruents or the sonorants. We have already seen that Ponapean sonorants have an SV node, as in (16a). We propose the representation in (16b) for Ponapean obstruents.

\[
\begin{array}{c}
\text{sonorant} \\
\text{Root} \\
\text{SV} \\
\text{Laryngeal}
\end{array}
\]

Only Laryngeal is present for obstruents\(^{12}\) and only SV is present for sonorants. The obstruents are realized as voiceless and SV as nasal, both by the application of universal default rules which fill in unmarked values.

3.1.1.2 Rotokas

A language with representations like those in Ponapean is Rotokas. However, some significant differences between Ponapean and Rotokas show that the SV node may be realized as an obstruent as well as a sonorant. Rotokas is reported by Firchow & Firchow (1969) to have two dialects, one with nasal sonorants and one without sonorants. The dialects are illustrated in (17).

\[
\begin{array}{ccc}
\text{Rotokas (Firchow & Firchow)}^{13} & \text{Dialect A} & \text{Dialect B} \\
\text{voiceless} & \text{p} & \text{t} & \text{k} & \text{p} & \text{t} & \text{k} \\
\text{voiced} & \text{m} & \text{n} & \text{ŋ} & \text{b} & \text{ɾ} & \text{g}
\end{array}
\]
We assume that these dialects do not differ in terms of underlying representation, but rather in terms of phonetic realization. In Dialect A, with sonorants, the feature [nasal] is filled in, the unmarked case, and the underlying SV node is implemented as a nasal. In dialect B, the nasal default rule does not operate and voiced obstruents result. The voiced obstruents contain the SV node, and are the sonorants of the language.

A parallel situation is found in Hawaiian. In some dialects, the consonants /p k ʔ/ are found, while in others /p t k/ occur. In Avery & Rice (forthcoming), we suggest that the difference in these Hawaiian dialects results from the failure of the Coronal default rule to apply in the dialect with glottal stop rather than /ʔ/. The dialects do not differ with respect to underlying representation, but rather with respect to the default rules that supply the articulatory gestures to sounds.

Rotokas demonstrates that SV can be present in obstruents. Other languages appear to show similar properties; for instance, Thompson & Thompson (1972) cite a number of nasal-less languages in the Northwest Coast, including Nisina and Makah of the Wakashan family, Quileute of the Chemukuan family, and Puget Sound Salish and Twana of the Salishan family. In all cases, these languages have /b/ and /d/ developing from *m and *n. One possible analysis of such facts is that they are like Rotokas: the Nasal default rule simply fails to operate, with voiced obstruents resulting. In the next section, we will see that although SV can be present in obstruents, it is not a necessary feature of voiced obstruents.

3.1.2 Class Ib languages - laryngeal distinction

In class Ib languages we find both voiced and voiceless obstruents as well as sonorants. These languages, like Class Ia languages, are characterized by the absence of [nasal] in underlying representation. They also show syllable-final neutralization of laryngeal distinctions.

3.1.2.1 Dutch

Dutch has both voiced and voiceless obstruents as well as sonorants. Voiced and voiceless obstruents show alternations in Dutch, but the sonorants do not enter into this system.

Dutch exhibits syllable-final devoicing (data from Mascaró 1987a).

(18) huif[z]en 'houses'
uhi[s] 'house'
uhi[s k]ammer 'living room'
kie[z]en 'to choose'
kie[st] 'you/she/he chooses'

Syllable-final obstruents are not always voiceless, however. If they are followed by a voiced obstruent, they are voiced.

(19) huif[z b]aas 'landlord'
kie[z b]aar 'eligible'

When followed by a sonorant onset, syllable-final consonants are phonetically voiceless.

(20) huif[s]raad 'household goods'
We account for these facts as follows. Voiceless obstruents are characterized by a laryngeal node, voiced obstruents by a laryngeal node dominating LV, laryngeal voice, and sonorants by the SV node.

<table>
<thead>
<tr>
<th>(21)</th>
<th>vcls obs</th>
<th>vd obs</th>
<th>sonorant</th>
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In Dutch, syllable-final neutralization results in the loss of laryngeal contrasts. The voiced syllable-final obstruents achieve their voicing by spreading of the laryngeal dependent from the following consonant. Since sonorants are not laryngeal, they fail to trigger assimilation.\textsuperscript{15} Typical derivations are shown in (22).

<table>
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<tr>
<th>(22)</th>
<th>a.</th>
<th>b.</th>
<th>c.</th>
<th>d.</th>
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Laryngeal neutralization

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Laryngeal spreading

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\[s\] \[s\ \text{k}\] \[z\ \text{b}\] \[s\ \text{r}\]

All of the examples show syllable-final laryngeal neutralization, expressed as delinking of laryngeal dependents. In both (22a) and (22b), the consonant is realized as voiceless. In (22c), delinking is followed by laryngeal spreading, which functions to revoice the syllable-final /z/. In (22d), spreading does not occur since the sonorant does not have a laryngeal node. Thus, the structural description of spreading is met only when the consonant on the right is a voiced obstruent and not when it is a sonorant.

Given these representations we predict that [nasal] is absent in underlying representation in Dutch. We do not have any positive evidence for this position as there are no examples of spreading to SV in Dutch that we know of. However, in the Teralfene dialect of Flemish, a language related to Dutch, it appears that [nasal] is absent underlyingly. Levin (1988) points out that under certain circumstances nasals become laterals.
This spreading of [lateral] can be accounted for if nasals consist of just an SV node, without a nasal dependent. If we assume that the underlying representations in Teralfene and Dutch are the same, then Dutch is like Ponapean in that [nasal] is absent underlyingly.\textsuperscript{16}

3.2 Class II languages

In the languages illustrated so far, the SV node is present only for sonorants and sonorants and voiced obstruents do not form a natural class. Languages in which sonorants and voiced obstruents do pattern together are our class II languages. In these languages, voiced obstruents contain the SV node. Furthermore, these languages maintain voicing distinctions syllable-finally and have [nasal] specified underlyingly.

3.2.1 English

The patterning of sonorants and voiced obstruents as a natural class can be seen in the inflectional morphology of English: voiced obstruents and sonorants require the voiced allomorph and voiceless stops the voiceless allomorph, as in (24).

(24) English

\begin{tabular}{ll}
  voiceless & plural \quad & past tense \\
  voiced & pet[s] & walk[t] \\
  sonorant & pad[z] & lag[d] \\
      & pen[z] & open[d] \\
      & pal[z] & roll[d] \\
      & car[z] & fare[d] \\
\end{tabular}

Because English voiced obstruents and sonorants both require the voiced allomorph of the inflectional items, they should share a common trigger feature. Mascaró (1987a) accounts for these facts by proposing that the voicing value of the affix is determined by spreading of [voice] from the previous segment, with spreading occurring after the default value of [voice] for sonorants is filled in.

We suggest a rather different analysis. We propose that in English voiced obstruents are spontaneously voiced. Given this proposal, representations for English obstruents and sonorants are as given in (25).

(25) voiceless obstruent \quad voiced obstruent \quad sonorant

\begin{tabular}{lll}
  Root & Root & Root \\
  \text{\large \text{l}} & \text{\large SV} & \text{\large SV} \\
  \text{\large Lar} & \text{\large \text{\textv l}} & \text{\large nasal} \\
\end{tabular}

We characterize English obstruents as having both a laryngeal node and an SV node. There is some evidence from English for this position. Ladefoged (1982) points out that voiced obstruents are only partially voiced syllable-finally (unless followed by a voiced sound) (p.83). This partial devoicing can be accounted for if the obstruents maintain SV, losing the laryngeal feature. The laryngeal distinction is lost through the operation of the universal
syllable-final laryngeal neutralization rule. However, the SV node remains, giving these obstruents a partially voiced quality phonetically.

Notice that in English, where the voiced obstruents have an SV node, we suggest that the nasal sonorant must be characterized by the feature [nasal] underlyingly. This is different from the other language types examined so far, where [nasal] is realized by default. The feature [nasal] is necessary on the sonorants in English in order to keep voiced obstruents and sonorants distinct: if [nasal] were not present, there would be no SV difference between these two classes, and one might predict that the default rule for [nasal] would fill in [nasal] in all instances. The proposed representation for English nasals predicts that spreading of [lateral] and [r-features] onto a nasal should not occur since the target for spreading is not empty. This is true of English level 2, as can be seen in the forms in (26).

(26) unlawful
     unrehearsed

The proposed representations account well for the failure of sonorant assimilation to apply in the forms such as (26). However, recall that spreading to a nasal does occur at level 1 in English (see section 2.2). Our hypothesis is that the reason that spreading occurs at level 1 but not at level 2 is because there are differences in the inventory at these two levels. We suggest that SV is not distinctive in obstruents, at least obstruents in certain positions, at level 1, and thus [nasal] is absent underlyingly. At level 2, SV is distinctive for obstruents and [nasal] is present underlyingly, blocking sonorant assimilation from applying.

3.2.2 Catalan

Catalan is very similar to English in treating voiced obstruents and sonorants as a natural class. In Catalan, stops assimilate to the voicing of a following obstruent or sonorant, as in (27). In (27a), assimilation to the voicing of a following obstruent is shown, and syllable-final obstruent assimilating to the voicing of a following sonorant is shown in (27b). Data is from Mascaró (1987a) and Wheeler (1979).

(27) a. assimilation to voicing of obstruent

se[t]     'seven'
se[d d]ones 'seven women'
se[b b]eus 'seven voices'
λar[k]    'large'
λar[g d]e cames 'long-legged'

b. assimilation to voicing of sonorant

to[t]     'all'
to[d r]ic 'all rich person'\textsuperscript{18}
se[t]     'seven'
se[d m]ans 'seven hands'
cap       'no'
cal[b m]a 'no hand'
pok       'few'
pog \lambda lure 'few free'
Thus in Catalan, sonorants and voiced obstruents pattern as a natural class, with both functioning as a trigger with respect to the spreading of voice. Given this, we assume that the representations for obstruents and sonorants are like those shown in (25) for English.

Catalan, like English level 2, exhibits place assimilation with nasals but nasals do not take on other sonorant features. This can be seen in (28), where nasal remains despite the fact that a sonorant follows.

(28) so[p] rics 'they are rich'
    so[n]iures 'they are free'

The proposed representations account for this as the feature [nasal] is specified underlyingly and thus spreading to [nasal] is not allowed. Note that in Catalan spreading appears to be a very pervasive phenomenon. If [nasal] were not specified underlyingly, we would likely find nasal-lateral assimilations.

There is controversy about the voicing of syllable-final obstruents in Catalan. While they are often reported to be voiceless (e.g. Mascaro 1987b), others report that they are actually phonetically distinct from underlying voiceless obstruents (e.g. Dinnsen and Charles-Luce 1984, Charles-Luce and Dinnsen 1987). Assuming that they are distinct, our hypothesis accounts well for this fact: voiceless obstruents have a laryngeal node while devoiced obstruents have both a laryngeal node and an SV node. Laryngeal neutralization occurs, causing devoicing of the voiced obstruents, but they remain distinct from the voiceless obstruents due to the presence of SV. Such an account would be totally consistent with the type of debate found in the literature as both positions have some degree of truth.

3.2.3 Sanskrit

Sanskrit is similar in nature to Catalan and English, treating voiced sonorants and obstruents as a natural class. In examining Sanskrit, it is necessary to distinguish between cases of internal and external sandhi. Whitney (1889, section 157) states that a major difference between these sandhi types is that initial vowels, semivowels, and nasals do not change the final consonant of a root or stem in internal combination, but do in external combination, where any syllable-initial voiced segment (i.e. sonorant, vowel, voiced stop) changes a voiceless consonant to a voiced consonant.

While Whitney attributes this difference in patterning of final consonants to morphological factors, a phonological source for these differences is available. Rice (forthcoming) suggests that in Sanskrit syllabification is complete at the word level. In internal cases, the consonant and following sonorant share an onset, and thus the structural description for laryngeal neutralization is not met. In external sandhi, on the other hand, the final stop and following sonorant are in different syllables, and thus neutralization and spreading are able to apply. Data is given in (29).

(29) a. assimilation to voicing of an obstruent
    ap 'water' + ja 'born of' → abja 'born of water, a lotus'

b. assimilation to voicing of a sonorant
    tat namaḥ → tad namaḥ (no gloss, from Allen 1962, p.92)

Based on these assimilations, it appears that voiced obstruents and sonorants pattern as a natural class in Sanskrit. We propose the representations in (30).19
The aspirated and unaspirated stops are distinguished by the presence of [SG] on the aspirates, but not on the unaspirates. In addition, the voiced stops have an SV node.20

The devoicing of syllable-final consonants is potentially problematic in Sanskrit since our analysis predicts a phonetic difference between underlyingly voiced and underlyingly voiceless consonants. While Sanskrit is generally reported as showing syllable-final devoicing, Whitney makes an interesting comment on this topic, reminiscent of the debate on Catalan final devoicing. He reports that 'there was some question among the Hindu grammarians as to whether the final mute (stop) is to be estimated as of surd or sonant quality, but the great weight of authority, and the invariable practice of the manuscripts, favor the surd' (section 141b). Thus, as in Catalan, there is the possibility that subtle phonetic differences distinguished final stops derived from voiceless stops and final stops derived from voiced stops.

4. Formalism

We have presented no formal way of capturing the relationship between voice and sonorancy in the assimilation cases of English, Catalan, and Sanskrit. If we analyze these cases as spreading of SV, we encounter rather serious difficulties as we must block the spread of an SV dependent. For example, in the English past tense, it would be difficult to allow the SV node to spread without its dependent also spreading. This is shown in (31).

(31) n past tense

   root  root → \n n (Ind)
   \SV
   \nasal

One way to account for this would be to give up the dominance relationship between [nasal] and SV. While this is a possible way out of the dilemma, we would prefer to allow for the generalization concerning Klamath, Ponapean, and Toba Batak to stand with the solution given. Furthermore, this move would cause us to lose any possibility of capturing the sonorant-voice relationship.

Before turning to a possible solution, let us consider the Catalan and Sanskrit data in (32) and (33).

(32) Catalan

a. /cap ma/  b. [cab ma]  c. [camma]
   /set mans/ [sed mans] [semmans]

(33) Sanskrit

a. /tat namaḥ/  b. [tad namaḥ]  c. [tan namaḥ]
   /tristūp numān/ [tristub numān] [tristum numān]
These data differ in an interesting way from the English data. In both Catalan and Sanskrit, two possibilities exist concerning the assimilation of a stop to a following sonorant: assimilation can result in either a voiced stop (32a, 33a) or a sonorant (32b, 33b).

We propose the following tentative account of these facts. In English, Catalan, and Sanskrit, voiced stops and nasals have representations such as those in (34). Laryngeal features are omitted.

\[
(34) \quad \text{voiced stop} \quad \text{nasal} \\
\quad \text{root} \quad \text{root} \\
\quad \quad \mid \\
\quad \text{SV} \quad \text{SV} \\
\quad \quad \mid \\
\quad \quad \text{nasal}
\]

We suggest that SV is copied, not spread. We would like to have the choice of copying or spreading follow from the level of structure involved, and suggest that there is a general prohibition on the spreading of organizing nodes: organizing nodes copy and content nodes spread. If we assume that a copied node does not copy any dependents, then these languages can be accounted for. Avery & Rice (forthcoming) propose that organizing nodes cannot fuse while content nodes can. If this position is correct, an analysis where organizing nodes copy and content nodes spread is perhaps not so surprising: it appears that organizing nodes cannot be shared across segments.21

If this analysis is in the right direction, then in the English inflectional morphology, copying of SV to the suffix takes place. In Catalan and Sanskrit copying alone produces the results in (32b) and (33b). In addition, an optional process spreads the daughter of SV onto an empty SV node, yielding the forms in (32c) and (33c).22

5. Summary

We claim that the typology of languages with respect to voicing and sonorancy is as in (35).

\[
(35) \\
\text{Class Ia} \quad \text{Lar} \quad \text{SV} \\
\quad x \quad x \\
\quad \text{root} \quad \text{root} \\
\quad \quad \mid \\
\quad \quad \text{Lar} \quad \text{SV} \\
\text{Class Ib} \quad \checkmark \quad x \\
\quad \text{root} \quad \text{root} \quad \text{root} \\
\quad \quad \mid \\
\quad \quad \text{Lar} \quad \text{Lar} \quad \text{SV} \\
\quad \quad \mid \\
\quad \quad \text{LV} \\
\text{Class II} \quad \checkmark \quad \checkmark \\
\quad \text{root} \quad \text{root} \quad \text{root} \\
\quad \quad \mid \\
\quad \quad \text{Lar} \quad \text{Lar} \quad \text{SV} \\
\quad \quad \mid \\
\quad \quad \text{LV} \quad \text{nasal}
\]

\(x\) - no contrast at this node, \(\checkmark\) - contrast at this node

(t, d, n representative of voiceless, voiced, and sonorant at a particular place of articulation)
In (35) the underlying contrasts and representations in the two language types are shown. In general, sonorants are characterized as SV and obstruents as Lar. Obstruents may be spontaneously voiced as well; when this is the case nasals do not assimilate to a following sonorant.

6. Conclusion

Following from our assumptions about spreading and the universal nature of final laryngeal neutralization, we have made the following points in this paper:

(a) A node, SV, dominates the sonorant features.
(b) Voicing in obstruents may be marked at the laryngeal node or at both the laryngeal and SV nodes.
(c) [Nasal] is absent underlyingly unless voiced obstruents have an SV node.
(d) [Nasal] is generally filled in by default unless obstruents have an SV node.

How would the language learner arrive at the representations proposed in (35)? Recall that we assume that syllable-final laryngeal neutralization is universal and that [nasal] is universally the unmarked SV dependent. The least marked languages are those of class Ia, with only obstruent/sonorant contrasts. Once a contrast is introduced with obstruents, the learner would posit a class Ib language, with final devoicing. Evidence for class II must be positive in that the learner would need to hear final spontaneously voiced obstruents. The relationship among the three types is thus clear with a markedness relationship holding: class Ia < class Ib < class II.

We have proposed that languages differ with respect to their representations of voiced obstruents and nasals. This difference does not require any stipulation beyond the putative universal final laryngeal neutralization. We have not had recourse to the ordering of redundancy rules in the grammar, nor to any special parameters to account for the differences. Of course, apart from the problems that remain in the paper, many other problems remain to be solved. We have not attempted to provide an account of prenasalized stops (see Piggott 1989), something which must be incorporated into the theory, nor have we attempted to sort out the details of the feature geometry. The status of glides and vowels requires attention as well. We do not feel that these problems present an insuperable barrier and believe that the results we have achieved in this paper give significant grounds for continuing along the lines proposed.

Notes

* This is a much revised version of a paper presented at the Annual Meeting of the Canadian Linguistic Association, Laval University, May 1989. We would like to thank Glyne Piggott for helpful discussion of some of the issues raised in this paper.
1 We will not argue as to whether laryngeal neutralization involves delinking of laryngeal dependents or of the laryngeal node itself. Some evidence from syllable-final laryngeals in Athapaskan languages suggests that (3) is correct. See Rice (1989) for details.
2 We use r-features for lack of a better term.
3 In this form, the daughter of Place - Labial - spreads from right to left into an unspecified Place node. The consonant is realized as a nasal by default.
4 This is only true of English level 1. In section 3.3.1, we argue that [nasal] is present underlyingly at level 2.
5 Note the syllable-final laryngeal neutralization in this form, consistent with (3).
6 Ponapean shows a wider range of assimilations within sonorants than we discuss. The assimilations are consistent with the theory proposed here, but a detailed analysis would take us beyond the scope of this paper. See Rice & Avery (in preparation) for discussion.

7 We follow Hyman (1975) rather than Clements (1988) in assuming that both /l/ and /r/ are continuant. The assumption that /l/ is [continuant] is not without problem. For example, in Catalan /t/ assimilates fully to a following noncontinuant (ia) and assimilates in everything but continuancy to a following continuant (ib), suggesting that [continuant] does not spread in Catalan.

   (i) a. set cases set[k] cases 'seven houses'
      b. set foc set[p] foc 'seven fires'

   ([p] is a voiceless labiodental stop.)

   /l/ assimilates fully to /l/ (ia), but only partially to /t/ (ib).

   (ii) a. set lines sel lines 'seven lines'
      b. tot ric to[d] ric 'all rich'

   /l/ and /r/ thus do not pattern together in Catalan in the same way they do in Toba Batak. Perhaps further studies of the phonetics of laterals in Catalan and in languages like Toba Batak and Ponapean will reveal the reasons for this difference.

8 As is well known, not all r's are the same. We assume that phonetic cues allow for different representations of r's. The structure of r's is worthy of additional attention that is beyond the scope of this paper.

9 Following Cho (1988), we assume that structure preservation blocks [lateral] from spreading to noncoronal places of articulation. Since /l/ is unspecified for place underlyingly (Cho 1988), spreading of SV dominating [lateral] to Labial or Dorsal would introduce representations that are not allowed lexically.

10 We ignore some of the details of the rule here. In fact, the rule also requires identity of place or absence of specification for place.

11 Rehg & Sohl (1981) describe /d/ as a voiceless coronal stop and /l/ as a voiceless coronal affricate.

12 It may be that the obstructants do not require a laryngeal node. This topic requires further investigation.

13 We take the inventory from Firchow & Firchow (1969). They report much variation in the realization of the voiced consonants in dialect B: they can be realized as follows: /v/: [b], [b], [m]; /f/: [f], [n], [l], [d]; /g/: [g], [g], [g].

14 It appears that in some of the Salishan languages, sonorant consonants have in general become voiced stops, with *m becoming b, *n becoming d, *y becoming d, and *w becoming gw. The lateral also apparently participates in this system, although Thompson & Thompson (1972) do not indicate exactly how. In languages of this sort, a possible analysis involves delinking of the SV node.

15 This analysis is similar to that offered by Mascaró (1987a) for the same set of facts.

16 Levin (1988) takes these data as an argument that [lateral] is a Coronal dependent as, in this Flemish dialect, the spreading of [lateral] can occur just in case the intervening consonant is a coronal. If the intervening consonant is a labial or a velar, spreading is blocked. Thus a form such as /elp-n/ 'to help' is realized as [elpan] rather than *[elp]. We believe that this does not present an argument for the coronal status of the lateral, but rather for the transparency of coronals to spreading. We suggest that the transparency of the coronals is due to their unmarked status. Note that if we were to adopt Levin's analysis, we would have to claim that nasals had a Coronal node, a move we do not feel is warranted.

17 The treatment of English laryngeal distinctions is not an issue in this paper.

18 Notice that [continuant] does not spread in this form. In Catalan, all features spread except for [continuant]. It is for this reason that we have made [continuant] a daughter of the Root node and SV and Place sisters, daughters of the Supralaryngeal node, in (1). See also note 7.

19 We are not taking a position on details of the laryngeal representation here.

20 There is what at first looks like assimilation of /n/ to /l/ in Sanskrit. For instance, /asvana labhate/ becomes [asvanal labhate] he receives horses' with m representing anusvara. However, in this case, it is more likely that [lateral] is spreading to an empty consonant position following the /n/ rather than to the node dominating [nasal] (Kiparsky personal communication).

21 This may cause problems for geminates. However, see Selkirk (forthcoming) for arguments that geminates have two root nodes.

22 This solution requires a rethinking of the Korean facts discussed in section 2.5 along the lines proposed in this section. SV copies, followed by the operation of the nasal default rule.
References


