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## Chapter 7

### On the Major Class Features Elisabeth Selkirk and Syllable Theory

#### 1. Major Class Features in a Theory of the Syllable

Developments in the theory of phonological representation have progressively chipped away at the set of distinctive features presented in *The Sound Pattern of English* (SPE). The new understanding of the nature of stress patterns and their representation that has been gained in metrical phonology has meant the elimination of the feature [stress] from that repertoire. The autosegmental theory of tone has made it possible to do without contour tone features. Given the autosegmental theory of the syllable, it is also possible to do without features relating to the implementation of segments in time: [+long] segments may now be viewed as single segments associated with two terminal positions in syllable structure, [+delayed release] segments (affricates) as a sequence of two segments associated with a single position in syllable structure, and so on. It has also been suggested that the major class feature [ $\pm$ syllabic] might be eliminated, given that syllable structure forms part of a phonological representation,<sup>1</sup> though the consequences of eliminating that feature have not been fully explored, as we shall see. In each instance, an enrichment of the theory of representation has meant a reduction in the need for certain features in the representation of distinctions between particular forms. In this paper I will explore yet further the consequences for distinctive feature theory of the theory of hierarchical representation in phonology, and the theory of the syllable in particular.

I will present evidence pointing to the conclusion that *all* the major class features—[ $\pm$ syllabic], [ $\pm$ consonantal], and [ $\pm$ sonorant]—should be eliminated from phonological theory. Specifically, I will show that characterizing segments in terms of these features is an obstacle to a descriptively adequate account of syllable structure in language, and thus

that in a truly explanatory theory of syllable phonotactics they must be given no role.

The major class features that have been standardly assumed since SPE characterize as follows the natural classes of segments listed on the left in (1):

(1)

	[syllabic]	[sonorant]	[consonantal]
Glides	-	+	-
Vowels	+	+	-
Sonorants (consonants)	-	+	+
Syllabic sonorants	+	+	+
Obstruents	-	-	+
Syllabic obstruents	+	-	+
	-	-	-
	+	-	-

(The feature complexes of the last two lines characterize no classes of segments, presumably because the assignments [-son] and [-cons] are somehow "contradictory" and therefore universally impossible in combination.) Examples of segments belonging to these classes are listed in (2):

- (2)
- a. Glides: j, w, ɥ
- b. Vowels: i, u, y, ɪ, e, o, ε, æ, a, etc.
- c. Sonorants: m, n, ŋ, etc. (nasals); l, r, etc. (liquids)
- d. Syllabic sonorants: m, n, ŋ, etc. (nasals); l, r, etc. (liquids)
- e. Obstruents: s, z, f, etc. (fricatives); b, p, t, etc. (stops)
- f. Syllabic Obstruents: s, ? ?<sup>2</sup>

(Throughout this paper, the reader should note that by using the terms *glide* and *vowel*, I am not committing myself to their theoretical validity.)

In the taxonomy provided in (1) and exemplified in (2), the feature [±syllabic] suggests itself as an especially obvious candidate for elimination from phonological theory. Given that segments are organized into syllable structure, but are independent of it, if "syllabicity" is to be represented with a feature, that feature has the peculiar property of being syntagmatic: whether a segment is "syllabic" depends on its position in a syllable, not on any inherent phonological property of its own. Every

sonorant consonant, companion vowel, and not clear that any repertoire. On the this feature is eliminated simply as the property more exactly, a proposal will argue below that an element to be

If [±syllabic] were a feature, then the features, then they simply be as follows

(3)

Vowels (2a,b):

Sonorants (2c,d):

Obstruents (2e,f):

There would be no distinction would be no distinction obstruents. Yet the basis for certain glides that must be made is needed in the phon

(4)

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(4')

The onset of a syllable

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(4''')

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sonorant consonant has its syllabic counterpart, every glide has its companion vowel, and *s* (and perhaps others) may stand alone as syllabic.<sup>3</sup> It is not clear that anything is lost by eliminating [ $\pm$ syllabic] from the feature repertoire. On the contrary, it would seem that a great deal is gained. If this feature is eliminated, then the property of being "syllabic" can be seen simply as the property of having a particular place in syllable structure, or, more exactly, a particular relation to other elements in the same syllable. I will argue below that this is the correct interpretation of what it means for an element to be "syllabic."

If [ $\pm$ syllabic] were indeed eliminated from the repertoire of major class features, then the natural classes defined by the remaining ones would simply be as follows:

(3)

Vowels (2a,b): [+son, -cons]

Sonorants (2c,d): [+son, +cons]

Obstruents (2e,f): [-son, +cons]

There would be no class of glides to be opposed to vowels, and there would be no distinction between syllabic and nonsyllabic sonorants and obstruents. Yet the natural classes so defined are unable to provide the basis for certain generalizations concerning possible syllable structures that must be made in language. Consider statement (4), the likes of which is needed in the phonotactic description of many languages:

(4)

The onset of a syllable in L may be occupied by any consonant or glide of L.

If [ $\pm$ syllabic] is included among the distinctive features, such a commonplace restriction can be stated quite simply.

(4')

The onset of a syllable in L may be occupied by any [-syll] segment of L.

But without [ $\pm$ syllabic], the restriction must be stated as a disjunction, as in (4'')

(4'')

The onset of a syllable in L may be occupied by any segment of L that is either [+cons] or [-cons, +high].

(Without [ $\pm$ syllabic], glides and high vowels have the same feature complex [-cons, +high].) Or consider the equally commonplace phonotactic statement (5):

(5)

The rime of a syllable in L may end in either a glide or a nasal.

With [ $\pm$  syllabic] in the feature repertoire, such a restriction can be expressed quite simply:

(5')

The rime of a syllable in L may end in a [ $-$  syll,  $+$  son] segment of L.<sup>4</sup>

Without [ $\pm$  syllabic], it must be stated as follows:

(5'')

The rime of a syllable in L may end in a [ $+$  son,  $-$  cons,  $+$  high] or a [ $+$  son,  $+$  cons] segment of L.

The dilemma, then, is this: the feature [ $\pm$  syllabic] appears to be necessary to a straightforward characterization of (natural) classes of segments that play a role in phonotactic descriptions of the syllable, but at the same time appears to be rendered unnecessary by the mere existence of syllable structure as part of phonological representation.

There are a number of possible responses to this dilemma. One is based on the view that it is entirely appropriate to cast generalizations about the natural classes involved in phonotactic description in terms of complexes of binary distinctive features. It would involve eliminating [ $\pm$  syllabic], for the reasons given, and hypothesizing some other binary major class feature(s) that would permit a simple characterization of these natural classes.<sup>5</sup> Another response is based on the view that the problems encountered by a theory using only the major class features [ $\pm$  sonorant] and [ $\pm$  consonantal] to characterize the natural classes of phonotactic description are symptomatic of a more general problem with the theory, and that the natural classes involved must be characterized in some entirely different way. In this paper, I will offer a response of the second sort. My proposal is that the major class features be eliminated entirely from a theory of the phonotactics of the syllable (and, perhaps, from phonological theory as a whole), and that they be replaced in effect by the *sonority hierarchy* and the assignment of a *sonority index* to individual segments that reflects the niche they occupy in that hierarchy. In other words, I propose that there is a single  $n$ -ary feature, call it [ $n$  sonority], that is at play in language, where the feature specification  $n$  is the *sonority index*. In what follows I will show that the notion of natural class that is required for an insightful expression of phonotactic generalizations must be cast in terms of sonority indices, and not in terms of complexes of binary distinctive features.

## Major Class Features

The point to be then, from the one "work" done by the now done by the hi of syllables with th segment with two that the "work" of hierarchical repres of that hierarchic describing it, simpl way, by something thought of as a fea the sonority hierar segment of the lang

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The point to be made about the major class features is a bit different, then, from the one made earlier about the features [stress], [long], etc. The "work" done by the latter features in earlier phonological descriptions is now done by the hierarchical representation itself: "stress" is the alignment of syllables with the metrical grid,<sup>6</sup> "length" is the association of a single segment with two positions in syllable structure, etc. My proposal is not that the "work" of the major class features be done by any aspect of the hierarchical representation. Rather, I am suggesting that an understanding of that hierarchical representation, and of the theory required for describing it, simply shows that their "work" must be done in a different way, by something else. That something else, I submit, is what may be thought of as a feature representing the phonetic dimension of sonority, the sonority hierarchy, and the assignment of a sonority index to every segment of the language.<sup>7</sup>

In the general case, any segment of a language may be more or less sonorous than any other, so that a continuum  $\alpha_1, \dots, \alpha_n$  may be established, wherein  $\alpha_1$  is the least sonorous segment type and  $\alpha_n$  the most sonorous. The subscript integer  $i$  is the sonority index of the segment. Moreover, it seems that members of certain natural classes of segments, defined in terms of nonmajor class features such as [ $\pm$ continuant], [ $\pm$ voice], [ $\pm$ nasal], [ $\pm$ high], etc., are so alike in sonority as to make distinctions among them irrelevant for most descriptive purposes. For example, the nasal consonants appear to pattern alike, as do the high vowels or the class of voiceless stops, when it is degree of sonority that is at issue in phonological description. The members of these classes, and some others, will therefore be assigned the same sonority index.

A new definition of *natural class* is available in terms of this sonority continuum, or hierarchy. Any set of segments with the *same sonority index* or with *consecutive sonority indices within designated limits* forms a natural class from this point of view. The discussion here will show that it is natural classes defined in just these terms that appear to be at play in phonotactic description.

I will not offer a definition of sonority here. There is clearly a phonetic basis for it, probably corresponding in part to simple "loudness." But just what the relevant acoustic parameter is cannot be determined independently of linguistic analysis. Just what the natural classes of segments are is an empirical question, whether they are defined in terms of the  $n$ -ary feature for the sonority dimension or in terms of features for place and manner of articulation, for example. And only once phonology has pro-

vided sufficient information about the hierarchy can the precise phonetic character of sonority be determined.

A number of proposals have been made concerning the sonority hierarchy,<sup>8</sup> based on various sorts of evidence, including the place segments may occupy (with respect to each other) in syllable structure. In (6) I suggest a provisional version of the hierarchy, to be used as a working hypothesis. What I will say below bears only on the relations between the sound types represented in (6); just where sounds that are not represented in (6) are to be introduced into the hierarchy will be left an open question.

(6)

Sound	Sonority index (provisional assignment)
a	10
e, o	9
i, u	8
r	7
l	6
m, n	5
s	4
v, z, ð	3
f, θ	2
b, d, g	1
p, t, k	.5

The right-hand column lists the hypothesized sonority indices of the segments on the left. It is not clear whether the absolute integer value of the sonority indices assigned to each of these segment types is important. I assign absolute values for expository convenience, though for the moment I will assume that only the sonority *relations* expressed by the indices are important. Later we will see that in fact a purely relational characterization of the sonority hierarchy is inadequate and that some indication of absolute sonority values is needed after all.<sup>9</sup>

It is now clear how to express certain natural classes involved in phonotactic descriptions. The class "glides plus sonorants" is simply the set of segments whose sonority indices range from 8 (*i, u*) to 5 (nasals). The class "glides plus consonants" includes segments whose indices are less than or equal to 8. The class "vowels" includes those whose indices are greater than or equal to 8. And so on. The claim here is that natural classes defined in this way, and only these, are relevant for characterizing syllable structure in natural language.

## Major Class Features

It is a systematic feature of sonority indices that they have certain features and can be characterized in certain terms. Thus, compare the sonority indices in (6) in terms of conditions with binary distinctive features, as illustrated in (7).

(7)

Natural class	Characterizing features
l, m, n, obstruents	[-sonorant]
r, l, m, n, s	[+sonorant]

Like those mentioned in the previous section, these features as vehicles for

The general claim that the sonority hierarchy is the basis for just the syllable structure required in a theory of natural language.

It should be noted that the natural classes defined in terms of sonority indices are more numerous than the natural classes defined in terms of distinctive features. The major classes defined in terms of sonority indices must be supplemented by the major classes defined in terms of distinctive features, and the manner of articulation of the segments in the absence of a theory of natural language complexes of place of articulation and junctive statements appears to give a better theory cast in more terms.

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It is a systematic fact that many of the natural classes defined in terms of sonority indices have no simple expression in terms of the major class features and can be designated only by a disjunction of feature complexes. Thus, compare the sets of segments that can be treated as a natural class in terms of conditions on the sonority index  $n$  and the designation of that class with binary distinctive features (but without the feature [ $\pm$ syllabic]), as illustrated in (7).

(7)

<i>Natural class</i>	<i>Conditions on sonority index</i>	<i>Binary feature complexes</i>
l, m, n, obstruents	$6 \geq n^{10}$	$\left\{ \begin{array}{l} [+son] \\ \{ +lat \} \\ \{ +nas \} \\ [-son] \end{array} \right\}$
r, l, m, n, s	$7 \geq n \geq 4^{11}$	$\left\{ \begin{array}{l} [+son] \\ [+cons] \\ [-son] \\ +cor \\ +cont \\ [-voice] \end{array} \right\}$

Like those mentioned in (4) and (5), these natural classes appear in phonotactic descriptions, and they show the difficulty of using the major class features as vehicles for their expression.

The general claim, then, is that the theory of sonority indices provides the basis for just the right characterization of natural classes that is required in a theory of syllable structure.

It should be noted that this proposal offers a more restrictive theory of natural classes than the proposal that they be based on the major class features. The major class features alone are inadequate to the task and must be supplemented by features appealing to, among other things, place and manner of articulation, as illustrated in (4"), (5"), and (7). And in the absence of a theory of sonority, no explanation is provided for why some complexes of place and manner features, and not others, enter into disjunctive statements like those above. For this reason, the new theory appears to give a better account of natural classes (for phonotactics) than a theory cast in more traditional terms.

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## 2. Sonority Indices in a Theory of Syllable Phonotactics

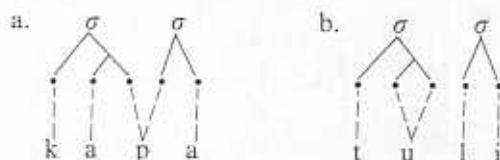
According to the autosegmental theory of the syllable that has been proposed recently,<sup>12</sup> the terminal positions of hierarchical syllable structure are "empty positions" of sorts. Phonological segments (a distinctive feature matrix) are represented on a separate *segmental melody tier*, and are associated with the terminal positions of syllable structure by universal conventions and/or language-particular rules. One advantage of this theory is its ability to properly represent "long" segments. A long vowel or geminate consonant is a single segment on the segmental melody tier and may be treated as such by rules applying to segments on that tier, but it is also double, in the sense that it is associated with two terminal positions in the core syllable structure.<sup>13</sup> Hypothetical *kappa* would have the representation (8a), and hypothetical *tudi* the representation (8b):

(8)

Syllable structure

Association lines

Melody tier



Given an autosegmental theory of the syllable, the phonotactic description of the syllable has at least three parts: (i) the characterization of possible syllable structures, (ii) the characterization of possible (or impossible) sequences on the melody tier, and (iii) the characterization of possible associations between the two.<sup>14</sup> Each of these is to be viewed as a set of well-formedness conditions. For a syllable to be ruled well formed, it must be well formed with respect to (i-iii).<sup>15</sup>

For each of the three sets of well-formedness conditions on syllables in an autosegmental framework, there will doubtless be some that are universal and some that are language-particular. Included in the conditions of type (i), which define the possible syllable trees for a language, are (a) a characterization of the internal structure of the syllable (perhaps only a (universal?) division into onset and rime), (b) a specification of the minimum and maximum number of terminal positions in the syllable, and (c) a set of conditions on the terminal nodes. I propose to view this as a syllable template, as in Selkirk (1982), and will require that every syllable tree of an utterance be nondistinct from it.<sup>16</sup> Included in (ii) are specific filters (collocational restrictions, in the sense of Fudge (1969) and Selkirk (1982)) that rule out particular sequences of segments. Included in (iii) is the

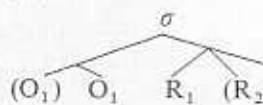
## Major Class Features

universal condition that the terminal position  $\beta$  in syllable structure is made precise) from  $\beta$ . Such associations may exist under conditions of type (ii) in the sequences of a language, but more important. For a language, it must be characterized by a syllable structure(s) of a certain type. The specification of structures, itself specific to a language, is a position in the syllable structure segment sequences.

The nature of the terminal positions in the debate in recent years. Clements and Keyser (1982) argue that either C or V (where  $w$  is in the spirit of Selkirk (1982) autosegmental framework) are characterized by a certain type. Kiparsky (1979), also argued that marked  $s$  or  $w$  and  $g$  are so-called Liberman and Liberman (1979) is that those terminal positions are *indices*.<sup>20</sup>

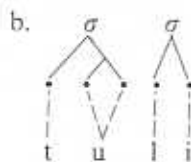
The syllable template is a number of terminal positions with a certain internal structure divided into onset and rime. An example of such a template is:

(9)



$O_i$  and  $R_j$  are terminal positions and rime positions.  $O_1$  is the first position,  $O_2$  is the second position,  $R_1$  is the first position, and  $R_2$  is the second position. This is a template schema,  $s$ .

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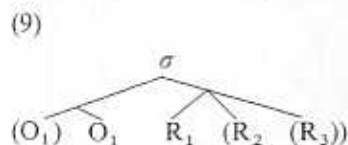
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universal condition that association lines not "cross," as well as the universal condition that a segment  $\alpha$  may be associated with a terminal position  $\beta$  in syllable structure only if  $\alpha$  is nondistinct (in a manner to be made precise) from  $\beta$ . Other language-particular conditions on these associations may exist as well.<sup>17</sup> Clearly, it is not only well-formedness conditions of type (ii) that contribute to defining the possible segment sequences of a language. In fact, as we will see, types (i) and (iii) are even more important. For a segmental melody to be a possible melody of a given language, it must be capable of being mapped onto a (sequence of) possible syllable structure(s) of the language. The template, which defines this class of structures, itself specifies what sort of segment will be permitted in what position in the syllable, and in this way puts severe constraints on possible segment sequences.

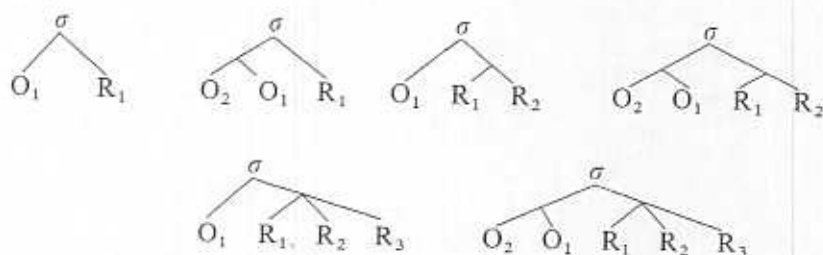
The nature of the terminal positions in syllable structure has come under debate in recent years. McCarthy (1979), Halle and Vergnaud (1980), and Clements and Keyser (1981) have argued that those terminal positions are either C or V (where what C and V stand for is not always explicit).<sup>18</sup> In the spirit of Selkirk (1982) and Harris (1982), which are couched in a non-autosegmental framework, it might be argued that those terminal positions are characterized by a complex of major class features. According to Kiparsky (1979), also a nonautosegmental account, the terminals are marked  $s$  or  $w$  and given integer values of strength according to the so-called Liberman and Prince algorithm.<sup>19</sup> What I wish to propose here is that those terminal positions are characterized in terms of *sonority indices*.<sup>20</sup>

The syllable template of a language indicates the maximum and minimum number of terminal positions in the syllable and identifies the terminal positions with names. The template structure is also (universally) divided into onset and rime, though this may not be crucial. (9) is an example of such a template:



$O_i$  and  $R_j$  are terminal position names, convenient mnemonics for *onset position* and *rime position*, respectively. The subscript integers stand for *first position*, *second position*, etc. It is in fact possible to view template (9) as a *template schema*, standing for the set of templates in (10):

(10)



Accompanying the template schema is a set of conditions on its terminal positions, which are expressed in terms of sonority indices (SI). The following are some examples of language-particular conditions on the terminal positions:

(11)

- If  $x$  is associated with  $O_1$ , then  $SI(x) \leq 8$ .
  - If  $x$  is associated with  $O_2$ , then  $SI(x) \leq 3$ .
  - If  $x$  is associated with  $R_1$ , then  $SI(x) \geq 8$ .
- etc.

Cast in terms of sonority indices, these conditions state in effect what classes of segments may be associated with particular positions in the syllable structure of the language in question. The condition on  $SI(R_1)$ , for example, states that the first position of the rime must contain a "vowel." The condition on  $O_1$  states in effect that this position must be filled by  $i, u$ , or any other segment with a sonority index less than 8. In an autosegmental framework, it is assumed that a segment on the melody tier may not be associated with a particular terminal position of the syllable unless its sonority index falls into the range specified by these conditions.

It is well known that syllables conform in general to what may be called the *Sonority Sequencing Generalization* (SSG):<sup>21</sup>

(12)

*Sonority Sequencing Generalization*

In any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.

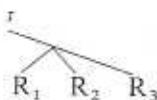
The existence of (12) as a universal of syllable structure gives some plausibility to the sonority-hierarchy-based approach to phonotactics being advocated here (though it is consistent with other theories as well). Such a condition could be easily formalized in terms of sonority indices, but I will

not do so here. There is no reason to think that it is possible for a language to have a syllable structure that is not possible for any other language. It is not possible for a language to have a syllable structure that is not possible for any other language. The hypothetical language below.

The advantage of this approach is not only that it allows for the possibility of languages that can have a syllable structure that is not possible for any other language, but also that it allows for the possibility of languages that can have a syllable structure that is not possible for any other language. The advantage of this approach is not only that it allows for the possibility of languages that can have a syllable structure that is not possible for any other language, but also that it allows for the possibility of languages that can have a syllable structure that is not possible for any other language.

The theory I have outlined here is a theory of syllable structure. There are many other theories of syllable structure, but this one is the most comprehensive. It is a theory of syllable structure that is based on the sonority index and the sonority sequencing generalization. It is a theory of syllable structure that is based on the sonority index and the sonority sequencing generalization.

In recent articles I have offered a relational theory of syllable structure. This theory is based on the sonority index and the sonority sequencing generalization. It is a theory of syllable structure that is based on the sonority index and the sonority sequencing generalization.



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not do so here. The SSG can be viewed as imposing universal constraints on the possible form of language-particular sets of conditions on syllable structure. It in no way constitutes on its own a theory of syllable phonotactics, however, for languages will differ precisely in their choice among the various conditions on terminal positions that are consistent with (12). The hypothetical list (11) is one such set, and I will give examples of others below.

The advantage of the sonority index theory of conditions on terminal positions is not only that it properly characterizes the natural classes of segments that can be associated with particular positions in particular languages, but also that it allows a straightforward expression of the *relations between* particular positions that need to be stated in grammars of particular languages. As Harris (1982) points out, a theory of syllable phonotactics must have a way to specify a *minimum sonority difference* (or *dissimilarity*, to use Harris's term) between two adjacent positions in a syllable. This sort of relation is easily stated in terms of sonority indices (and impossible to state directly without them, as we will see). For example, the generalization that in an onset nasals may precede glides but not liquids might be expressed as the requirement that for a sequence  $O_2 O_1$ ,  $SI(O_2) \leq SI(O_1) - 3$ , where "3" is the minimum sonority difference required. Such a condition would also rule out the sequences *\*lr, \*lw, \*lj, \*rw, \*rj*, and so on. As a final point, note that all of these (hypothetically) ill-formed onset sequences would be consistent with the SSG. Clearly, individual languages impose even greater restrictions on sequences of segments, marking off particular spans of the sonority hierarchy that may be realized in one position or another, and in one position with respect to another.<sup>22</sup>

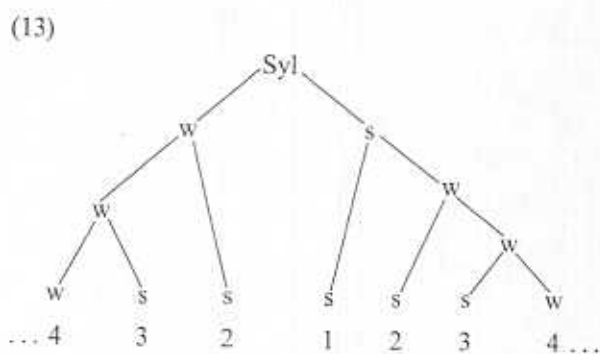
The theory I have outlined may be referred to as a *relational theory* of the syllable. There are three distinct senses in which it is relational. (i) The specification of individual syllable terminals is cast in terms of theoretical constructs that are themselves inherently relational: sonority indices and conditions on sonority indices. (ii) It permits the formulation of explicit statements of conditions involving relations between adjacent terminal positions in the syllable. (iii) The set of possible conditions on sonority indices and terminal positions is presumably restricted overall by the essentially relational SSG.

In recent articles on syllable structure, Kiparsky (1979, 1981) has also offered a relational theory of the syllable. There are two major differences between his theory and mine. My theory stipulates the SSG (as part of

universal grammar), while Kiparsky's attempts to derive it from yet deeper principles of universal grammar. Also, mine is a theory of language-particular phonotactics (within a universal framework), while Kiparsky's is not.

Kiparsky proposes that, universally, the syllable has a *relational structure* that is represented in terms quite analogous to the relational (metrical) representation of stress, that is, with binary branching trees having nodes labeled *s* or *w*. As Kiparsky points out, given certain stipulations concerning the nature of (a) the branching structure assigned to syllables, (b) the *s/w* labeling of that structure, and (c) the interpretation of that labeled structure in terms of integer values, along with one additional assumption concerning the relation between segments and this tree structure, it is possible to make something like (12) follow as an automatic consequence. Kiparsky's enterprise is an interesting and important one, to be sure. But I do not think it is entirely successful.

Specifically, Kiparsky proposes that it be stipulated that syllables universally have the branching structure in (13) and that their nodes be labeled as shown there. The strength relations among the terminal nodes tree (13) can be straightforwardly translated into (relative) integer values, as written below them.



Then, assuming (as I do) that segments have integer values corresponding to the relative sonority associated with them (Kiparsky suggests that complexes of binary features, including the major class features, determine the integer value of a segment in the sonority hierarchy) and that the relations between integers in the tree (which are either "greater than" or "less than") are matched by the relations between the sonority-determined integers of adjacent segments, the SSG follows automatically.

My theory of syllable phonotactics based on sonority indices is perfectly consistent with Kiparsky's tree proposal and the theory of (12). If the tree

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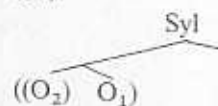
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### 3. Case Studies in

#### 3.1 English Rimes The English syllab

(14)



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proposal were right, the only consequence for my proposal would be that the SSG would not have to be stipulated. However, there is an important reason for questioning Kiparsky's assumptions about syllable structure and its interpretation from which the SSG is considered to follow—namely, the relational tree theory of stress that provides the analogy on which Kiparsky's tree theory of the syllable is based is quite possibly wrong. Both Prince (chapter 11 of this volume, 1983) and Selkirk (forthcoming) argue that stress patterns are not to be represented by trees, but only as the alignment of syllables with a metrical grid. If this theory is right, there is no motivation independent of the syllable for branching structures of this sort in phonological representation (though onset and rime may remain), and no independent motivation for the labeling conventions required. Moreover, another explanation must be sought for the SSG. I have no such explanation to offer, and so for the time being will have to leave (12) as a mere stipulation.

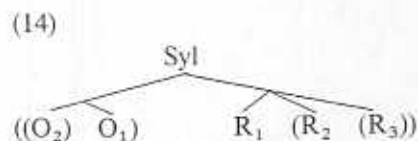
I should also add that, as the later examination of Spanish syllable phonotactics will show, deriving the SSG from a uniformly labeled branching structure of the syllable runs into certain serious problems and gives reason to question an approach like Kiparsky's that bases the SSG on syllable geometry.

In addition to his proposal concerning the SSG, Kiparsky (1979, 1981) points to the need for viewing syllable phonotactics in terms that are relational in the second sense that I mentioned. Specifically, he points out the impossibility of specifying absolute conditions on the terminal positions of syllable templates, but does not elaborate on just what such a relational theory of phonotactics might be. This is in fact what I am doing—namely, offering a theory of the phonotactics of particular languages, one that is couched in terms of sonority indices and conditions upon them.

### 3. Case Studies in Phonotactic Description

#### 3.1 English Rimes

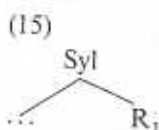
The English syllable template schema is shown in (14):



It specifies that the maximum number of positions in the onset is two, and that there may be none. It also specifies that the maximum number of

positions in the rime is three, and the minimum one. Elsewhere it has been shown that, given two assumptions, this schema correctly characterizes both English onsets and English rimes.<sup>23</sup>

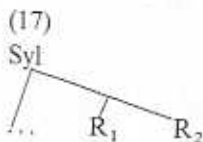
I will examine the English rime, looking first at the smallest syllable template schematized in (14) and then at the larger ones. It turns out that conditions stated on positions in smaller templates remain valid for the larger ones. This is an interesting result, which supports the view of the maximal template as simply a schema that "collapses" all the templates together. Consider first the template (fragment) in (15):



(16)

If  $x$  is associated with  $R_1$ , the  $SI(x) \geq 5$  (equivalently,  $SI(x) \geq SI(m, n)$ ).

There is only one condition to be stated, (16). This condition says that an English rime may consist of a vowel or a sonorant (in such a case "syllabic") on its own. This generalization distinguishes English from French or Spanish, for example. As for the rime template (17), the next larger in size, the same condition (16) on  $R_1$  obtains, along with the additional condition (18) on  $R_2$ .



(18)

If  $x$  is associated with  $R_2$ , then  $SI(x) \leq 8$  (equivalently,  $SI(x) \leq SI(i, u)$ ).

(18) says that  $R_2$  must be a glide or something less sonorous. Conditions (16) and (18) together allow for the sequences in (19), which are permitted in English.

(19)

VV: cow, bye, toy, etc.<sup>24</sup>

VL: pal, far, etc.

VN: run, sing, slam, etc.

VO: cut, tap, pick, etc.

rN: pattern<sup>25</sup>

rO: mallard

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(20)

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It is clear that this theory of two-part English rimes "overgenerates" as well, in that it alone allows impermissible sequences such as those in (20).

(20)

- a. L"G", LL, N"G", NL, NN      ("G" = *i, u*, L = liquid, N = nasal,  
b. *rl, lN, NO*                              O = obstruent)

One might think that the SSG rules out the combinations in (20a), which appear in an ascending order of sonority.<sup>26</sup> If the SSG were not to do the job, then an additional condition on the adjacent positions  $R_1$  and  $R_2$  would be required in the grammar. However, the impermissible combinations in (20b) show that some such additional condition is required in any case, for even sequences that are consistent with the SSG are impermissible—if they are too close in relative sonority. Therefore, I will posit a condition on the sequence  $R_1R_2$ , as follows:

(21)

If  $x$  is associated with  $R_1$  and  $y$  is associated with  $R_2$ , then  $SI(y) \leq SI(x) - m$ .

For any positive value of  $m$ , (21) clearly rules out the combinations in (20a), and, given the appropriate assignment of a value to  $m$ , it will rule out those in (20b) as well.  $m$  in (21) is the value of the minimum sonority difference that must exist between the two segments  $R_1$  and  $R_2$ .

Just what  $m$  is remains to be determined, and can only be specified once a full-fledged theory of the sonority hierarchy has been developed. What must be resolved before  $m$  can be specified is whether the values assigned to the segment types in the sonority hierarchy (6) are correct. As given in (6), the values are purely relational: the distance between each niche in the hierarchy has the same value.  $SI(l)$  is greater than  $SI(r)$  by one;  $SI(f)$  is greater than  $SI(b)$  by one; etc. It is not unlikely that this is the wrong approach, and that the sonority distances between segments of lesser sonority are smaller than those between segments of greater sonority, that is, that there are significant discontinuities in the sonority hierarchy. In fact, only if this is the case can a single value be assigned to  $m$  in (21) that would allow the condition to simultaneously rule out  $*rl$  and  $*ln$ , sequences of segments that are adjacent in the sonority hierarchy, and, for example,  $n$  plus stop, a sequence of segments that are not adjacent. So while the generalization to be expressed about  $R_2$  with respect to  $R_1$  is clearly that a minimum sonority distance is required between them, the specification of the value of  $m$  will have to await further research on the precise nature of the sonority hierarchy.

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Since the effect of (18) can be guaranteed by (21), (18) can be dispensed with. Nevertheless, in other languages, both sorts of conditions on a given position may be required. A condition on an individual position can have the effect of requiring, for example, that a segment occupying that position have both a minimum and a maximum sonority value, regardless of the precise degree of sonority of surrounding segments.

Now consider three-part rimes in English. Suppose that the only requirement on  $R_3$  were that it be less sonorous than  $R_2$ . If this were so, then the permissible combinations of (22a) would be allowed, but so would the impermissible ones of (22b):

(22)

- |  |  |
|--|--|
| a. $R_2 = \text{glide}, R_3 = l, N, O$<br>e.g., tile, time, tith, tide, type | b. $*R_2 = \text{glide}, R_3 = r$                                      |
| $R_2 = r, R_3 = l, N, O$<br>e.g., girl, harm, carve, mark                    |  |
| $R_2 = l, R_3 = N, O$<br>e.g., helm, elf, milk                               |  |
| $R_2 = N, R_3 = \text{voiceless stop}$<br>e.g., bump, drink, want            | $*R_2 = N, R_3 = \text{fricative, voiced stop (not } d)$               |
| $R_2 = s, R_3 = \text{voiceless stop}$<br>e.g., wasp, ask, list              | $*R_2 = \text{fricatives (not } s), R_3 = \text{stops, (not } t)^{27}$ |

Again the generalization seems to be that too great a closeness in sonority is not allowed, here between segments in the  $R_2$  and  $R_3$  positions.  $r$  is apparently too close to the high vowels to be permitted in  $R_3$  position. (Evidence of this is the bisyllabic pronunciation [faj.ɾ] for *fire*, for example.) Nasals are too close to fricatives and voiced stops, but not to voiceless stops, while fricatives other than  $s$  cannot be followed by anything. The generalization that a minimum sonority difference  $n$  (whose exact value is yet to be determined) is required between  $R_2$  and  $R_3$  can be formulated as follows:

(23)

If  $x$  is associated with  $R_2$  and  $y$  is associated with  $R_3$ , then  $SI(y) \leq SI(x) - n$ .

Note that (23) does not impose a condition on the associate of  $R_3$  alone. It merely says that the SI of the associate of  $R_3$  must be less than that of the associate of  $R_2$  by  $n$ . Thus, there are no minimum sonority requirements on the associate of  $R_3$ . For English, this seems to be exactly what is needed.<sup>28</sup>

This concludes a well-known fact in English rime reason I do no syllables. In H generalization: final position t already cited.<sup>30</sup>

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(24)

- a. If  $x$  is associ
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This concludes my sketch of English rimes. I will not deal here with the well-known fact that there is a fourth coronal obstruent position available in English rimes. It appears to be restricted to ends of words, and for that reason I do not see it as forming part of the basic template for English syllables. In Halle and Vergnaud's terms, it is an "appendix."<sup>29</sup> The generalization seems to be that a coronal obstruent may be added in word-final position to any sequence allowed by the phonotactic conditions already cited.<sup>30</sup> I will not pursue this matter here, however.

By way of summary, I bring together the conditions on the terminal positions of English rimes:

(24)

- a. If  $x$  is associated with  $R_1$ , then  $SI(x) \geq 5$ . (= (16))  
 b. If  $x$  is associated with  $R_1$  and  $y$  is associated with  $R_2$ , then  $SI(y) \leq SI(x) - m$ . (= (21))  
 c. If  $x$  is associated with  $R_2$  and  $y$  is associated with  $R_3$ , then  $SI(y) \leq SI(x) - n$ . (= (23))

Clearly these conditions do the major work of defining possible segment sequences in English rimes.<sup>31</sup>

Note that when there is a third rime position in English, the fact that these conditions must be met simultaneously entails much severer constraints on the second position than there would be without the third position. This is not because of any condition on the individual  $R_2$  position (or its relation to  $R_1$ ), but because of the condition on the relation between the last two positions. Thus, the condition on  $R_2$  (and its relation to  $R_1$ ) can be the same both in the template for two-part rimes and in the template for three-part rimes, and the smaller templates can simply be "collapsed" with the larger.

This theory of the phonotactics of the English rime is relational in that (i) the natural classes in terms of which conditions on individual terminal positions are expressed are defined in terms of sonority indices, and (ii) conditions relating the sonority indices of adjacent terminal positions are given expression. Sonority indices are themselves essentially relational, in that they are defined in terms of the sonority hierarchy, itself simply an expression of the relative sonority of the segment types in language. It is possible now to see how the universal condition on association between the two tiers of this autosegmental representation of the syllable might be expressed.

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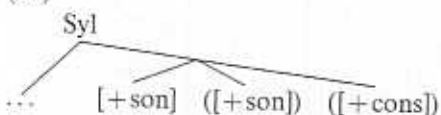
(25)

*Autosegmental Syllable Association Convention*

A segment  $\alpha$  of a segmental melody tier may be associated with a terminal position  $\beta$  in a syllable structure only if its sonority index falls within the range specified by conditions on that terminal position and conditions relating it to adjacent positions.

Without the feature [*n* sonority] it is extremely difficult, if not impossible, to express generalizations concerning individual terminal positions and the relations between them in English rimes. Suppose that the terminal positions of the syllable template were specified in terms of major class features (not including [ $\pm$ syllabic]), as in (26):

(26)



The [+son] specification of  $R_1$  ensures that in English both vowels and (syllabic) sonorants are possible in this position. And the  $R_2$  position would have to be marked [+son], if glides were to be made possible in that position. The  $R_3$  position could exclude glides (and *r*, if it were considered to be a glide) by being specified [+cons].<sup>32</sup> Of course a template such as this would overgenerate wildly and would have to be supplemented by a number of "filters." These filters would have to state, essentially one by one, what pairs of segment types were impermissible as first and second position rime members and as second and third position rime members, as follows:

(27)

	$R_1 R_2$	$R_2 R_3$
a.	*rl	*Gr
	*IN	*NO
	*NO	
	(*GV)	
b.	*LG	*lr
	*lr	*NL
	*NL	*NN
	*NN	
	*LV	
	*NV	

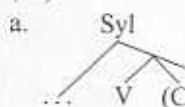
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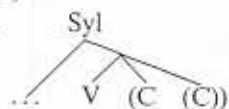
The force of Kiparsky's proposal is that filters such as those in (27b) would be unnecessary, if the Sonority Sequencing Generalization were given a role in the grammar. But the SSG would not rule out the combinations in (27a), for they are consistent with it. And then, one might ask, what is the point of including the SSG in a grammar such as this, where a major part of the work of phonotactics is being done not by considerations of relative sonority, but by an appeal to natural classes defined in terms of binary distinctive features?

The straw-man proposal I have sketched here does not give a fundamental place to considerations of relative sonority in the characterization of possible syllable structures, and that is its shortcoming. Both the specifications of the template positions in (26) and the need to filter out (27b) reflect the same generalization—the SSG. But this sort of theory does not permit the generalization to be stated uniformly. Of course, the terminal specifications in (26) could be dispensed with. But that would only require more filters to be stated, and added to those in (27a). The other problem with this (straw-man) analysis is, obviously, that the set of filters in (27a) expresses no generalization at all. This set of filters systematically obscures the minimum sonority difference generalization that lies behind them. But such a set of filters is necessary in any theory not making use of the feature [*n* sonority] in its phonotactic statements. On the other hand, when [*n* sonority] plays a fundamental role in the theory of phonotactics, the grammar is able to state significant generalizations about segment combinations in syllable structure in a uniform and extremely simple way.

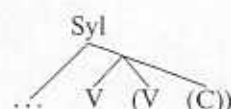
The shortcomings of the straw-man major class feature analysis of the phonotactics of the English syllable are shared, and even compounded, by a theory in which only the distinction C vs. V is made in characterizing the terminal positions of the syllable template, as in the proposals of Clements and Keyser (1981) and Halle and Vergnaud (1980). Neither a rime template like (28a), nor one like (28b), comes close to characterizing the real combinatorial possibilities in English rimes:

(28)

a.



b.



Such a theory would again have to be supplemented by a host of filters, in order to rule out the impermissible combinations the CV template would allow. Moreover, the generalizations I have pointed out would be lost.

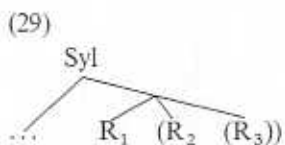
Table 1

	<i>Medial</i>	<i>Final</i>		<i>Medial</i>	<i>Final</i>
a. 1. <i>V</i>	pa-ta	tapa	b. 1. <i>Vs</i>	pas-ta	res
2. <i>VG</i>	au-tor	lej	2. <i>VGs</i>	claus-tro	sejs
3. <i>VL</i>	sal-ta	mar	3. <i>VLs</i>	pers-picaz	vals
4. <i>VN</i>	com-pra	sartén	4. <i>VNs</i>	mons-truo	Mayans
5. <i>VO</i>	seg-mento	red	5. <i>VOs</i>	abs-tracto	Félix [feliks]
6. <i>VGL</i>	*	*	6. <i>VGLs</i>	*	*
7. <i>VGN</i>	(vejn-te)	*	7. <i>VGNs</i>	*	*
8. <i>VGO</i>	(auxilio) <sup>3,2</sup>	*	8. <i>VGOs</i>	*	*
	[auk-siljo]				
c. 1. <i>GV</i>	nue-vo	apjo	d. 1. <i>GVs</i>	fjes-ta	pues
2. <i>GVG</i>	*	buej <sup>3,4</sup>	2. <i>GVGs</i>	*	* <sup>3,5</sup>
3. <i>GVL</i>	fuer-te	fjel	3. <i>GVLs</i>	*	*
4. <i>GVN</i>	sjem-pre	Juan	4. <i>GVNs</i>	*	*
5. <i>GVO</i>	djag-nosis	Go-liat	5. <i>GVOs</i>	*	*
6. <i>GVGL</i>	*	*	6. <i>GVGLs</i>	*	*
7. <i>GVGN</i>	*	*	7. <i>GVGNs</i>	*	*
8. <i>GVGO</i>	*	*	8. <i>GVGOs</i>	*	*

3.2 Spanish Rimes

I now turn to an examination of Spanish rimes, which will be based on Harris's (1982) work on Spanish syllable structure. As I will show, rime structure in Spanish provides additional evidence for the theory of syllable phonotactics that I have advocated here.

The rime in Spanish may contain at most three segments and must contain at least one. The template schema for Spanish is therefore no different from the one proposed for English (repeated here):



However, the conditions on the terminal positions of the Spanish template are rather different, as we will see, though different in ways that are quite simple to characterize, given a sonority-hierarchy-based theory of phonotactics.

Table 1, from Harris (1982, 14-15), displays the possible segment combinations found in Spanish rimes. In this table, G stands for glide, V for vowel, L for liquid, N for nasal, and O for obstruent (where, *vowel* and *glide* are Harris's terms, the use of which again should not be taken as committing me to their theoretical validity). The purpose of this section is to

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(31)  

$$\left. \begin{matrix} V O \\ V N \\ V L \end{matrix} \right\} = R_1 (S$$

$$\left. \begin{matrix} V G \\ G V \end{matrix} \right\} = R_1 (S$$

This is by and la some refinement:

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This viewpoint vowels with resp: rime sketched th

provide an account of the cooccurrence restrictions illustrated here in the framework outlined so far.

If the Spanish rime consists of one segment, it must be a vowel. I will express this generalization by imposing condition (30) on the  $R_1$  position of the template.

(30)

If  $x$  is associated with  $R_1$ , then  $SI(x) \geq 8$ .

This condition allows any of the Spanish vowels  $a, e, o, i, u$  to constitute the rime, but precludes sonorants, for example, from serving this function. (This is one way in which Spanish differs from English.)

When the rime consists of two positions, the generalization, expressed in conventional descriptive terms, is that if a vowel is the first element, any sort of segment may follow, but if a glide is the first element, only a vowel may follow. (Harris demonstrates that the GV sequences are contained in the rime in Spanish, that is, that the G does not belong to the onset in such circumstances.) In the context of the present theory, this generalization is expressed merely by saying that the second position  $R_2$  of the Spanish rime is subject to no conditions at all, either on its own or in relation to  $R_1$ . With condition (30) on  $R_1$  and no conditions on  $R_2$ , it is predicted that the sequences in (31) are permissible.

(31)

$$\left. \begin{array}{l} V O \\ V N \\ V L \end{array} \right\} = R_1 (SI \geq 8) \text{ followed by } R_2 \text{ with } SI \leq 7$$

$$\left. \begin{array}{l} V G \\ G V \end{array} \right\} = R_1 (SI \geq 8) \text{ followed by } R_2 \text{ with } SI \geq 8$$

This is by and large a correct result, though it will become apparent that some refinements are needed.

Note first that it is unnecessary, given this theory, to specify that sequences consisting of glide plus consonant are ruled out. A glide is no different from a high vowel; it has the sonority index 8. If it should happen to precede a consonant, which is necessarily less sonorous, that high vowel will be perceived to be "syllabic." This is simply because it is more sonorous than its neighbor in  $R_2$ . On this theory, glidehood and vowelhood are defined with respect to context.

This viewpoint leads to an explanation for the distribution of glides and vowels with respect to each other in Spanish syllables. The theory of the rime sketched thus far allows for both VG and GV sequences. The attested

<i>lial</i>	<i>Final</i>
ta	res
s-tro	sejs
-picaz	váls
is-truo	Mayans
tracto	Félix [feliks]
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Spanish VG sequences listed in (32) are simply sequences where a more sonorous vowel precedes a less sonorous one.

(32)

*Spanish VG (from Harris (1982, 17))*

<i>ai:</i> hai	<i>au:</i> au-to
<i>ei:</i> pei-ne	<i>eu:</i> Eu-ropa
<i>oi:</i> oi-go	<i>ou:</i> bou

The attested Spanish GV sequences listed in (33) are simply sequences where the opposite ordering of relative sonority obtains:

(33)

*Spanish GV (from Harris (1982, 17))*

<i>ia:</i> dia-blo	<i>ua:</i> cual
<i>ie:</i> bien	<i>ue:</i> cue-va
<i>io:</i> pio-jo	<i>uo:</i> cuo-ta

The point is that there is no need to make separate distributional statements about vowels and glides. Simply by allowing for sequences of two vowels in the rime, the grammar allows for just the combinations that are attested. What is heard as a glide is simply the less sonorous of the two in sequence.

Some important details require mention. First, why is it possible to have *either GV or VG* when both vowels are high, as in (34)?

(34)

<i>VG</i>	<i>GV</i>
mui	cui-da
ciu-dad	viu-da

According to Harris, the choice between the two possibilities is not predictable and instead must be lexically specified. His proposal is to mark either one or the other of the high vowels as a rime in a lexical entry. It is suggested that this lexical rime status would guarantee that the vowel would remain a vowel and that its high neighbor would have to be interpreted as a glide. An alternative proposal concerning the lexical representation of this differences is possible: that one or the other be marked for alignment with "main stress" (however stress is to be represented). The latter approach would be consistent with Harris's observation that when a syllable with two high vowels is not (main) stressed in the word,

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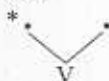
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(35).

(35)

\*ii, \*uu, \*ee, \*oc

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(1982) work on It  
prohibition agair  
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(36)



where V is a segn  
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The final detail  
Spanish involves

(37)

eo	ao	ae
oe	oa	ea

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either one may be heard as a glide (i.e., nonsyllabic); the two alternations vary freely.

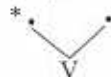
Another detail concerns the lack of the vowel-vowel combinations in (35).

(35)

\*ii, \*uu, \*ee, \*oo, \*aa

That is, there are no long vowels in Spanish. Following Chierchia's (1981, 1982) work on Italian, I take the absence of long vowels to indicate both a prohibition against sequences of identical segments on the melody tier and a prohibition against the autosegmental configuration (36),

(36)



where V is a segment on the melody tier and the points stand for terminal positions in syllable structure.

The final detail to be discussed concerning vowel-vowel combinations in Spanish involves the (apparent) lack of the combinations in (37):

(37)

eo ao ae  
oe oa ea

Whether these are to be ruled out by collocational restrictions, such as the one ruling out  $*V_iV_i$  sequences, or whether these are simply not realized in surface syllables because they are neutralized with the permissible combinations in (32)–(33), I will not attempt to resolve here.<sup>36</sup>

For two-part rimes in Spanish, then, the combination of condition (30) on  $R_1$  and no condition at all on  $R_2$  goes a long way toward accounting for the segment sequences that are allowed. Two important points remain to be made. The first is that Spanish two-part rimes are clearly different from those found in English, particularly insofar as GV sequences are allowed. In English, GV sequences are ruled out by the condition requiring that the sonority index of  $R_2$  be lower in value than the sonority index of  $R_1$ . Spanish GV sequences are permitted precisely because this condition does not exist for Spanish. This leads to the second point, which concerns the role of the Sonority Sequencing Generalization in a grammar. If the SSG played a role in language-particular phonotactics, and if phonotactic constraints are indeed expressed in terms of onset and rime, as Harris has

amply demonstrated for Spanish, then it might be thought that the SSG would rule out GV sequences in Spanish rimes. Clearly it does not do that. But then what role does the SSG have in a particular grammar, or in a theory of grammar? I must leave that question open for the moment, but I speculate in so doing that the SSG may have more the status of a surface generalization about the structure of the syllable as a whole than that of a guiding principle of basic phonotactics.

Finally, let us turn to Spanish three-part rimes. Here, too, a theory of phonotactics including conditions on terminals cast in terms of sonority indices provides a very simple means of expressing the generalizations at hand. A look at table 1 shows that three-part rimes may consist of (i) any of the two-part sequences described above plus *s* and (ii) the sequence GV plus consonant, but that no combinations of VG plus consonant are allowed.

The possibilities (for medial syllables) are repeated here (recall notes 34 and 35 on the peculiarities of certain final syllables):

(38)

*VGL	GVL	GVs
*VGN	GVN	VGs
*VGO	GVO	VLs
		VNs
		VOs

Assuming condition (30) on  $R_1$ , what other conditions will be needed on the maximally expanded template to ensure the existence of the permitted sequences and the ungrammaticality of the others? I propose the following disjunction of conditions:

- (39)
- If  $x$  is associated with  $R_3$  and  $y$  is associated with  $R_2$ , then either
- $SI(x) = SI(s)$
- or
- $SI(x) \leq 7$  and  $SI(x) \leq SI(y) - p$ .

The first part of the disjunction is tantamount to stating that (in violation of the SSG)  $R_3$  can be *s*. Since there is no accompanying condition on the relation between  $R_3$  and the preceding  $R_2$ , it follows that *s* will be able to follow any sequence of  $R_1R_2$  in the rime, as it does. Part (b) of the disjunction requires two things: first, that  $R_3$  be at least a consonant (i.e., not *i*, *u*, or any other "vowel"; again, see notes 34 and 35); second, that there exist a minimum sonority difference (or dissimilarity)  $p$  between  $R_3$

and  $R_2$ . The latt

nations of (38), c

(40)

*VGL	*V
*Vrl	*V
*VLN	*V
*VLO	

Properly specify absolute values o vague here. The i difference between the same. Clearly English rimes. As ity difference (dis set in the phonot

Closing this dis favor this analys analysis. Harris u rime for a theory bility of account nonrelational cha constituent, and f notion of minim short of giving an place in his descr with major class l out the impossibl can be leveled ag discussed for En significant genera relative sonority.

#### Notes

1. It is suggested in
2. The existence of Hoard (1978)). Eve tation. Pike (1945, 9; initial syllabic *s* tak

and  $R_2$ . The latter proviso is intended to rule out the impossible combinations of (38), as well as those of (40):

- (40)
- |      |      |
|------|------|
| *VGL | *VNO |
| *Vrl | *VNN |
| *VLN | *VOO |
| *VLO |      |

Properly specifying the value of  $p$  depends of course on refining the absolute values of the niches in the sonority hierarchy. Therefore, I leave it vague here. The important point is that the value of the minimum sonority difference between the  $R_2$  and  $R_3$  positions in Spanish and in English is not the same. Clearly, Spanish three-part rimes are far more restrictive than English rimes. As Harris points out, the specification of a minimum sonority difference (dissimilarity) between adjacent positions is a parameter to be set in the phonotactic descriptions of individual languages or dialects.

Closing this discussion of the Spanish rime, I would like to suggest why I favor this analysis of the rime facts presented by Harris to Harris's own analysis. Harris underlines the importance of these facts about the Spanish rime for a theory of phonotactics. In particular he points out the impossibility of accounting for them within a theory imposing some absolute nonrelational characterization of the three segment positions in the rime constituent, and he also brings to light many generalizations relating to the notion of minimum sonority difference (his *dissimilarity*). But he stops short of giving an  $n$ -ary feature for the sonority dimension a fundamental place in his description, which is couched instead in terms of a template with major class features (excluding [ $\pm$  syllabic]) and a set of filters ruling out the impossible sequences the template allows. Thus, the same criticism can be leveled against this proposal as against the straw-man proposal discussed for English rimes: it allows no uniform means of expressing significant generalizations about sequences of segments in terms of their relative sonority.

### Notes

1. It is suggested in Selkirk (1982), for example.
2. The existence of syllabic obstruents is sometimes reported (see for example Hoard (1978)). Even in English syllabic obstruents occur in phonetic representation. Pike (1945, 98) remarks that there is a pronunciation of *it's the truth* in which initial syllabic *s* takes the place of *it's*.

3. It will become clear below why only glides have a corresponding vowel, and also why only some obstruents may have a "syllabic" counterpart.

4. Here and in (5") I will abstract away from the question of how *l* and *r* might be excluded from this position, short of complicating these statements. This is a problem for either theory.

5. A return to  $[\pm \text{vocalic}]$  is what naturally first comes to mind. But  $[\pm \text{vocalic}]$ , as interpreted in SPE (pp. 302-303), doesn't help much for these cases. The natural classes it defines with the other major class features are as follows (SPE, 303):

(i)	[sonorant]	[consonantal]	[vocalic]
Voiced vowels	+	-	+
Voiceless vowels	+	-	-
Glides I: w, y	+	-	-
Glides II: h, ?	+	-	-
Liquids	+	+	+
Nasal consonants	+	+	-
Nonnasal consonants	-	+	-

6. The now controversial position that there are no metrical trees in the representation of stress patterns and that an alignment of syllables with the metrical grid is the only representation of stress is defended in Prince (1983) and Selkirk (forthcoming).

7. Hankamer and Aissen (1974) propose something very like this. They argue that an *n*-ary sonority feature must be adopted, and the major class features discarded, if certain generalizations pertaining to the operation of phonological rules are to be captured in a grammar. What I will say here about the major class features vs. [*n* sonority] in a theory of syllable phonotactics is in effect complementary to their arguments concerning a theory of phonological rules. Unfortunately, for reasons of space I cannot address here the more global question of the status of the major class features in phonological theory as a whole. I offer this paper as a contribution to the much-needed debate on that question.

8. In the more recent literature see, for example, Hankamer and Aissen (1974), Hooper (1976). Hooper also reviews earlier proposals by Jespersen, de Saussure, Grammont, and others.

9. Two remarks about this hierarchy are in order. First, the absence of a niche for glides is not an oversight. Hierarchy (6) embodies the claim that there is no distinction between glides and the high vowels *i*, *u*, etc., and that whether or not a segment is "phonetically" a glide is simply a matter of its place in the syllable and the relative sonority of the other segments surrounding it. Indeed, a theory incorporating a sonority hierarchy and a segment repertoire such as this is able to explain why only "high vowels" may have corresponding "glides." High vowels are simply less sonorous than low, and this degree of sonority may allow them to occupy positions in the syllable different from those allowed for *a*, etc., and more like those of the even less sonorous liquids and nasals, for example. Second, observe that the *s* occupies a place in the hierarchy next to the nasals and higher than all other obstruents. There is some psychoacoustic basis for assigning *s* to this position, for it

is far more salient than other obstruents. Placing *s* more like the sonorant *r* is more likely than the *c* a syllable rime, and in the example, the only consonants (a geminate) are the sonorants. Treating geminates as a class under this restriction can be seen in the sequences of segments: less than 4. If the restriction becomes clear below.

10. This is the class of segments. This is the class of segments. This is the class of segments.

11. This is the class of segments. This is the class of segments.

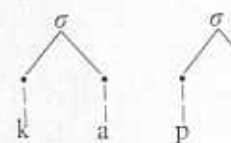
12. See, for example, Prince and Vergnaud (1980), and Selkirk (this volume).

13. Most of the references in this paper are to the segmental theory of the syllable.

14. This conceptual distinction is explicitly in Chierchia (1985) and the general points to be made are particular.

15. More specifically, the sort of tree-checking done in the segmental model of a morpheme. No other segment in a syllable. This is because the segment cannot be represented in the segmental model. For example, the segmental model of a language lies in the association of the segment with the lexicon. Therefore be the lexicon representation (8a) of the segment.

(i)



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	-

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is far more salient acoustically (and, presumably, perceptually) than any of the other obstruents. Placing *s* here would explain why it patterns in syllable structure more like the sonorant consonants than any other obstruent. Among other things, *s* is more likely than the others both to be "syllabic" and to occupy a coda position in a syllable rime, and in this way it behaves more like nasals and liquids. In Italian, for example, the only consonants permitted in the coda (aside from the first element of a geminate) are the sonorants and *s* (Basbøll (1974)). In an autosegmental theory treating geminates as a single segment on the segmental melody tier (see section 2), this restriction can be expressed on the melody tier as a prohibition against sequences of segments in which both the first and the second have a sonority index less than 4. If the restriction were cast in this way, it might not be necessary to place any restrictions on the second rime position at all. What I mean by this remark will become clear below.

10. This is the class of sounds that can appear in third position in English rimes, for example.

11. This is the class of consonants that can appear in second position in Italian rimes (see note 9).

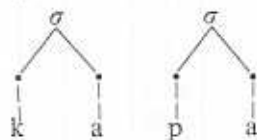
12. See, for example, McCarthy (1979, 1981), Ingria (1980), Leben (1980), Halle and Vergnaud (1980), Clements and Keyser (1981), Chierchia (1981, 1982), Prince (this volume).

13. Most of the references in note 12 discuss the treatment of length in an autosegmental theory of the syllable.

14. This conceptual division of autosegmental syllable phonotactics is made explicitly in Chierchia (1981, 1982) and Prince (this volume) as well. A fair number of the general points to be made here were worked out in concert with Chierchia, in particular.

15. More specifically, these well-formedness conditions will have to be viewed as a sort of tree-checking device. That is, it must be assumed that the syllable structure and the segmental melody are paired up and associated in the lexical representation of a morpheme. No other option is available, given an autosegmental theory of the syllable. This is because distinctive contrasts like those having to do with length must be represented lexically. Given autosegmental syllable theory, that distinction cannot be represented in terms of the segmental melody alone (cf. (8) and (9)), but instead must be represented in the association of that melody with syllable structure. For example, the distinction between *kapa* and *kappa* in the same (hypothetical) language lies not in their segmental content, which is *k-a-p-a* in both cases, but in the association of the two forms with different syllable structures. (i) must therefore be the lexical representation of *kapa*, contrasting with the lexical representation (8a) of the geminate form *kappa*.

(i)



An alternative theory according to which syllable structure is "built up" on the basis of the segmental melody is impossible if *kapa* and *kappa* do indeed share a segmental melody. Chierchia (1981, 1982) shows this for Italian, where the gemination of consonants is distinctive.

16. Nondistinctness of tree structures is discussed in Selkirk (1982) and Chierchia (1982).

17. Italian provides examples of these. According to Chierchia (1981, 1982), certain consonantal phonemes *must* be geminate, and this may be expressed as the requirement that a phoneme of such and such a type is necessarily associated with two terminal positions in the syllable structure.

18. Clements and Keyser (1981) do discuss whether the feature [ $\pm$ syllabic] or the feature [ $\pm$ vocalic] should distinguish between C and V.

19. Liberman and Prince (1977, 259) state that there is an algorithm that could in effect "interpret" trees and assign integer values to the terminals that would mirror the standard theory degrees of stress. But they reject this interpretation algorithm (p. 314) in favor of a mapping of metrical trees onto a metrical grid, a mapping governed by an entirely different principle, the Relative Prominence Projection Rule.

20. It is important to recall that what is required for the specification of terminal positions in a given language's syllable template is not necessarily reflected in the actual *representations* of syllable structure. My specific proposal is that the terminal positions of the syllable template, which is part of the phonotactic analysis of syllable structure in language (contributing to the definition of the possible "underlying" syllables in individual languages), are defined in terms of sonority indices. It remains to be seen whether such indices are relevant for characterizing syllable terminals in the actual phonological representation, which plays a role in phonological derivations. Only the operation of phonological rules, and the syllabification that may result from them, will shed light on the latter question. Among the most promising areas of empirical investigation in this regard are compensatory lengthening (see Ingria (1980)), gemination (see Clements (1978) on Luganda, Leben (1980) on Hausa, and Chierchia (1981, 1982) on Italian), and other phonological phenomena that involve the reassociation of segments to syllable structure in the course of a derivation.

21. This principle has been formulated in various ways. See, for example, Hooper (1976) and Kiparsky (1979, 1981).

22. This sonority-hierarchy-based theory of syllable phonotactics shares many properties of the theory of syllabification presented in Hooper (1976). Hooper proposes that language-particular statements about possible syllable structures may take the form of (i), for example (where C stands for "consonant" (including the class of glides), V stands for "vowel," and (i) is a maximal expansion of the syllable in terms of number of positions):

- (i)  
 \$ C<sub>m</sub> C<sub>n</sub> C<sub>p</sub> V C<sub>q</sub> C<sub>r</sub> \$

Hooper argues that c between positions m defined only for cons example,  $r \geq 5, n > 1$

In my proposal, the ing the importance o syllable phonotactics statements to be mac tactive description. Ot perhaps, is my claim features in phonotac Hooper assumes they is a major class featu Hooper's analysis to proposal can be see between the two prop features vs. an *n*-ary : that syllable structure segments and gives a given above, this vie that it is solely the se selves occupying a  $\tau$  hierarchical concept (1982).

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25. Bloomfield (1933 in the second syllabl illustrates the *rn* seq

26. As Harris points out if the SSG as fo cation possibilities i

27. These combinat obstruent, for reaso

28. But in Thai, for c or nasals (Henderso

Hooper argues that conditions on individual consonant positions and on relations between positions must be stated in terms of a *strength hierarchy*, which notably is defined only for consonants. These conditions are of just the sort proposed here, for example,  $r \geq 5, n > 1$  implies  $m \geq 6$ , etc.

In my proposal, then, I am merely incorporating Hooper's basic insight concerning the importance of an  $n$ -ary sonority (or "strength") dimension in a theory of syllable phonotactics, as well as certain specific proposals concerning the types of statements to be made in terms of that hierarchy in a language-particular phonotactic description. Our proposals nonetheless differ in a few ways. Most important, perhaps, is my claim that the feature [ $n$  sonority] entirely supplants the major class features in phonotactic description, and in phonological theory more generally. Hooper assumes they exist side by side. Implicit in the distinction between C and V is a major class feature division, for example. (Note that this division also commits Hooper's analysis to a distinction between glides and high vowels.) Thus, my proposal can be seen as taking Hooper's to its logical extreme. Other differences between the two proposals have nothing to do with the issue of binary major class features vs. an  $n$ -ary sonority feature, of course. Hooper's view, shared by many, is that syllable structure is established by a procedure that takes as input a sequence of segments and gives as output a syllabified sequence of segments. For the reasons given above, this view is untenable. Further, Hooper's view of the syllable itself is that it is solely the sequence contained between two syllable "boundaries," themselves occupying a position in a terminal string. Reasons for rejecting this non-hierarchical conception of syllable structure are given in Kahn (1976) and Selkirk (1982).

23. See Selkirk (1982), where I have argued that three-segment onsets like *str* are simply special instances of onsets with two terminal positions. The sequence *s* plus voiceless stop, I suggest there, is affricate-like in its ability to associate to a single syllable position in English.

Halle and Vergnaud (1980) argue that the apparently fourth rime position occupied by coronal obstruents in English is really an "appendix," not forming part of the basic syllable structure, and limited in its location to word-final position. (On the notion of basic syllable structure, see Selkirk (1982).)

24. There are many important details to be worked out concerning the analysis of vowels and vowel sequences in English, especially concerning the relation of the tense vowels to diphthongization. I am glossing over these issues entirely here.

25. Bloomfield (1933) notes the contrast *pattern* [pæDɪn] vs. *patron* [pejtrɪn], which in the second syllable seems to reside in the locus of the syllabic sonorant. *Pattern* illustrates the *ɪn* sequence.

26. As Harris points out, Spanish rimes allow GV sequences, which would be ruled out if the SSG as formulated by Kiparsky actually governed directly the syllabification possibilities in a language. I will return to this issue.

27. These combinations are permitted when the third is a word-final coronal obstruent, for reasons explained later and in note 23.

28. But in Thai, for example, no obstruents are permitted in  $R_3$  position, only glides or nasals (Henderson (1949)).

29. Halle and Vergnaud (1980). See also Fujimura and Lovins (1978), who characterize coronals in this position as "affixes."

30. Compare the accepted sequences below with the analogous impossible sequences in (27):

- (i)  
 R2 = N, R3 = coronal fricative, voiced coronal stop  
 e.g., month, prince, pond, wind  
 R2 = fricative, R3 = voiceless coronal stop  
 e.g., tuft, waft  
 R2 = stop, R3 = coronal stop  
 e.g., act, rapt

31. Other supplementary conditions will be required, of course. The motivation for these is the necessity of ruling out, on a language-particular basis, certain "gaps in the paradigms" that are ruled well formed by the template itself. English, for example, will require filters indicating the ill-formedness of \**tl*, \**dl* (alongside the permissible *kl*, *gl*, *pl*, *bl*) and the ill-formedness of \**pw*, \**bw* (alongside the permissible *tw*, *dw*, *kw*, *gw*). It is these very specific restrictions that require filters, or collocational restrictions.

32. See Kahn (1976), who offers a number of reasons for considering *r* to be a so-called glide in English. In the theory proposed here, the glide-like character of *r* with respect to rules of the phonology can be captured if those rules are seen to make reference to the feature [*n* sonority], rather than to complexes of binary distinctive features.

33. Though listing it here, Harris ultimately arrives at the conclusion that *veinte* is unrepresentative and that VGN sequences are in general not allowed in Spanish. He arrives at the same conclusion for VGO, *auxilio* notwithstanding.

34. GVG is restricted to word-final position in actually occurring words and might be thought to arise from the combination of GV and an extrametrical high vowel at word-end. (See Hayes (1980, 1982) on extrametricality.) Harris does report, though, that speakers accept nonce forms where GVG is medial.

35. Harris notes that in restricted morphological circumstances, GVGs is indeed allowed, e.g., *limpiajs*. But I will ignore it here.

36. Hutchinson (1974) reports that in external sandhi environments in Texan Spanish there are "glide" realizations of the mid vowels, when in combination with certain others.

## Chapter 8

### Tone Alternation in Nzema

Nzema, a Volta-Cc what more intricate ing Akan. This pag the tones of nouns.

In Nzema it is neutralized in cert forms, whose behav in the appendix.

- (1)
- |               |   |
|---------------|---|
|               | I |
| a. 'comb'     | é |
| b. 'calabash' | k |
| c. 'bed'      | é |

The three nouns b pattern as at least c (1b) share the patte in the third. (1c) is pattern LLL.

A first attempt for these three wor /kólókhwé?/, with o the L of the definit in the terminology H in isolation; and the definite marker as underlying, exc posited on the fin.