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Stricture is Structure

Chris Golston   Harry van der Hulst

1. Introduction

Most models of phonology assume that lexical representations involve a linear sequence of segments. Segments consist of a featural organization and some of the features (i.e. major class and certain stricture features) determine how a set of syllabification rules assign a syllabic organization to the string. In this article we propose a different view. We propose that lexical representations are syllabified in the lexicon and that there is no segmental representation per se. We present various types of linguistic and psycholinguistic evidence for this proposal. A consequence of our proposal is that syllable structure can be used to encode most major class[1] and manner properties. Hence, stricture is structure. We remove all stricture features from the 'segmental structure', reducing the latter to place features. Laryngeal features are represented as modifiers of the syllabic constituents onset, nucleus and coda, following Golston and Kehrein (1998, 1999).[2] Thus, if we view syllabic structure as the phonological counterpart of

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1. Some major class features like [consonantal] may not be needed in phonology at all. See Hume and Odden (1996).

2. Jensen (1994) proposes a version of Government Phonology element theory that does not have stricture elements. Hence, in order to express lexical contrast between, for example, stops and fricatives, other means must be used. Jensen proposes to encode such contrasts in terms of extra syllabic structure. This approach thus identifies stricture with structure. Our approach is less radical since we, strictly speaking, maintain a set of stricture features, be it as labels of syllabic terminal nodes, rather than as features that associate to these and non-terminal nodes. By representing these as labels of syllabic ~~terminal~~ nodes we do, therefore, represent stricture features as direct extensions of the syllabic structure.

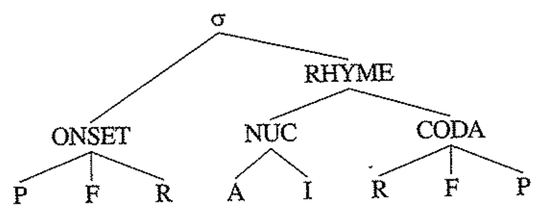
syntactic phrase structure and the place features as the phonological 'lexical items', the latter are essentially 'category-free', i.e. whether [labial] represents a consonantal or vocalic segment will depend on where it associates in the syllabic phrase structure.

Summarizing, we seek to demonstrate the following:

a. Stricture is part of syllable geometry.
b. Syllable structure is underlying.

A preview of the stricture model is given in (1). The general syllable template is meant to express that each syllabic constituent has one anchor for place features:

(1)

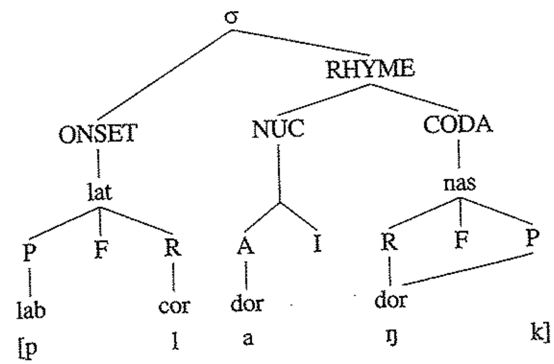


The capitals represent the labels of the syllabic terminal positions. In (1) P stands for *plosive*, F for *fricative*, R for *sonorant*, A for *low* or *open*, and I for *high* or *closed*. Thus, we regard aperture properties as nuclear stricture features.[3] Actual syllables result from attaching place, laryngeal and nasality features to a specific syllabic structure. A preliminary example makes clearer how this is to be done. Consider a representation for [plaŋk]:[4]

3. See Van der Hulst (1995, 1996, 1999, forthc.) for a different notational expression of the claims that are made in this article.

4. We overlook a number of other possibilities here for the sake of expediency. The final /k/ of this form, for instance, might be part of degenerate syllable, it might be extrametrical, and so on. These are issues we will not touch upon here because they do not affect our main point: that stricture is part of syllable structure.

(2)



The relevance of our proposal for the present volume is this: given claims A and B, one might argue that there is no need for a *process of syllabification*. We treat syllabification as a state of affairs, not as a derivational process. This rids generative phonology of what is perhaps its central derivational tenet: the derivation of surface representation from underlying representation through syllabification. If there is a derivational residue in phonology, syllabification need not be a part of it. Once distinctive laryngeal, place and manner features are linked into syllable structure, we know linear order, just as we know the linear order of a noun and a verb in a given language once we know that the former is the subject of the latter.

This article is organized as follows. Section 2 gives a general overview of lexical representation in generative phonology; it explains how we got where we are today and argues that we do not want to stay there. In Section 3 we develop the proposal that major class and major stricture features are part of syllable geometry and how this obviates the need for segments in phonological representation. In Section 4 we provide psycholinguistic and grammatical evidence for underlying syllabic organization. Section 5 concludes.

2. Background

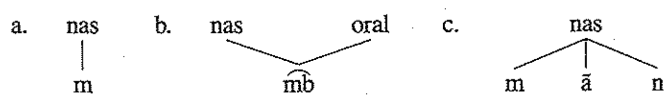
From the mid-sixties to the mid-seventies generative views on phonology were largely based on the theory behind Chomsky and Halle's *Sound Pattern of English* (SPE, Chomsky and Halle 1968). SPE did not recognize a syllabic organization in addition to the linear string of segments. In later developments of the theory, however, it was proposed that syllabic structure was necessary in order to capture significant phonological generalizations. This never led to the view that syllabic organization was present in the lexical representation. The assumption was — and continues to be — that syllabic organization is predictable on the basis of the segmental make-up and is therefore not part of underlying representations; syllabic structure was assigned by (early) rules.

Phonological theory has undergone a number of important changes since the mid-seventies. These changes involved structure both below and above the level of the segment. Sub-segmental changes led to the development of autosegmental phonology, supra-segmental changes led to the development of metrical phonology.

Autosegmental phonology differs from the SPE-conception in that phonological segments are not represented in terms of a feature bundle, but rather in terms of a skeletal point (i.e. essentially a syllabic position) to which a number of features associate. The features, as it has sometimes been put, form segments on their own ('autosegments'). Segmentation is done separately for each dimension of speech that is captured in a phonological feature category. Despite this broader use of the notion segment, the closest equivalent to the traditional notion is the skeletal point.

A general principle of licensing requires that all features be associated to a skeletal point in order to be realized phonetically. Within this conception, features and skeletal points may be related in a one-to-one, many-to-one, or one-to-many relation. In the unmarked case each point bears exactly one feature for tone, one for place, one for laryngeal specification and so on (cf. 3a). Complex segments have more than one such specification, (3b), per segment. Contours or prosodies have more than one segment per such specification, (3c):

(3)



Note that this autosegmental treatment of complex segments such as affricates makes crucial use of linear ordering of specified features within the scope of single segments. We will argue that features can also associate to non-terminal syllabic nodes (such as Onset). Thus, we deprive the skeletal level of its special status, moving toward a non-segmental phonology. This move will imply other ways of representing complex segments, not involving linear information.

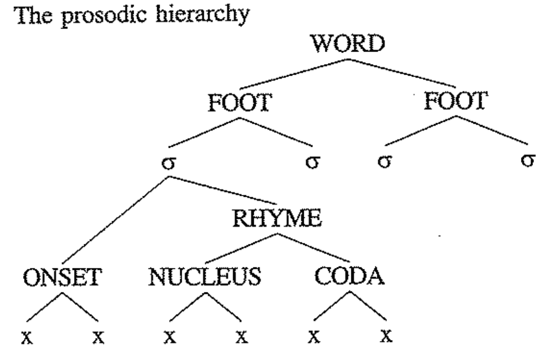
In certain cases the association of specified features to skeletal points is predictable, for example simply because *all* segments (of some type and within a certain domain) show up with this specified feature. In such cases the association can be removed from the lexical or underlying representations and be added by rule, usually in a left-to-right fashion. This approach has been especially

succesful in the analysis of tone (Leben 1973; Goldsmith 1976; Pulleyblank 1983) but has also been used for consonantal and vocalic 'melodies' (McCarthy 1979), and individual vocalic features (Clements 1976; Pulleyblank 1988; Archangeli and Pulleyblank 1994). This marks a major departure from SPE conceptions of phonology because it is now allowed that the information contained in lexical entries is only partially linearized. We will argue that linear order can be suppressed more rigorously.

A further enrichment of phonological representations claimed that features are hierarchically organized, such that it is possible to refer to groups of features, as well as to individual features (Clements 1985, 1991; Sagey 1986; Den Dikken and Van der Hulst 1988; McCarthy 1990; Padgett 1991). This in turn led to a general recognition that stricture features (which define sonority) are in some sense more central than those which define place, oral/nasal or laryngeal specifications. Van der Hulst (1990, 1995, 1996, 1999, forthc.) argues that stricture (incl. major class) features are *head* features on which all other features are dependent. With respect to major class features this has also been argued by McCarthy (1988) whereas Steriade (1993, 1994a, 1995) suggests that many features are dependent on stricture. Our proposal below incorporates this particular dependency between manner and place in a principled way.

Metrical phonology is a theory of how skeletal points are hierarchically organized into prosodic structure: segments into syllables, syllables into feet, feet into phonological words, and so on:

(4) The prosodic hierarchy



Most metrical theories claim that prosodic constituents are headed, i.e. that within every constituent one unit is the head and the others are dependents. The most sonorant segment heads the nucleus, the nucleus heads the rhyme, the rhyme heads the syllable; one syllable heads each foot, one foot heads each word, and so on.

Despite all of these changes above and below the segment since 1968 the central role of the segment (X-slot, etc.) has gone unchanged, especially in underlying representation. This has led to what we might call complete prosodic underspecification:

(5) *Complete Prosodic Underspecification*
Underlying forms are not syllabified; surface forms are fully syllabified.

This results in an increased disparity between what types of object underlying and surface forms are. In SPE, both URs and SRs were the same types of object: strings of segments (no syllable structure at either level). With the advent of metrical phonology, a schism has developed between UR and SR such that they are completely different types of object. Golston (1996a) calls this the theorem of *impossibility*:

(6) *Impossibility*
Every underlying form is an impossible surface form and vice versa.

Impossibility is the result of having surface forms from the 1990s and underlying forms from the 1960s.

Impossibility should immediately call into question the psychological plausibility of Complete Prosodic Underspecification since, if understood as a psychologically real model, *impossibility* entails the claim in (7):

(7) Speakers cannot store what they can say and vice versa.

How or why a species would develop a communication system as inefficient as this is not clear to us. Why should something as fundamental as prosodic structure be left out of underlying form? The traditional answer is of course that prosodic affiliation is predictable given a linear string of segments. This is no doubt true and in any case not a point we would want to contest. Maintaining the idea that predictable properties are derived by the grammar, we wish to make the opposite claim: that the linear order of autosegments is predictable given a prosodic affiliation.

The point is hardly a new one and rests on two well-known universals of phonology, cf. especially Anderson (1987). The first is that the order of onset, nucleus and coda is fixed for all languages:

(8) *Universal left-right order of syllable constituents*
Syllable: Onset > Nucleus > Coda

The second is the familiar Sonority Sequencing Principle (Sievers 1881, Jespersen 1904; Fujimura and Lovins 1978; see Clements 1990 for discussion):

(9) *Sonority sequencing*

Onset:	less sonorant > more sonorant
Nucleus and Coda:	more sonorant > less sonorant

Given the universality of (8) and (9), we may safely factor the generalizations that these statements embody out of underlying representation, along with the linear order they entail. That is, we know the answer to (10) because we know that the principles of linearization in (8) and (9) hold in English:

(10) *Think of an English word in which*
[æ] is in the nucleus
[p] is in the coda
[m] is in the coda
[l] is in the onset
[k] is in the onset

Given the syllabic affiliation of a set of sounds, their linear order is completely predictable. This paves the way for a theory of representation in which there is no distinctive linear ordering. The importance of this should not be overlooked: a central observation about linguistic structure in syntax, morphology and semantics is that it is hierarchically structured, not linearly ordered; the same claim is fairly obvious for surface representation in phonology. The odd man out is underlying phonological representation, the last stronghold of linearity in linguistic theory. Our proposal is that linearity plays no role here either.

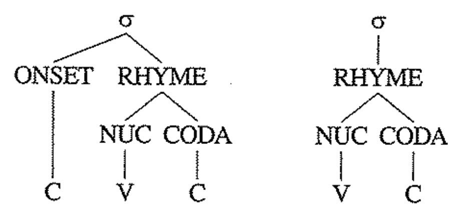
Our idea to make underlying and surface form isotypical is related to the view within Government Phonology that phonological representations are fully interpretable at all levels of representation (Kaye, Lowenstamm and Vergnaud 1990). Indeed, within Goverment Phonology it is also assumed that syllable structure is omnipresent. This model, however, does not address the issue of linearization.

Before we turn to a sketch of the kinds of representations that we use for various types of segments and (complex) syllabic constituents, we must address a potentially damaging empirical problem for our proposal.[5] It is a widely observed fact that a sequence of a closed syllable followed by a syllable that starts with a vowel, is empirically unattested. The traditional view that assumes

5. We are grateful to Marc van Oostendorp for pointing out this problem to us.

that linearly organized strings form the input for syllabification explains this by saying that a string VCV is universally syllabified as V.CV. This is due to constraints that Prince and Smolensky (1993) call ONSET and NOCODA. ONSET penalizes vowel-initial syllables and NOCODA penalizes consonant-final syllables. As a consequence, any possible contrast between V.CV and VC.V will be neutralized. It would seem, at first sight, that our model predicts that such contrast could exist since nothing seems to prevent us from having a sequence of an (unordered) syllable rhyme (V/C) that is directly followed by a rhyme:

(11)



A further aspect to the same problem is that in languages that allow complex onsets like /pr/, no lexical contrast can occur between V.prV and Vp.rV (and Vpr.V). A further related problem involves what has been called the 'Syllable Contact Law' (Vennemann and Murray 1987). According to this law, in many languages codas are less sonorant than following onsets. How can we express such a generalization if linear order is not part of the lexical representation?

We believe that these effects are best captured by assuming that phonological output is subject to constraints like ONSET, NOCODA and the Syllable Contact Law, just like in segment-based phonology. The linearization principles in (8) and (9) are responsible for linearization *within* the syllable and notions like ONSET, NOCODA and the Syllable Contact Law are responsible for well-formedness across syllables.

If this seems like a weaker position than having no syllable structure underlyingly, think again. If no language has syllable structure underlyingly, why (we must ask) does *every* language have syllable structure on the surface? The fact that every language makes use of syllables on the surface and the very reasonable assumption that speakers store things that are similar to what they say strongly suggests that syllable-free underlying representations are unlikely. Our position and the standard position differ only in the magnitude of the problems they face. We must account for why no language contrasts CV.CV with CVC.V and we do so with principles that regulate syllable structure. Standard segment-based phonology must account for the same fact and it does so with the same

principles *plus* a stipulation that underlying forms are universally unpronouncable and must be syllabified to be spoken. Occam's razor places the burden of proof on theories that use *both* syllabified (SR) and unsyllabified (UR) material.

3. The Representation of Stricture

Stops and fricatives are articulated with a degree of stricture that involves full contact or close approximation leading to turbulence; vowels are made with a degree of stricture that never involves contact or close approximation; and sonorants fall somewhere in between, with no turbulense but some contact or close approximation.

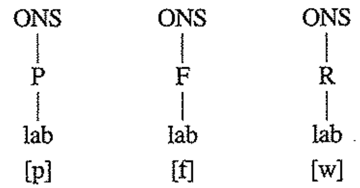
It is a well-founded observation that stricture features do not spread. Alongside processes like nasalization, place-assimilation and voicing assimilation we do not commonly find occlusivization (C → stop / __stop), fricativization (C → cont / __cont) or sonorization (C → son / __son). We understand this as a corollary of our claim that stricture is part of syllable structure: stricture does not spread because prosodic structure does not.

This section will be aimed at refining this claim and at treating the difference between simplex and complex onsets, nuclei and codas. The particulars of our proposals are somewhat tentative and will surely need to be refined further.

3.1 *Simple Margins*

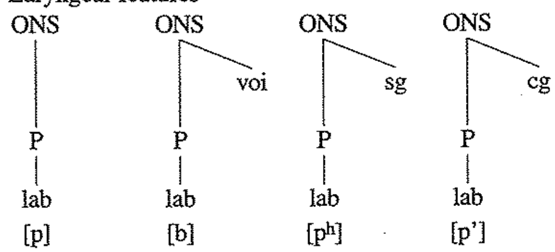
Let us begin with simple onsets. In the unmarked case, an onset has a single uniform place property, a single uniform laryngeal property and a single uniform nasal property. This, we claim, is what makes onsets 'simple,' not some system of segment counting. We begin with place features. Within the onset (and coda) they may be licensed as stops (P), as fricatives (F) or as sonorants (R) as follows:

(12) Place features



Much phonological and phonetic research has shown that laryngeal features like [spread glottis], [constricted glottis] and [voice] are not properly features of segments but of onsets, rhymes, or nuclei (Iverson and Salmons 1995; Golston and Kehrein 1998, 1999). This must be stipulated in a segmental model, which has no other option than to locate laryngeal distinctions on skeletal points, since at UR there is nowhere else to locate features, prosodic structure being absent. The non-segmental nature of laryngeal features is straightforwardly captured in a model such as ours, however, because it recognizes prosodic structure underlyingly. Following Golston and Kehrein (1998, 1999) we assume that laryngeal features are licensed not by stricture nodes but by higher syllabic nodes, as follows:

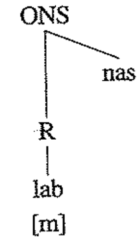
(13) Laryngeal features



While it is possible to represent complex events like [kt], [ps] and [bd] in our model (cf. 19), it is now not possible to represent *[kd], *[bs] and *[bt] onsets, which are laryngeally disharmonic. The universal absence of such onsets is thus accounted for geometrically and without phonotactic stipulation because all features that associate to the ONS node necessarily have scope over everything that is in it.

We take nasality to be another feature that associates directly with margins and nuclei (Golston 1998). Evidence for this comes from the non-occurrence of contrastive nasal contours within the margin: we know of no language in which [mb] and [bm] contrast within an onset or coda. This is how we intend to represent simple nasal onsets:

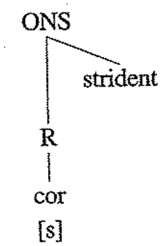
(14) Nasality



Similar representations apply for codas, but we will not go through the details here since the outcome is fairly obvious.

The question arises whether a similar attachment can be defended for features like [lateral], [rhotic] and [strident].

(15) Strident fricative

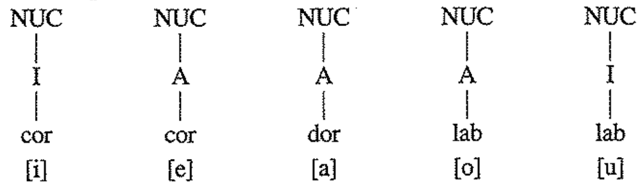


Laterals and rhotics do not often have contrastive places of articulation, but cases are attested. Mid-Waghi contrasts laminal, apical and dorsal laterals (Ladefoged and Maddieson 1996: 190) and Toda contrasts fronted alveolar, alveolar and retroflex trills (ibid: 223). Thus there is no reason not to treat the features [lateral] and [rhotic] analogously with [strident].

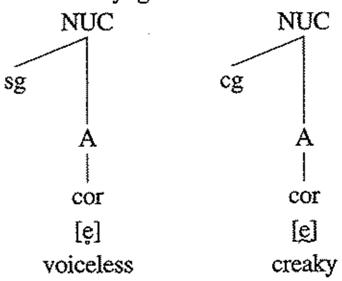
3.2 *Simple Nuclei*

Nuclear representations are similar, with the height encoded in terms of the stricture features A (lo) and I (high). In the unmarked case, a nucleus has a single, uniform place gesture (cf. 16); a single, uniform laryngeal gesture (cf. 17); and a single, uniform nasal gesture (cf. 18). This is what makes nuclei 'simple':

(16) Vocalic place features

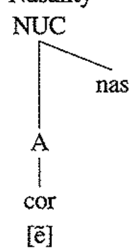


(17) Vocalic laryngeal features



As in syllable margins, nasality is associated directly to nuclei, not to stricture features. Nasalized nuclei are represented thus:

(18) Nasality

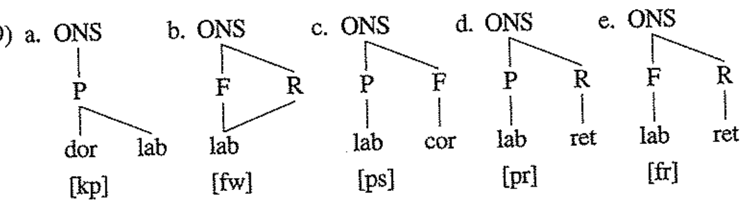


This concludes our discussion of simple onsets and rhymes. We note in passing that each of the representations above would be transcribed in IPA with a single segment (plus diacritics). We turn now to complex syllable structure.

3.3 *Complex Onsets*

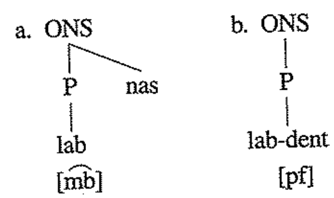
We make no principled distinction between traditional branching onsets like [pla], [tra], [kna] and traditional complex segments like [k͡p], [m͡b], [t͡l] since there is little evidence that languages can contrast e.g., [kp] with [k͡p], or [tla] and [t͡la] within an onset or coda (Golston 1998). We represent both types of sound as in (19); the notion 'complex' is defined here not in terms of multiple segments but in terms of multiple place features:

(19)



Contour segments invoke an extra cavity feature (prenasalized stops) or a stop at a noisy place of articulation (Kehrein 1998):

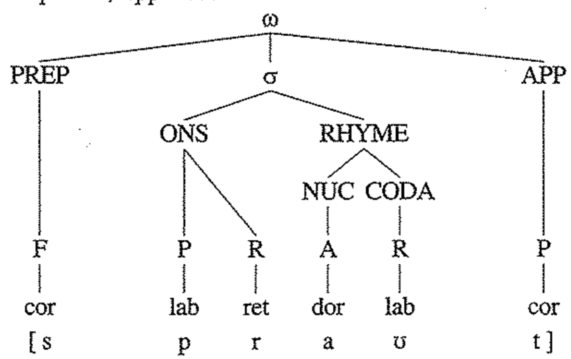
(20)



/kn/-type clusters (in Dutch, for example) do not behave like a true onset. Trommelen (1983) showed that they are invariably split up intervocalically. In this model, such clusters cannot be represented as one (complex) onset because the place of the stop and the nasal cannot be disharmonic for place in our model. Hence, the sequence /kn/ must be parsed in terms of two onsets with an intervening empty rhyme, in the style of Government Phonology, or in terms of an extrasyllabic position (prependix) at the word edge.

We have not yet dealt with sC clusters, a topic we feel deserves special consideration. In many languages word-initial obstruent clusters may begin with [s] but with no other consonant: [spa], [sta], [ska] but not *[fpa], *[fta], *[fka] nor *[θpa], *[θta], *[θka] or *[ʃpa], *[ʃta], *[ʃka]. Rather than complicate the prosodic structure of the syllable, we follow a number of researchers in recognizing extra-syllabic metrical positions at word-edge: the word-final appendix and the word-initial prependix (Fudge 1969; Selkirk 1984; Steriade 1982, 1988). We represent words like *sprout* [spraʊt] as follows:

(21) *Prependix, Appendix*



We assume that the appendix can only hold coronals (Fudge 1969; Trommelen 1983; Van der Hulst 1984).[6]

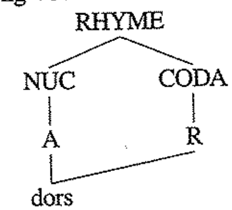
3.4 *Complex Nuclei*

Next, we return to the core of the syllable again. In (22) we represent long vowels that associate their features to both the nuclear and coda position. Associating different features to the nucleus and coda nodes leads to long diphthongs, (23). Short diphthongs involve two place features associated to the nucleus node only, (24).

6. In a word like *ramps*, the [m] might be in the coda, the [p] in a degenerate syllable, and the [s] in the appendix. We will not pursue this here as it leads directly away from the point at hand.

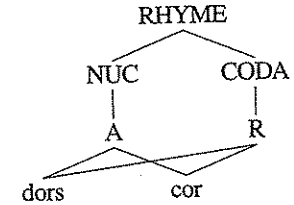
(22) Long vowels

a.



[a:]

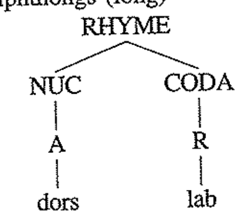
b.



[e:]

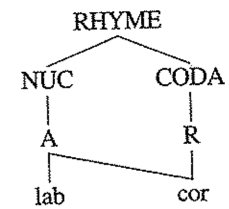
(23) Diphthongs (long)

a.



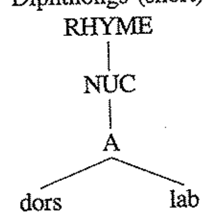
[aʊ]

b.



[øɪ]

(24) Diphthongs (short)



[a^ʊ] 'short diphthong'

This concludes our brief survey of the kinds of stricture that our theory allows. We will now turn to additional evidence supporting our claim that prosodic structure is underlying.

4. Evidence for Underlying Prosody

The phonological representations we have proposed make no use of segmental structure and maximal use of prosodic structure. We take it as given that prosodic structure is well-motivated in surface representations but now need to motivate our claim that it is well-motivated in underyling representations as well.[7] And so we turn now to the issue of underlying prosody.

It is worth pointing out that there is no empirical evidence *against* underlying prosodic stucture. There are a number of quasi-theoretical considerations that have led linguists to eschew underlying syllabification (see Blevins 1995 for recent discussion), but they all address having *both* syllable structure *and* segment strings underlyingly, a possibility obviously fraught with redundancy and one which we will not pursue. We propose replacing segment strings with prosody, not supplementing them with prosody.

So what evidence is there in favor of underlying syllable structure? Here we can distinguish two broad types, linguistic and psycho-linguistic evidence.

4.1 *Linguistic Evidence*

We will adduce no new types of linguistic evidence for underlying prosody in this section. Rather, we will show that our case has already been made for us. The phonological literature of the eighties is replete with arguments that prosody (moras, syllables and feet) is underlying — we merely need to remind the informed reader of these arguments.

4.1.1 *Moras*

A number of phonologists have argued for representing consonant and vowel length in terms of underlying prosody (Hyman 1985; McCarthy and Prince 1986, 1988; Hayes 1989).[8] Long vowels and geminate consonants may be represented as in (25), with a rule that adds a single mora to every vowel, or as in (26) with no such rule:

(25) Minimal moraic specification

```
 μ               μ
 |               |
 a       a       k       k
(long V) (short V) (long C) (short C)
```

7. See also Dobrin (1993). Inkelas (1994) argues that all non-alternating prosody must be underlying in Optimality Theory, given consistent application of Lexicon Optimization (Prince and Smolensky 1993).

8. See Noske (1992) for critical assessment of the moraic account of compensatory lengthening; we are concerned here with the representation of contrastive length.

(26) Maximal moraic specification

```
 μ   μ        μ        μ
  \ /         |        |
   a          a        k        k
(long V)  (short V) (long C) (short C)
```

Either way, *some* prosodic information is treated as underlying. Any theory of phonology that embraces such a view of length already makes use of prosody in underlying representation.

More direct evidence for the underlying status of moras comes from minimal requirements on lexical formatives. Extending work on word-minimality (McCarthy and Prince 1986) to the level of roots and affixes, Golston (1990) has argued that English, Latin and Classical Greek require the underlying forms of derivational affixes to be minimally monomoraic. As with contrastive length in moraic theory, this is only statable in a grammar which allows moraic structure in underlying representations.

4.1.2 *Syllables*

There is ample evidence that syllable structure is underlying in many languages. Two general classes of phenomena can be distinguished here: minimality requirements on roots and prosodically defined templatic morphology, both ultimately due to the pioneering work of McCarthy (1979, 1981), Marantz (1982) and McCarthy and Prince (1986, 1990).

Let us take minimality requirements first. Golston (1996b) notes that the well-established shape of Proto-Indo-European roots is exactly the type of evidence one needs for claiming that syllable structure is underlying in a language. PIE had the following types of roots (where R denotes the class of sonorants):

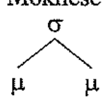
(27) Proto-Indo-European root shapes
(C)VC
(C)VR
(C)VRC

The generalization here is that PIE roots are all single closed syllables: this and nothing else captures the fact that CV, CVV, CVCR and CVCV are impossible PIE roots. A grammar of PIE which does not countenance underlying syllable structure or constraints that regulate it in underlying representation cannot capture this.

Sanskrit provides a similar case. Sanskrit inherited roots from PIE but lost its laryngeal consonants, with compensatory lengthening in coda position. The result, as Steriade (1988) has shown, is that Sanskrit roots are both monosyllabic and bimoraic. Again, this is simply not statable without underlying syllables: if roots are stored simply as segment strings, the fact that the strings all happen to constitute exactly a heavy syllable goes completely unaccounted for.

A similar case can be made for reduplicative morphology. Work by Marantz (1982), McCarthy and Prince (1986), Steriade (1988) and others has shown that reduplication is inherently prosodic. Reduplicative morphemes which consist solely of a syllable template straightforwardly depend on syllable structure being part of lexical representation. McCarthy and Prince's (1986) analysis of Mokilese is typical — the underlying form of the prefix that marks progressive aspect is given as:

(28) Mokilese progressive



The underlying form of this prefix is thus a heavy syllable. Any theory of morphology which countenances prosodic templates such as this supports the claim that prosodic structure can be underlying.[9]

4.1.3 *Feet*

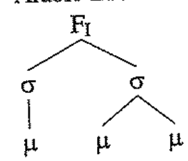
Entirely parallel facts obtain for feet. A number of languages require lexical words to consist of minimally a foot (McCarthy and Prince 1986; Crowhurst 1991). Golston (1990) demonstrates that this can apply to roots as well, suggesting that foot structure must be available underlyingly. Van der Hulst and Klamer (1996) argue for this point using data from Kambera, an Indonesian language, showing that the shapes of roots are often based on the feet used elsewhere in the phonology. Again, such restrictions on underlying forms do not seem to be statable without underlying prosody.

Languages that express morphological category by shape, such as Classical Arabic (McCarthy 1979; McCarthy and Prince 1990), Yawelmani (Archangeli

9. With the advent of OT this might seem to have changed. McCarthy and Prince (1993ab, 1995) propose dealing with the size of reduplicants in terms of constraints: Red = σ, Red = Ft, and so on. But the difference is merely cosmetic: either way, the sole surface regularity of a reduplicative morpheme is its size and this will have to be indicated in any type of grammar.

1991) and Choctaw (Ulrich 1986, 1994; Lombardi and McCarthy 1991; Hammond 1993) also show the necessity of underlying prosody. The point has been made repeatedly in the literature that morphemes in such languages may consist solely of a certain prosodic shape: this *is* underlying foot structure, another clear case of underlying prosody. Consider McCarthy and Prince's analysis of the Arabic Broken Plural as an iambic foot (F_I).

(29) Arabic Broken Plural



Underlying prosody constitutes the underlying form of this morpheme; again, a clearer case of underlying prosody cannot be imagined.

We see then that underlying prosody has become a central part of generative phonology in the past decade. This is true both of pure prosody (reduplicative and templatic morphology) and of prosody attached to melody (the moraic analysis of geminates); and it is true of all well-established levels of prosody — mora, syllable and foot. In this context our proposal that prosodic structure is underlying is utterly banal.

4.2 *Pyscholinguistic Evidence for Underlying Prosody*

Psycholinguistic evidence offers an important check on linguistic theory by casting light on the psychological reality of different grammatical models. The best models of grammar are compatible both with linguistic and with psycho- linguistic data. As we will see here, two types of evidence bear on the phonolog- ical representations speakers actually store and it is significant that they agree with one another point for point (Cutler 1986: 173; Levelt 1989: 355).

4.2.1 *Tip of the Tongue (TOT) States*

Brown and McNeill (1966) showed that speakers who cannot think of a word tend to know three things about it: the initial segment or onset, the number of syllables and the stress pattern. When a speaker tries to access the phonological form for *sextant*, for instance, words like *secant* and *sextet* come to mind. The results have been confirmed by much subsequent research (Gardiner, Craik and Bleasdale 1973; Yarmey 1973; Koriat and Lieblich 1974, 1977; Rubin 1975; Browman 1978; Reason and Lucas 1984; Kohn, Wingfield, Menn, Goodglass, Berko-Gleason and Hyde 1987; Priller and Mittenecker 1988). This strongly suggests that speakers store words as syllables and do not store them merely as strings of segments.

Consider the alternative. If a speaker stores a word as a string of segments and cannot access (part of) that string, she should not be able to compute the number of syllables or location of stress. For to do so would require access to the string of segments she (ex hypothesi) has no access to. If, on the other hand, prosodic structure is stored, we expect it to be accessible even if the full form of the word is not.

4.2.2 *Malapropisms*

Classifications of speech errors include a category of sound-related substitutions (Fromkin 1973) or malapropisms (Fay and Cutler 1977), involving mis-selection of a word that is phonologically but not semantically similar to the intended word. Typical cases include ('F' from Fromkin; 'FC' from Fay and Cutler):

(30) Sound-related substitutions

Intended		Spoken	
white Anglo-Saxon Protestant	>	white Anglo-Saxon prostitute	F
a routine proposal	>	a routine promotion	F
the conquest of Peru	>	the conquest of Purdue	F
prohibition against incest	>	prohibition against insects	F
week	>	work	FC
open	>	over	FC
constructed	>	corrected	FC

As these cases illustrate, the overall prosody of the target is matched by the overall prosody of the error:

(31)

Intended	Spoken	stress pattern	syllable count
Protestant	prostitute	(x..)	3
proposal	promotion	(.x.)	3
Peru	Purdue	(.x)	2
incest	insects	(xx)	2
week	work	(x)	1
open	over	(x.)	2
constructed	corrected	(.x.)	3

What we do not generally find in sound-related substitutions are cases like *protest* for *Protestant*, *proposition* for *proposal*, *Peruvian* for *Peru*; or *insecticide*

for *insects* — forms we have every reason to expect if words are stored merely as segment strings.

The criteria for phonological similarity here are identical to those found in TOT states: same onset, same stress pattern, same number of syllables. Data like this has led researchers like Crompton (1982), Fromkin (1985) and Butterworth (1989) to posit a phonological sub-lexicon within the mental lexicon. *White Anglo-Saxon prostitute* is produced when *prostitute* is mis-selected because of its proximity to *Protestant* in the phonological sub-lexicon. None of this makes any sense if syllable count and stress pattern are not somehow stored.

Again, it is most significant that two quite different sources of evidence converge on the same criteria: word-onsets, stress pattern and number of syllables are used in accessing the phonological forms of words. Any psychologically plausible model of grammar must come to terms with this and admitting prosody into underlying representation seems like the necessary first step.

5. Conclusion

We have tried to provide a psychologically plausible and linguistically reasonable theory of phonological representation that makes maximal use of prosodic structure and minimal use of extrinsic ordering. Our model makes no use of segments, root nodes, C-, V- or X-tiers and the like and minimizes the differences between underlying and surface forms. More specifically we propose that stricture is not encoded featurally in phonological representation but structurally in the form of syllabic sub-constituency.

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