Chapter 7

On the Major Class Features and Syllable Theory

Elisabeth Selkirk

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 [±syllabic] might be eliminated, given that syllable structure forms part of a phonological representation,[1] 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—[±syllabic], [±consonantal], and [±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, ɯ, e, o, ɛ, 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, ? ?[2]

(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 has its syllabic counterpart, every glide has its companion vowel, and *s* (and perhaps others) may stand alone as syllabic.[3] It is not clear that anything is lost by eliminating [±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 [±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 [±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 [±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 [±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 [±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.[4]

Without [±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 [±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 [±syllabic], for the reasons given, and hypothesizing some other binary major class feature(s) that would permit a simple characterization of these natural classes.[5] Another response is based on the view that the problems encountered by a theory using only the major class features [±sonorant] and [±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.

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,[6] "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 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.[7]

In the general case, any segment of a language may be more or less sonorous than any other, so that a continuum $\alpha_1, \ldots, \alpha_n$ may be established, wherein α_1 is the least sonorous segment type and α_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 [±continuant], [±voice], [±nasal], [±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 provided 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,[8] 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.[9]

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.

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 [±syllabic]), as illustrated in (7).

(7)

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

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.

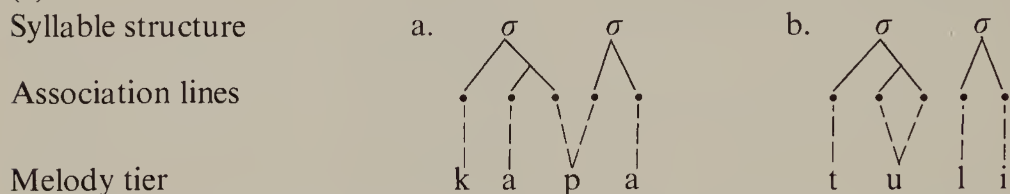
The general claim, then, is that the theory of sonority indices provides the basis for just the right characterization of natural classes that is required in a theory of syllable structure.

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.

2. Sonority Indices in a Theory of Syllable Phonotactics

According to the autosegmental theory of the syllable that has been proposed recently,[12] 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.[13] Hypothetical *kappa* would have the representation (8a), and hypothetical *tuuli* the representation (8b):

(8)



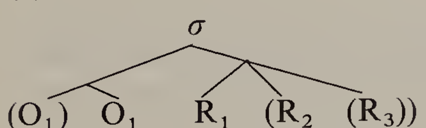
Given an autosegmental theory of the syllable, the phonotactic description of the syllable has at least three parts: (i) the characterization of possible syllable structures, (ii) the characterization of possible (or impossible) sequences on the melody tier, and (iii) the characterization of possible associations between the two.[14] 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).[15]

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.[16] 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 universal condition that association lines not "cross," as well as the universal condition that a segment α may be associated with a terminal position β in syllable structure only if α is nondistinct (in a manner to be made precise) from β. Other language-particular conditions on these associations may exist as well.[17] 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).[18] In the spirit of Selkirk (1982) and Harris (1982), which are couched in a nonautosegmental 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.[19] What I wish to propose here is that those terminal positions are characterized in terms of *sonority indices*.[20]

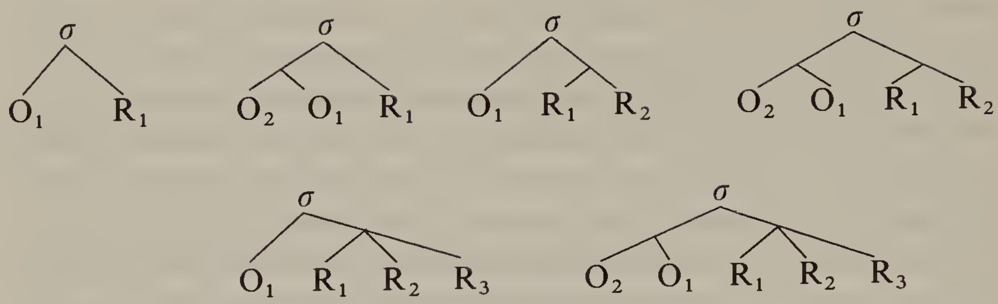
The syllable template of a language indicates the maximum and minimum number of terminal positions in the syllable and identifies the terminal positions with names. The template structure is also (universally) divided into onset and rime, though this may not be crucial. (9) is an example of such a template:

(9)



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)

a. If x is associated with O_1, then $SI(x) \leq 8$.
b. If x is associated with O_2, then $SI(x) \leq 3$.
c. 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):[21]

(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. 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.[22]

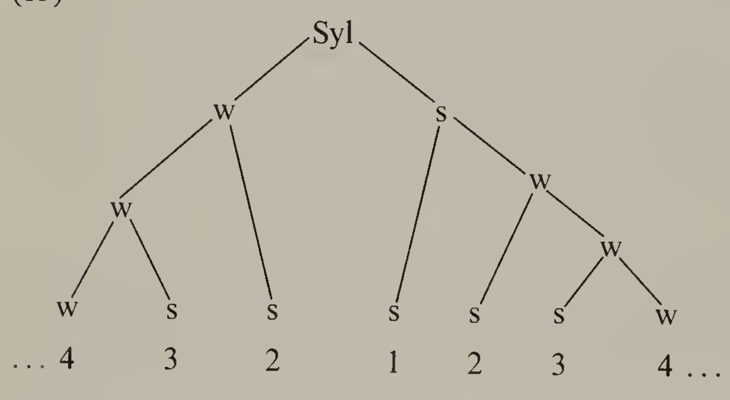
The theory I have outlined may be referred to as a *relational theory* of the syllable. There are three distinct senses in which it is relational. (i) The specification of individual syllable terminals is cast in terms of theoretical constructs that are themselves inherently relational: sonority indices 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.

(13)



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 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 Kiparšky'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.

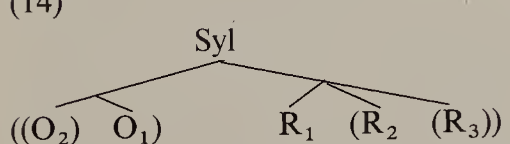
In addition to his proposal concerning the SSG, Kiparsky (1979, 1981) points to the need for viewing syllable phonotactics in terms that are relational in the second sense that I mentioned. Specifically, he points out the impossibility of specifying absolute conditions on the terminal positions of syllable 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):

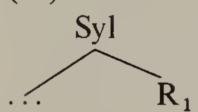
(14)



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.[23]

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):

(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.

(17)

(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.[24]
VL: pal, far, etc.
VN: run, sing, slam, etc.
VO: cut, tap, pick, etc.

rN: pattern[25]
rO: mallard