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A PROSODIC THEORY OF EPENTHESIS*

This paper argues for a theory in which epenthesis results from the interrelated requirements of prosody and not from obligatory skeletal insertion rules. Prosodic Licensing requires the incorporation of unsyllabified melodies into higher prosodic structure; syllabification conditions determine the particular insertion site; and contrasting epenthesis strategies are predicted by general prosodic principles of directionality and maximality.

0. Introduction

Taking up earlier proposals (e.g., Selkirk 1981, 1982; McCarthy 1979a; Halle and Vergnaud 1978; Broselow 1980, 1982; Lapointe and Feinstein 1982; Itô 1986), this paper outlines and motivates a theory in which epenthesis is treated as a prosodic phenomenon and accounted for directly by syllabification. We will contrast this with a theory in which epenthesis is formulated as skeletal slot insertion rules like those given in (1), where prime notation indicates unsyllabified status.

(1) *Skeletal Epenthesis Rules*:[1]
  a. $\emptyset \rightarrow V$ / $C'\_$
  b. $\emptyset \rightarrow V$ / $\_C'$
  c. $\emptyset \rightarrow V$ / C'_C'
  d. $\emptyset \rightarrow C$ / V_V.

In this paper we argue that it is not possible to maintain the popular type of argument (see e.g., Clements and Keyser 1983; Harris 1983; Steriade 1982; Archangeli 1984; Levin 1985) according to which insertion rules can be formulated with least redundancy on the skeleton (with the

* This is a substantially revised version of portions of Itô (1986). I hope to have made clear in the text my debt to earlier work as well as to the suggestions by John McCarthy, Armin Mester, and Alan Prince. Many of their ideas were incorporated into this article both directly and indirectly. Thanks also to Mark Feinstein and Lisa Selkirk for valuable discussions, and to Mike Hammond, Mike Kenstowicz, Paul Kiparsky, Juliette Levin, John Moore, Doug Pulleyblank, Moira Yip, and two *NLLT* reviewers for helpful comments. Earlier versions have been presented in talks given at Cornell University, UC/Santa Cruz, and Stanford University. This research was supported in part by faculty research grants funded by the University of California at Santa Cruz.

[1] The representational issue of CV versus X is found in Levin (1985). I will use CV-notation except in cases when the distinction between X and CV is crucial.

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melody supplied by later default rules). It will be shown that the SKELETAL RULE THEORY of epenthesis in fact leads to many undesirable redundancies which have no place in an adequate theory of phonology. Coupled with several independently motivated parameters, the PROSODIC THEORY of epenthesis defended here does not encounter these problems: By eliminating skeletal rules like those in (1), our approach is able to offer a more constrained theory in which all diacritic use of 'strayness' or 'unsyllabified status' is disallowed, and the close connection between epenthesis facts and the phonotactics of the language follows straightforwardly from the theory without stipulation.

After outlining the theoretical framework in Section 1, Section 2 argues that the Prosodic Theory predicts the correct typology of epenthesis whereas the Skeletal Rule Theory needs to impose further conditions to prevent nonexistent types of rules from arising. In Section 3 contrasting epenthesis strategies will be shown to be the result of general principles of DIRECTIONALITY and MAXIMALITY in prosodic constituent construction. Section 4 discusses further theoretical implications.

1. THEORETICAL FRAMEWORK

Any approach to epenthesis processes as they relate to syllabification must make sense of the fact that properties of syllable structure fall out in large measure from general prosodic principles. After all, the syllable is a prosodic constituent, and it is important to distinguish general principles of prosody from principles specific to syllable theory. Recent studies have also revealed the importance of subsyllabic prosodic constituents (in particular, moraic structure) in various subdomains of phonology and morphology (Hyman 1985; McCarthy and Prince 1986, 1987; Hayes 1988), and it is therefore appropriate to consider the implications of this emerging moraic hypothesis with respect to our analysis of epenthesis phenomena. Thus in laying out our theoretical framework three subtheories need to be identified: (1) the theory of prosodic structure in general, (2) the theory of syllable structure, and (3) the theory of subsyllabic (in particular, moraic) structure. Each of these are taken up in the sections below.

1.1. *Prosodic Principles and Parameters*

Prosodic Theory assumes the following principles and parameters:

(2)a. Maximality

b. Directionality
c. Prosodic Licensing
d. Extraprosodicity.

These assumptions are most explicitly stated in Prince (1985) but are generally assumed, at least implicitly, in most work in Prosodic Theory (see also Kiparsky 1979; Selkirk 1980, 1981; McCarthy 1979b, 1981; Hayes 1980, 1982; Prince 1983; Itô 1986 and references cited there).

The Maximality principle holds that "units are of maximal size, within the other constraints on their form (Prince 1985)". Maximality is invariably assumed in metrical foot construction, so that, for example, "construct a disyllabic foot" is taken to mean "disyllabic if conditions permit; otherwise monosyllabic" (Hayes 1987). A moment's reflection shows that things could not be otherwise. If the principle called for minimal structures instead, larger structures would simply never surface, and we would never know of their existence.[2] The same arguments hold for syllable structure assignment: consider the wellknown difference between the monosyllabic **film** and the disyllabic **prism**, where the latter contains a syllabic nasal. Sonority constraints allow incorporation of [*m*] into the syllable after [*l*] but not after [*z*]. Such explanations would not be valid without the tacit assumption that syllable structure is always assigned maximally up to wellformedness. In Section 3, we will see further syllable-related effects of this maximization principle.

The Directionality parameter is uncontroversial in stress theory, root-and-pattern morphology, and reduplication. As a well-established parameter available in prosodic phonology, we indeed expect directionality to play a role in syllable theory as well. Although a single consonantal onset is universally preferred (Kuryłowicz 1948; cf. also Steriade 1982; Clements and Keyser 1983), a certain amount of indeterminacy arises in the syllabic parsing of intervocalic consonants in languages with complex onsets and complex codas. In such cases, a biconsonantal sequence can in principle be parsed either as a complex onset or as coda + simple onset. Although the former case (onset maximization in e.g., English, Spanish) has attracted more attention in the literature (Hooper 1972; Kahn 1976; Lowenstamm 1981, etc.), the latter possibility (coda formation over onset maximization) is also observed, for example in Klamath (Steriade 1982) and Homeric Greek (Alan Prince, private communication). Such differences have previously been ac-

[2] Other scenarios, allowing various mixtures of maximal and minimal expansions, are certainly imaginable, but seem to lack empirical support.

counted for through extrinsic ordering of the Onset rule and Coda rule. The ordering: Onset rule > Coda rule yields the complex onset, while the opposite ordering yields coda + simple onset (VCCV → V · CCV, VCCV → VC · CV). Instead of ordering, however, we can appeal to the general directionality parameter.[3] Syllable mapping then proceeds directionally from left to right or from right to left, yielding exactly the same result as ordering of Onset and Coda rule. Right-to-left syllabification results in maximizing the onset and left-to-right syllabification results in maximizing the coda, modulo the universal monoconsonantal onset.[4] The hypothesis that syllabification is governed by the directionality parameter is clearly preferable to an approach which has recourse to ordering statements, because it brings the theory of syllabification in line with other areas of prosodic phonology, where directionality is recognized as a fundamental and independently necessary principle of the theory. In Section 3, we will see that the directionality parameter plays an important role in the typology of epenthesis systems.[5]

The principle of PROSODIC LICENSING (Itô 1986) requires that all phonological units belong to higher prosodic structure: segments to syllables, syllables to metrical feet, and metrical feet to phonological words or phrases. By requiring that each segment be syllabically sanctioned, Prosodic Licensing ensures exhaustive syllabification (Selkirk 1981, 1982). We can then understand STRAY ERASURE (McCarthy 1979b, 1981; Steriade 1982, Harris 1983; Itô 1986) as an ancillary mechanism eliminating unlicensed material from the phonological string. In this paper it will also be argued that syllable-related epenthesis is another mechanism by which phonological strings are brought in conformity with Prosodic Licensing.

EXTRAPROSODICITY has always been of prime importance in metrical theory (Lieberman and Prince 1977; Hayes 1980, 1982; Prince 1983) and plays a vital rule in templatic morphology (McCarthy and Prince 1986, 1987). For syllable theory, the notion has been discussed exten-

[3] Clements (1988), however, argues that syllabification of medial consonant clusters is governed by the Syllable Contact Law (Murray and Vennemann 1983). While perhaps a valid historical account, such an approach is problematic as a synchronic explanation in that it violates the Locality Principle in the domain of Syllable Theory (Itô 1986).

[4] That is, even when coda maximization takes place (left-to-right syllabification) parsings like VC.V or VCC.V do not arise because of the universal onset principle (to be discussed below in Section 1.2.) which disallows vowel-initial syllables.

[5] The idea of directional syllabification has been previously presented with different theoretical assumptions by Kenstowicz et al. (1982), Steriade (1984), Noske (1985), ter Mors (1985) and Dell and Elmedlaoui (1986).

sively in Clements and Keyser (1983), Steriade (1982), Harris (1983), Kiparsky (1984), Itô (1986) among many others. Cairene Arabic (McCarthy 1979a) provides a simple illustration, where superheavy syllables CVCC and CVVC are allowed only word-finally: If the final segment of a prosodic domain can be ruled extrametrical it is not necessary to allow for special syllable-types occuring only at word-edges, since all syllables (whether word-internal or at word-edge) conform to the syllable template CVX. A similar case is found in the Austronesian language Ponopean and discussed in Section 1.2.3.

1.2. *Syllable Theory*

Given the general principles of prosody, let us now proceed to the specifics of syllable structure: Syllable templates, sonority theory, the onset principle, and the coda filter. Syllable templates and sonority theory characterize syllable-internal wellformedness, while the onset principle and the coda filter also have transsyllabic consequences.

1.2.1. *Syllable Templates and Sonority Theory*

We will take the position that syllabification is based on templates and wellformedness conditions (McCarthy 1979a; Selkirk 1982; Itô 1986) rather than on specific syllable-building rules (Steriade 1982; Levin 1985).[6] Syllable templates can be defined by a sequence of CV-skeletal units (Clements and Keyser 1983), by structural nodes such as onset, nucleus, rhyme, coda (Selkirk 1982; Harris 1983), by X-bar structures (Levin 1985), or by moraic structures (Hyman 1985; McCarthy and Prince 1986, 1987; Hayes 1988).

Numerous proposals have been made concerning the role of sonority in syllable structure (Vennemann 1972; Hooper 1976; Kiparsky 1979; Steriade 1982; Selkirk 1984; see Hooper 1976 for a review of earlier proposals by de Saussure, Grammont, Jespersen) and all researchers agree that syllables generally conform to some principle of SONORITY SEQUENCING:

> 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. (Selkirk 1984, p. 116)

The exact implementation of this generalization in syllable theory,

[6] For explicit arguments against a rule-based approach to syllabification, see Itô (1986).

however, is still a matter of debate (see Clements, 1988, for important recent results in this regard).

1.2.2. *The Onset Principle and the Coda Filter*

While syllable templates and sonority theory characterize syllable-internal structure, the syllabic division of a phonological string of segments seems to require transsyllabic information.[7] As argued in Section 1.1, the setting of the directionality parameter can account for the maximization of either the onset or the coda. However, other onset and coda properties do not fall out of the directionality parameter and are therefore specific to syllable theory.

Let us first consider the ONSET PRINCIPLE. Typological studies have established a number of basic generalizations, including the following: All languages have syllables with onsets. Many languages require all syllables to have onsets in surface representation. In contrast, no language requires all syllables to have codas. The earlier view of universal onset maximization (Vennemann 1972; Hooper 1976; Kahn 1976; Lowenstamm 1981) has turned out to be problematic in two respects: First, in many languages (e.g., Klamath) intervocalic consonantal sequences are not necessarily tautosyllabic even when the particular sequence is otherwise a valid complex onset (Steriade 1982; Levin 1985). Second, even in languages which respect onset maximization, syllabification across word-boundaries follows different principles (Harris 1983). This does not mean, however, that nothing remains of the idea of onset preference. Underlying (or equivalently, first cycle) syllable parsing always makes a single intervocalic consonant into an onset (i.e., VCV → V.CV, *VC.V). The parsing of longer consonantal sequences is partially language-dependent, as explained above, but it is invariably true that the following syllable receives at least a monoconsonantal onset. That is, the sequence VCCV can be parsed either as V.CCV or VC.CV, but never as *VCC.V. Syllabification across word boundaries follows a similar pattern. Harris (1983) shows that in Spanish only vowel-initial words attract the final coda of the preceding word by resyllabification (i.e., VC#V → V.C#V and VCC#V → VC.C#V, but never VCC#V ↛ V.CC#V nor VC#CV ↛ V.C#CV). What this shows is that the universal aspect of syllable parsing is not onset maximization but onset satisfaction.

[7] See, however, Hooper (1976), Murray and Vennemann (1983) and Clements (1988) for uses of sonority in transsyllabic contexts (Syllable Contact Law).

In a rule-oriented approach to syllabification (rather than the template approach adopted here), Steriade (1982) proposes that syllables of the form [CV] (called 'core syllables') are created by the UNIVERSAL CORE SYLLABLE RULE which always applies first in a cycle and may reapply across word boundaries. This clearly reflects the important insight that a monoconsonantal onset + vowel has special syllabification status. However, the status as a universal rule entails neither that it should apply first (in fact, the opposite might be expected) nor that it should be able to reapply across word boundaries.

In the theory developed here, I propose that the Onset Principle (3) serves as a guiding principle for syllabification throughout the derivation so that onsetless syllables are avoided whenever possible.[8]

(3) *Onset Principle*:
Avoid $_{\sigma}[$v

There are of course languages in which surface onsetless syllables are allowed when no onset candidate is available (e.g. Japanese, Diola Fogny, Ponapean and English), just as there are languages for which the onset requirement is absolute (e.g., Temiar, Axininca Campa, Arabic). As suggested by Armin Mester (private communication), these differences can be considered to be reflections of a parameter setting for the Onset Principle where the values are 'relative' and 'absolute'. In other words, many languages strengthen the Onset Principle "Avoid onsetless syllables" to the STRICT ONSET PRINCIPLE "Onsetless syllables are impossible".

Turning now to those properties of the coda which cannot be explained by melodic sonority constraints, we note that in Japanese (which disallows both complex onsets and complex codas) the words in (4a) are phonologically well-formed but those in (4b) are not.

(4)a.	kap.pa	'a legendary being'	b.	*kap.ta
	tom.bo	'dragonfly'		*tog.ba
	gak.koo	'school'		*pa.kap
	kaŋ.gae	'thought'		
	kit.te	'stamp'		

[8] The Onset Principle as given in (3) has several implications. For example it does not allow analyses which posit resyllabification into coda position as proposed in e.g., Selkirk (1982), Borowsky (1984, 1986) and Myers (1987) to account for ambisyllabicity effects. Alan Prince suggests that to keep the 'resyllabification into coda analysis' it might be possible to relativize the Onset Principle to the foot level, and say that onsets are obligatory 'foot-initially'. For other possible approaches to the representation of ambisyllabicity, see Clements and Keyser (1983), van der Hulst and Smith (1982) and Borowsky, Itô and Mester (1984).

This is an instantiation of a requirement found in many languages, restricting codas to the first segement of a geminate or a consonant homorganic to the onset of the next syllable (Steriade 1982; Itô 1986). As shown in Itô (1986), such a condition is optimally expressed as a nonlinear filter referring to the syllable final position and the melody:

(5) *Coda Filter*

```
*      C ]σ
       |
       |
    [PLACE].
```

The Coda Filter (5) rules out syllables with final consonants. This may seem overly restrictive since we want to allow the first part of a geminate or homorganic cluster to close the preceding syllable. The solution lies in the doubly place-linked nature of geminates and homorganic clusters in a nonlinear representation, as shown in (6).[9]

(6)

```
                                            [+nas]
                                               |
skeleton:      C  V  C     C  V          C  V  C     C  V
               |  |   \   /   |          |  |   \   /   |
melody tier:   k  i     t     e          t  o     b     o
               kitte 'stamp'             tombo 'dragon fly'
```

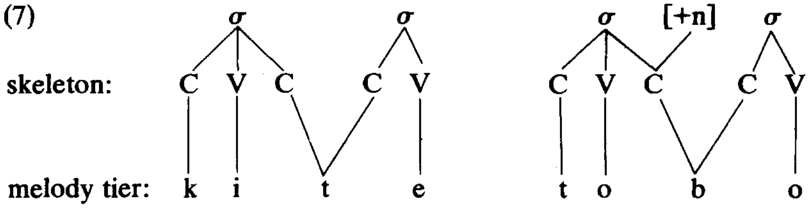
The condition in (5) allows exactly these doubly linked cases, once we adopt the LINKING CONSTRAINT of Hayes (1986) which interprets association lines in structural descriptions as exhaustive.[10] Geminates and homorganic clusters are doubly linked and hence immune from a Coda Filter like (5), which mentions a single association line. It follows that an admissible syllable-final consonant will always be place-linked to a fol-

[9] The representations given in (6) minimally reflect the crucial part of the melodic structure, namely, that the place features are doubly-linked. For visual simplicity, [+nasal] is linked to the skeleton to express the fact that the first part of the homorganic cluster is a nasal. For more recent developments in melody-internal structure, see Clements (1985), Mester (1986), Sagey (1986), Schein and Steriade (1986) and McCarthy (1988).

[10] There are several proposals in the literature on how to formally characterize Geminate Inalterability: Steriade (1982), Schein and Steriade (1986). I have adopted Hayes' (1986) Linking Constraint because it most straightforwardly applies to filters and conditions. It is, however, possible to interpret the other accounts of Geminate Inalterability in the appropriate way.

lowing consonant, and the forms in (6) can be properly syllabified as shown below.[11]

(7)



The coda filter can be found in Japanese, Ponapean, Lardil (Wilkinson 1988), Diola Fogny (Steriade 1982), and Southern Paiute, and variations of the coda filter are encountered in Finnish, Italian (Prince 1984; Itô 1986), and English (Borowsky 1986).[12]

An important characteristic of the theory of syllable structure presented in this section is that even the Onset Principle and the Coda Filter which have transsyllabic consequences have been stated as syllable-internal conditions, thereby maintaining locality.[13]

1.2.3. *Predictions and Exemplification*

The parameters of prosodic theory and of syllable theory are cross-classificatory, and their settings can be chosen independently. Once set for a given language, syllabification itself can be considered a simple mapping of the syllable template to the phonological string in conformity with the parameter settings.

Combining extrametricality with the coda filter yields an interesting prediction, which is in fact borne out. As pointed out by Steriade (1982),

[11] Extending the Linking Constraint in this way goes back to suggestions made by Alan Prince. See Itô (1986) for further discussion and motivation.

[12] Language specific syllable templates define the structural outlines of the syllable but do not contain reference to individual melodic features (see Section 1.2.1). The coda filter, on the other hand, refers to the melody and its relationship to the skeleton and supplements the syllable templates in guiding syllabification of the phonological material. The division of labor between syllable templates and such filters seems justified in that they define distinct domains: above and below the skeleton.

[13] In dealing with geminate syllabification, Christdas (1988) proposes that there is a universal coda rule which always syllabifies the first segment of a linked structure as a coda. While a universal coda rule of this kind can also cope with the phenomenon, it simply stipulates the difference between geminates and nongeminates and does not attempt to derive their special behavior from the nonlinear theory itself. This, however, seems to me to be the central issue in the theory of geminates (see Hayes (1986) and Schein and Steriade (1986) for extensive discussion). While the coda filter in (5) may eventually turn out not to be the optimal formulation, its success in eliminating one type of nonlocal transsyllabic constraint should not be overlooked.

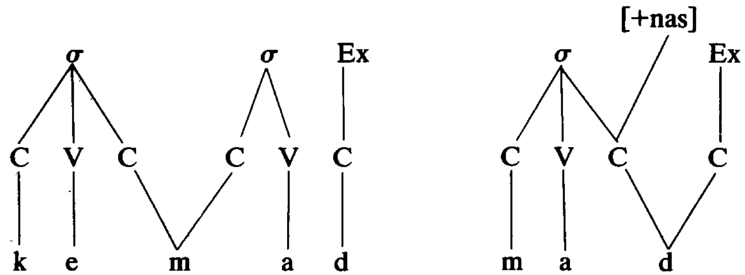
languages which only permit linked codas but invoke final extrametricality allow two consonants at word edges, because the final consonant is licensed by extrametricality and the penultimate consonant, if linked to the final extrametrical consonant, can be properly syllabified (see Steriade (1982) and Itô (1986) for further discussion related to Stray Erasure in Diola Fogny). A case in point is found in Ponapean.

Word-internal syllables in Ponapean can only be closed by the first segment of a geminate (8a) or by a consonant homorganic to the onset of the next syllable (8b). However, final syllables seem to allow two coda consonants, if they are geminate or homorganic (8c).[14]

(8)a.	a.re.wal.la	'to return to the wild'
	kem.mad	'to change into dry clothing'
	nap.pa	'Chinese cabbage' (loanword)
b.	nam.par	'trade wind season'
	naŋ.kep	'inlet'
c.	mand	'tame'
	emp	'coconut crab'
	kull	'roach'

We posit CVX as the Ponapean syllable template, coupled with final extrametricality and a coda filter like the one proposed for Japanese in (5) (Section 1.2.2). The final extrametrical consonant allows the penultimate consonant to be syllabified.

(9)



There is independent evidence in the phonology of Ponapean for the extrametrical status of final consonants. McCarthy (1983) shows that the pattern of Monosyllabic Noun Lengthening can be satisfactorily understood by assuming that final consonants are extrametrical.[15]

[14] Following Rehg and Sohl's (1979) transcription, I use [d] for voiceless dental stop and [t] for voiceless retroflex affricate. Ponapean has no voiced obstruents.

[15] Analyses invoking consonant extrametricality and minimal word size have been independently proposed by Kenstowicz (1981) for Lebanese Arabic and by Kiparsky (1984) for Icelandic Open Syllable Lengthening.

(10) *Monosyllabic Noun Lengthening*:

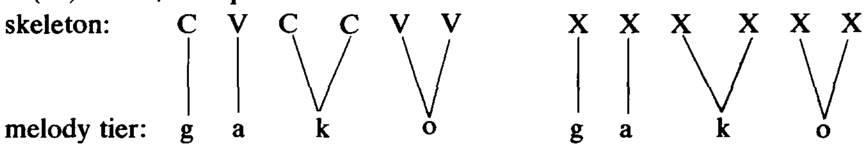
pik → piik		'sand'	(cf.pik-en)
keep → keep,	*keeep	'yam'	(cf. keep-in)
kent → kent,	*keent	'urine'	

The vowel in **pik** is lengthened to **piik**, but **keep** and **kent** do not lengthen their vowels. The underlying length distinction reveals itself in the suffixed form **pik-en** and **keep-in** (**/-n/** is the construct suffix 'of'). Since all three forms are heavy syllables even before lengthening, their different behavior is somewhat mysterious. McCarthy (1983) suggests that if final consonants are extrametrical the difference between **pi(k)** on the one hand and **kee(p)** and **ken(t)** on the other becomes apparent: In the latter two cases, even if the final consonant is not part of the syllable, the syllable still contains two moras. Monosyllabic Lengthening is then understood as adding a mora in order to satisfy the bimoraic word template.[16]

1.3. *Implications for the Moraic Hypothesis*

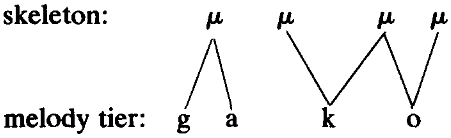
Under the Moraic Hypothesis recently proposed by Hyman (1985) and McCarthy and Prince (1986) the units of the prosodic skeleton are identified with the mora (μ) and not with the underspecified segmental units, such as C's, V's, or X's (McCarthy 1979b, 1981; Clements and Keyser 1983; Levin 1985, etc.). The Japanese word **gakkoo** 'school' containing a geminate consonant and a long vowel is given below in a CV/X representation (11a) and in a moraic representation (11b).

(11)a. *CV/X Representation*



[16] McCarthy (1983) furthermore shows that the choice of reduplicative affix depends on the mora count of the base, again excluding the final consonant (see also McCarthy and Prince 1986). Other proposals involving minimal word size constraints are Prince (1980) for Estonian, Broselow (1982) for Mohawk, Poser (1984) for Japanese, and Wilkinson (1988) for Lardil. A similar template for Axininca Campa will be discussed in Section 2.2.

b. *Moraic Representation*[17]



In support of the moraic representation, Hyman (1985) advances various phonological arguments, while McCarthy and Prince (1986) argue persuasively from templatic morphology that only units of prosody (i.e., feet, syllables, and moras but not CV-segments) define a templatic morpheme. Hayes (1988) shows that the typology of compensatory lengthening processes is correctly predicted only by the moraic theory. While these arguments are compelling, previous insightful CV-analyses of various phonological processes are not always translatable into a theory with only the moraic skeleton. In particular, skeletal rules such as those in (1) may seem to present problems, since the units manipulated are neither melodies nor moras. A straightforward translation would seem to require reference to both the moraic and the melody tier in order to state such rules (see Hyman 1985 for epenthesis rules of this kind). It will be argued in Section 3 that the Prosodic Theory of epenthesis defended in this paper not only avoids such problems but may actually have other positive implications for the emerging moraic theory of the skeleton.

2. Predicting Epenthesis Sites

This section considers regular syllabically motivated epenthesis phenomena from two languages, Ponapean (Section 2.1) and Axininca Campa (Section 2.2). It will be shown that the prosodic framework outlined above correctly predicts the epenthesis sites for these languages. While the Skeletal Rule Theory can provide an analysis for the same set of facts, it does so in an arbitrary fashion simply by stipulating certain rules and not others: Unattested types of epenthesis are predicted in the Skeletal Rule Theory because skeletal rules are intrinsically unrelated to syllable structure. A further consequence of our proposal is that it avoids

[17] McCarthy and Prince (1987) propose another type of moraic representation whereby the nonmoraic onset consonants are daughters of the syllable node, thus maintaining that the normal numbers of segments associated to a mora is one. As pointed out by a reviewer, this allows rules that are said to apply to rhyme-internal segments to be restated as applying only to segments dominated by μ (see also Steriade 1988). We will take up some of the related issues in Section 3.

the problematic appeal to the No-Crossing constraint for blocking epenthesis in linked structures.

2.1. *Ponapean Vowel Insertion*

As discussed in Section 1.2.3, Ponapean syllables can be characterized as CVX with a coda filter and final extrametricality. The relevant question here is what happens when certain segments do not fit the syllable template and cannot be syllabified. According to Rehg and Sohl (1981), biconsonantal clusters are split by Insert Vowels ($C_1C_2 \rightarrow C_1VC_2$), whose melodic character is either a copy of the initial vowel of the following morpheme (12) or an epenthetic high vowel (13).[18]

(12)a.	/ak-dei/	→ ak**e**dei	'a throwing contest'
b.	/ak-p^{w}uŋ/	→ ak**u**p^{w}uŋ	'petty'
c.	/ak-tantat/	→ ak**a**tantat	'to abhor'
(13)a.	/kitik-men/	→ kitik**i**men	'rat, indef.'
b.	/p^{w}iik-men/	→ p^{w}iik**i**men	'pig, indef.'

Adaptations of loanwords from English:

(13)c.	s**u**kuul	from 'school'
d.	s**i**damp	from 'stamp'
e.	sil**i**k	from 'silk'.

Thus in (13a) an epenthetic **i** breaks up the cluster **km**. The epenthetic vowel is a high front vowel, except when it is in a [+back] environment as in (13c) where it surfaces as a high back vowel.

The choice of the melodic content, that is, copy vowel versus epenthetic high vowel, is governed by morphological factors (see Rehg and Sohl 1981, pp. 91–95), and we suspect that the full analysis calls for a level-ordered solution, invoking lexical versus postlexical distinctions. We will not pursue this problem, since our present interest in the Ponapean epenthesis facts lies not in the melodic nature of the inserted vowel but in its insertion site, which, as we will see below, follows from the syllable theory advocated here.

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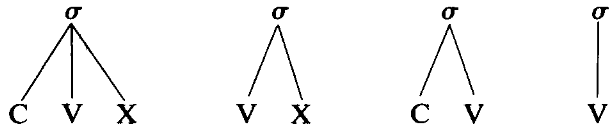
[18] I would like to thank Juliette Levin for discussion about epenthetic vowels in Micronesian (see also Levin 1988).

2.1.1. *A Prosodic Analysis*

The four possible syllable types in Ponapean are illustrated in (14).

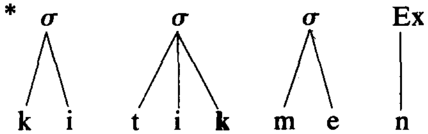
(14)a. b. c. d.



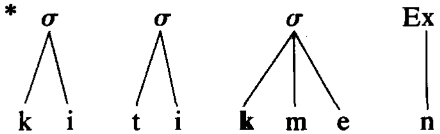
The Coda Filter requires that if X = C in (14a) and (14b) then it must be place-linked to the following consonant (cf. Section 1.2.3).

Consider the form **/kitik-men/** (with the stem **/kitik/** 'rat' and the indefinite enclitic for animate beings **/-men/**). Of interest is the stem-final **k**: Since **k** is not place-linked to the following consonant, its syllabification as a coda (15a) is prohibited. It of course cannot be an onset to the following syllable as in (15b) because Ponapean syllables only allow one onset consonant.[19]

(15)a.

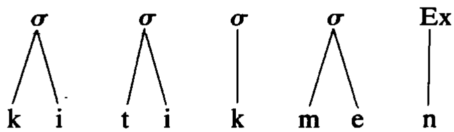


b.



Instead of resorting to a phonological rule, we follow earlier proposals (e.g., Halle and Vergnaud 1978; Selkirk 1981; Lapointe and Feinstein 1982) and let syllabification do all the work: A syllable node is assigned to the consonant **k** which otherwise does not fit into either the preceding or the following syllable.

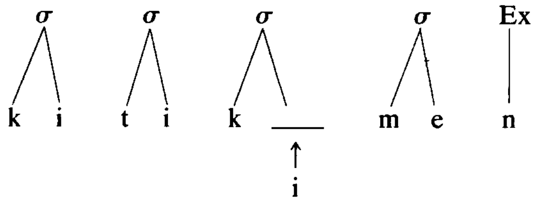
(16)



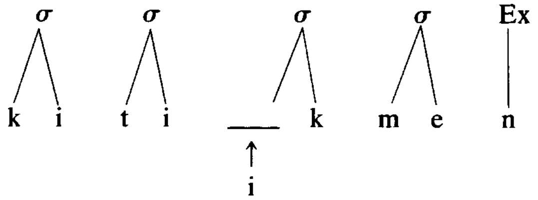
[19] The representation I have adopted here is the one minimally necessary to illustrate the point under discussion, the subsyllabic structure does not bear on the issue. In Section 3 we will explore the consequences of the moraic representation for Arabic epenthesis cases.

Since a nuclear vowel is an obligatory element of the syllable, it is inserted by default rules. Now there are two possible insertion sites: after the consonant (17a) or before the consonant (17b).

(17)a.



b.



It is clear that the only viable option is that depicted in (17a), with postconsonantal insertion: Given the syllable structure conditions of Ponapean, the vowel simply cannot be inserted before the consonant because this would again result in an illicit type of syllable $_\sigma$[**ik**]. The Coda condition which disallowed the consonant from being incorporated into the syllable in the first place would again prohibit such a syllable from being formed.

It seems reasonable to assume that languages choose whether or not assignment of such degenerate syllables is allowed. For example, languages like Diola Fogny and Lardil (in similar situations) delete the stray consonants by Stray Erasure (see Steriade 1982; Itô 1986; Wilkinson 1988). It should therefore be possible for languages to differ along these lines on a parametric basis. Prosodic licensing requires that there be no unlicensed stray segments, and it is up to the language to decide whether to license them by syllabification (as in Ponapean and Japanese) or to eliminate them by Stray Erasure (as in Diola Fogny and Lardil). From the results of earlier studies (e.g., Broselow 1982; Kenstowicz 1987), it appears that we also need to recognize parametric variation in designating the point in the grammar where degenerate syllables are allowed to be formed. If allowed from the very beginning, degenerate syllables would arise at the same time as other normal syllables and there should be no distinction between them. On the other hand, if allowed only later (at a later lexical level or in the postlexical phonology), degenerate syllables are expected to behave differently from normal syllables. In particular, we expect them not to count for stress. Further investigation into these parameter settings is surely called for, but it is beyond the scope of this paper and will have to be left for future exploration.

An important consequence of this analysis emerges in cases where a biconsonantal cluster is not split by epenthesis, namely, when we are dealing with a linked structure: a geminate or a homorganic cluster (discussed in Section 1.2.3). Relevant examples from (8) are repeated below in (18).

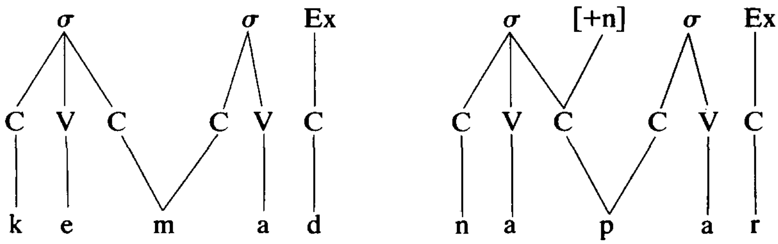
(18)	kem.mad	'to change into dry clothing'
	nap.pa	'Chinese cabbage'
	nam.par	'trade wind season'.

The Coda Filter (19) has no effect on coda segments which are doubly linked and therefore all the consonants in (18) can be properly syllabified as shown in (20).

(19) *Coda Filter* [=(5)]

$$* \quad \begin{array}{c} x\,]_{\sigma} \\ | \\ [\text{PLACE}] \end{array}$$

(20)

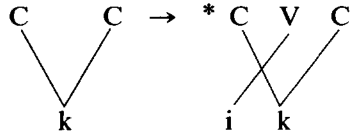


Since there are no stray consonants, no degenerate syllables are formed – hence no reason for epenthesis.

Notice that we did not invoke the often-repeated argument in CV-phonology, which holds that geminates cannot be split by epenthesis because of the No-Crossing Constraint (Goldsmith 1976).[20] If geminates are represented by double linking, so the argument goes, it is impossible to split them without violating the universal constraint against crossing

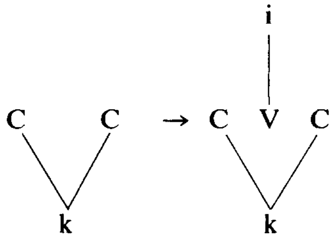
[20] See Sagey (1988) and Hammond (1988) for recent discussion on the formal interpretation of this principle.

association lines, because epenthesis must insert both a V position and the melody, as illustrated in (21).

(21) 

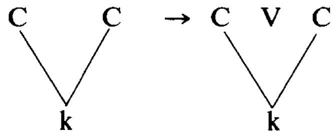
Several questions regarding this account of Geminate Integrity (terminology due Hayes 1986, p. 326) have been raised in the course of more recent developments in phonology, already indicating that No-Crossing is perhaps not a fully viable explanation.

First, with assumptions about nonconcatenative morphology (McCarthy 1979b, 1981) where vowels and consonants can reside on different tiers, association lines never cross in spite of epenthesis:

(22) 

TIER CONFLATION (Younes 1983; McCarthy 1986) becomes an important issue, then, in order to explain the apparent surface adherence to geminate integrity even in such systems (McCarthy 1986).

Secondly, Levin (1985) points out that even where vowels and consonants are on the same tier, the assumptions of Underspecification Theory (Kiparsky 1982; Archangeli 1984, etc.) dictate that the least redundant account of epenthesis within the skeletal theory is one where a pure skeletal slot (V or X) is inserted without melody (supplied by later default rules). Again the mere insertion of a skeletal slot cannot be blocked by the No-Crossing Constraint.

(23) 

One advantage of the prosodic account advocated here is that it does not rely on this problematic recourse to the No-Crossing Principle to block epenthesis. Epenthesis does not occur, since such doubly linked structures can be syllabified fully (see (20) above), and there is no reason to build a degenerate syllable. Double linking still plays a role in our explanation for why epenthesis does not occur – only linked consonants can be syllabified as codas. In the terminology of Hayes (1986), the Linking Condition not only explains 'geminate inalterability' but also 'geminate integrity'. Epenthesis fails to take place not because there is a principle blocking it but because there is no prosodic reason to expect its occurrence in the first place.[21]

2.1.2. *A Skeletal Analysis – A Comparison*

Let us then compare this analysis with a skeletal rule approach. The CV-rule needed for Ponapean epenthesis is given in (24), where V is inserted after a stray C.

(24) $\emptyset \rightarrow V \;/\; C'\_\_$

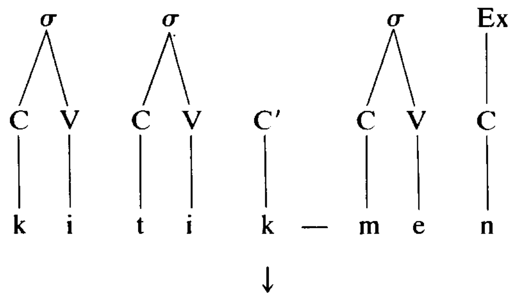
The derivation of **kitikimen** is given in (25). The medial consonant is left stray after syllabification, and rule (24) inserts a V-slot to the right of the stray consonant.

---

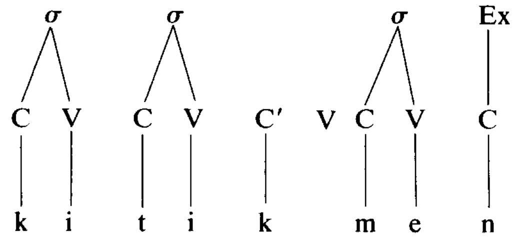
[21] It is not clear whether it is possible to maintain that line-crossing need never be invoked for epenthesis blocking but should always follow from syllabification conditions. One apparent problem is Turkish epenthesis and degemination (Clements and Keyser 1983). Word-finally, CC clusters are split by epenthesis (**devr** → **devir** 'transfer') but geminates are degeminated (**hakk** → **hak** 'right') because of failure of epenthesis (due to line-crossing), and the final unsyllabified slot is deleted (by Stray Erasure). A similar case (where a cluster consisting of homorganic nasal plus consonant also plays a role) is found in Tangale (Kidda 1985): A rule of elision can create triconsonantal clusters that are broken by epenthetic **u** in C___CC but epenthesis is blocked when the first two consonants share place of articulation: e.g., **bagda** 'pigeon', **bagud-no** 'my pigeon'; but **landa** 'dress', **lan-no** (***lanud-no**) 'my dress', **molle** 'brother', **mol-no** (***molul-no**) 'my brother'.

At first glance, there does not seem to be a simple purely syllable-based solution to these facts. One possibility for the Turkish case does suggest itself in a moraic theory (McCarthy and Prince 1987; Hayes 1988), where the underlying distinction between geminate and nongeminate consonants is expressed by linking vs. nonlinking of the consonantal melody to a mora. Double linking arises word-internally under the pressure of Onset Satisfaction (see Section 1.2.2 above), but obviously not finally. The word-final mora is simply syllabified without a competing following onset, giving the appearance of degemination. In order to distinguish Turkish from cases where degemination does not take place, as in Palestinian Arabic (Abu-Salim 1980), it might be possible to appeal to the admissibility of superheavy syllables in such languages. Further problems remain, however, if all underlying prosodic distinctions must be preserved, as proposed in McCarthy and Prince (1987). I leave the question open for future research.

(25)

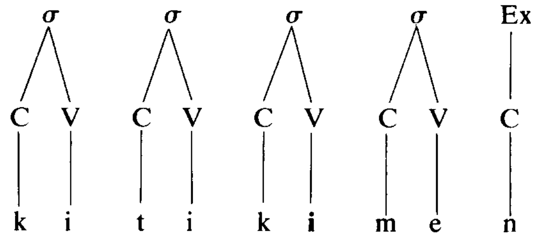


Rule (24)



Later syllabification builds the medial syllable and default melody insertion inserts [i].

(26)



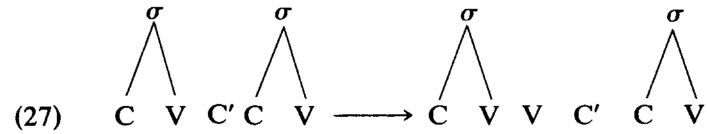
This account, although consistent with the facts, is problematic in that the environment of the skeletal rule in (24) clearly duplicates the syllable structure conditions of Ponapean, which require medial (singly-linked) consonants to be onsets (and not codas). The skeletal epenthesis rule in (24) must stipulate that a V-slot is supplied to the *right* of a stray consonant C′, where it can eventually become an onset, thereby pre-establishing syllabifiability before syllabification and thus encoding once again the restrictions of Ponapean syllable structure.

Since skeletal rules are not intrinsically related to the syllabification mechanism itself, we can imagine a language with the same syllabification parameters as Ponapean but having a different skeletal rule such as that given in (27), where a V-slot is inserted to the *left* of the stray consonant.

(27) $\emptyset \rightarrow V \ / \ \_\_ C'$

Consider the derivation with this hypothetical skeletal rule:

(28)a. b.



The stray consonant still cannot be syllabified with the newly inserted vowel: just as C′ in (28a) cannot be syllabified as a coda to the initial syllable, neither can C′ in (28b) be syllabified as the onset of the inserted vowel. It is clear that such a skeletal rule would never be posited in a language with the syllabification conditions of Ponapean. This gap, however, is unexplained within the skeletal rule approach itself, and it appears necessary to appeal to some functional notion like that of Kisserberth's (1970) phonological *conspiracy*. The arguments against the purely linear approach therefore carry over to the skeletal rule approach insofar as it crucially uses operations defined on linear sequences of skeletal slots.

No duplication of this kind is found in the prosodic theory of epenthesis advocated here because we can directly appeal to the independently necessary syllable conditions, which already determine the position of the nuclear vowel with respect to the relevant consonant.

2.2. *Axininca Onset and Nucleus Insertion*

The argument against positing skeletal rules for epenthesis given above is that the environment specification of the skeletal rule duplicates independently necessary syllable structure conditions. This redundancy argument would be invalidated if specimens of skeletal rules could be exhibited that are genuinely independent of syllable structure, such that a syllabically unattainable generalization finds a skeletal expression. Levin (1985) presents an interesting case in this regard. The evidence comes from Axininca Campa, an Arawakan language spoken in the Amazon jungle, as described in Payne (1981).

In Axininca, the vowel **a** is inserted between consonant clusters and the consonant **t** between two vowels. In the first example in (29), **a** appears between **m** and **p**, **t** between **o** and **i**.

(29) *a-epenthesis*

	/noN-kim-piro-i/ →	noŋkimapiroti	'I will really hear'
	/noN-citok-piro-i/→	noncitokapiroti	'I will really hit'
	/noN-pok-piro-i/ →	nompokapiroti	'I will really come'
cf.	/noN-pisi-piro-i/ →	nompisipiroti	'I will really sweep'
	/noN-piyo-piro-i/ →	nompiyopiroti	'I will really heap'

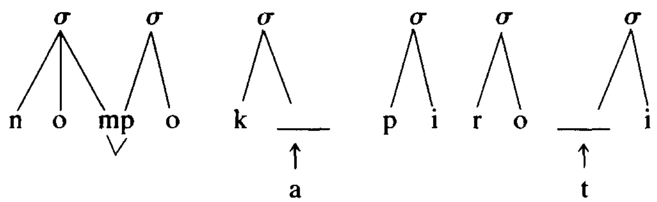
(30) *t-epenthesis*:

	/noN-pisi-i/ →	nompisiti	'I will sweep'
	/noN-piyo-i/→	nompiyoti	'I will heap'
cf.	/noN-kim-i/ →	noŋkimi	'I will hear'
	/noN-pok-i/ →	nompoki	'I will come'

Payne (1981) notes that **a** and **t** are the unmarked segments of the language and that epenthesis is a very general process breaking vowel hiatus and resolving consonant clustering. The capital **N** in (29) is the nasal archisegment posited by Payne which always assimilates to the following consonant. Assimilated clusters are not broken up by an epenthetic vowel. The analysis of Axininca syllable structure is the same as that of Ponapean, with a CVX syllable template as well as a Coda Filter disallowing singly linked consonantal place specifications. Different from Ponapean, however, is the choice of the Strict Onset Principle which disallows (and not only disfavors) onsetless syllables (at least during the lexical derivation). Therefore, every syllable contains not only the universally obligatory nucleus but also an onset.[22]

The syllabification of **nompokapiroti** 'I will really come' is given in (31).

(31)



nompokapiroti 'I will really come'

[22] Axininca permits onsetless syllables in word-initial position. This does not follow straightforwardly from the theory presented in Section 1, but it seems that some version of initial extrametricality would be appropriate to account for this fact. For example, we could assume that the domain in which all syllables must satisfy the syllable structure conditions starts from the head (i.e., the vowel) of the initial syllable. This requires word-medial syllables to have onsets.

The consonant **m** can be syllabified as a coda because it is place-linked to the onset consonant **p** (indicated in diagram (31) by ╲╱).

The consonant **k** cannot be incorporated into the syllable with [**po**], not being place-linked to the following onset. It therefore receives an independent syllable, and the default vowel **a** is inserted. The final syllable [**i**] receives the default consonant **t** as onset.

This analysis of Axininca epenthesis relies solely on the independently needed syllable structure conditions: The proper settings of onset parameter and coda parameter directly entail both vowel and consonant epenthesis in the appropriate contexts.

In presenting evidence for the X-skeleton, Levin (1985) argues that Axininca provides a strong argument for a purely skeletal rule using the X-notation. In the skeletal rule approach to epenthesis, references to syllable structure or to a CV-notation makes it impossible to collapse V-epenthesis and C-epenthesis into a single rule as shown in (32) but an X-skeletal rule can be simply stated as in (33).

(32) *CV-skeletal epenthesis*:
  a. $\emptyset \rightarrow C \;/\; V\_\_\_V$
  b. $\emptyset \rightarrow V \;/\; C\_\_\_C$

(33) *X-skeletal epenthesis* (Levin 1985, p. 330):
  $\emptyset \rightarrow X \;/\; X\_\_\_X$
  (morphological information suppressed)

It is argued that skeletal rules are subject to the following output filters.[23]

(34)a. $*\underline{\mathbf{X}}\ \underline{\mathbf{X}}$ b. $*X'\ X'$ (Levin 1985, p. 331).

The filters ensure that a skeletal rule does *not* result in a stray consonant being inserted next to another stray consonant (i.e., $*X'X' = *C'C'$) nor a nuclear vowel being inserted next to another nuclear vowel (i.e., $*\underline{\mathbf{X}}\ \underline{\mathbf{X}} = *_\sigma[\ldots V]_\sigma[V]$ or $*_\sigma[V]_\sigma[V\ldots])$. Thus, rule (33) would only insert a V-slot between two C's and a C-slot between two V's.

It turns out that Axininca provides an interesting type of evidence in choosing between the two theories of epenthesis, namely, in accounting for the phenomenon of 'double epenthesis' (Payne 1981, p. 145):

> any time a CV-verb is preceded by word-boundary and followed by a consonant-initial suffix, there is addition of a syllable /ta/ consisting of the unmarked consonant and unmarked vowel, appearing somewhat like a 'double epenthesis'.

---

[23] The filters stated in (57) are only a portion of the formal CONDITIONS ON X-TIER TRANSFORMATIONS posited by Levin (1985). The reader should consult the original work for further motivation and justification.

Consider the root **na** 'carry' in the forms in (35).

(35)a.	/**na**-piro-aaNci/	→ **nata**pirotaanci	'to carry well'
	/**na**-wai-aaNci/	→ **nata**waitaanci	'to carry continually'
b.	/no-**na**-wai-i/	→ no**na**waiti	'I will continue to carry'
	/no-**na**-piro-i/	→ no**na**piroti	'I will carry it well'.

The examples in (35a), where the root occurs without prefixes, illustrate the double epenthesis phenomenon (**NA-piro-** · · · → **NA-TA-piro** . . .). In (35b), the root does not undergo double epenthesis because of the presence of the prefix **no-**. As Armin Mester (p.c.) points out, under the assumption that the insertion of **ta** is accomplished by two applications of the epenthesis rule, the Axininca skeletal rule (33) guided by the filters in (34) will fail to apply: The first application of insertion will necessarily create either a VV sequence (**na*a*piro-**) or a CC sequence (**na*t*piro-**), violating the output filter at this point in the derivation.

In the prosodic theory, these facts can be handled by positing a minimal bisyllabic stem template (cf. McCarthy and Prince 1986, Wilkinson 1988 for other minimal stem/word templates of this type.)

(36) $[\sigma \quad \sigma]_{\text{STEM}}$

After mapping the root /**na**/, there would still be another syllable node lacking melodic content. Following McCarthy and Prince (1986), prosodic templates are assumed to be obligatorily satisfied, in this case supplying the default vowel and consonant.

(37) [σ σ] → [σ σ]
n a → n a t a

The relevance of this 'double epenthesis phenomenon' transcends the question of the proper analysis of epenthesis, extending to the fundamental question of how syllabification is performed. This case also constitutes evidence for the template-based approach to syllabification rather than the rule-based approach, because epenthetic segmental material is inserted to satisfy a syllable template already present. A strict rule-based approach to syllabification, which is predicated on the assumption that syllable structure is a projection from the segmental level, cannot easily account for these facts. More generally, a strict 'bottom-up' or 'segment-up' view of constructing the prosodic hierarchy is inconsistent with the approach of Prosodic Morphology (McCarthy and Prince 1986).

The filters in (34) correctly rule out certain types of skeletal rules which never seem to be attested. For example, they disallow rules such as (38a), which inserts a consonant after a stray consonant, or (38b), which deletes a vowel before another consonant.

(38) *Impossible types of skeletal rules*:
a. $\emptyset \rightarrow C$ / C'___
b. $V \rightarrow \emptyset$ / ___C'

The unexpectedly limited distribution of such skeletal rules clearly calls for an explanation, and although the filters in (34) are certainly desirable as a step towards restricting the types of possible skeletal rules, their sole function is to exactly prohibit highly marked syllables from arising. The output filters simply ensure that skeletal rules always serve to improve the syllabic wellformedness of the string. Since syllable structure conditions (both universal and language specific) are independently needed in the grammar, these filters – even if expressing valid observations – lack explanatory force, and the basic generalization that skeletal rules always improve syllable well-formedness remains a stipulation.[24]

In a prosodic analysis, such filters are superfluous since the epenthesis sites are determined by the independently needed syllable conditions of the language. Epenthesis occurs where it does, not because it satisfies the structural description of an obligatory rule, but because syllable structure dictates the only possible and necessary insertion site. The prosodic theory allows us to maintain even stronger constraints on rule form, altogether disallowing reference to 'stray' or 'unsyllabified status'.[25] No rule could then be triggered by a stray segment, and it would not be possible to spread to a stray consonant, or lengthen a vowel before a stray consonant. As pointed out by Michael Kenstowicz (personal communication), the fact that the theory eliminates all such diacritic uses of strayness is clearly an advantage for this prosodic approach.

[24] One reviewer points out that the skeletal rule filters in (34) can be subsumed under an extended version of the OCP as suggested by Yip (1988). As discussed above, we are in agreement that the filters do not constitute an independent wellformedness statement, but take issue with the position that it be subsumed under any version of the OCP. Properly construed, the OCP is a principle governing **melodic** (autosegmental) structure, which involves relations of **predication** not **metrical** structure, which involves relations of **constituency**. If so, we achieve only a spurious generalization in extending the OCP to pure **positions** like the skeleton or to syllables and feet, which define **constituency** and not predication.

[25] This is presumably too strong as a condition on true suprasegmentals: Crucial reference to 'floating' tones is quite frequent in the tonal literature, see e.g., Goldsmith (1976), Pulleyblank (1983).

3. Contrasting Epenthesis Strategies

For languages with restricted syllable structure (e.g., if coda consonants are disallowed, as in Ponapean) the prosodic theory straightforwardly predicts the epenthesis site, but when the syllable conditions are more liberal, insertion may occur either before or after the stray consonant depending on the language. Such contrasts at first appear to argue for a skeletal epenthesis rule which can encode the location of the vowel insertion site in the structural description. We will show below that a prosodic theory which adheres to the principles of Directionality and Maximality not only is equipped to handle these cases effectively but also predicts the correct typology of different epenthesis strategies. Furthermore, a comparison of the prosodic and the skeletal approaches will lead to the conclusion that the two theories are not mere notational variants: the skeletal rule theory is insufficiently restrictive in that it must specify both left-to-right (or right-to-left) application as well as which side of C′ is to receive the epenthetic vowel. This section also explores some of the consequences of the Moraic Hypothesis (Hyman 1985, McCarthy and Prince 1986, 1987) with regard to epenthesis. (An analysis with somewhat different assumptions is given in Itô 1986.)

3.1. *Directional Parameter Settings for Two Arabic Dialects*

The directionality parameter provides a revealing account of the contrasting epenthesis strategies found in Cairene and Iraqi Arabic. The analysis in this section owes much to the insightful discussions and proposals in Broselow (1980, 1982) and Selkirk (1981).

In Cairene an epenthetic **i** breaks up a triconsonantal $C_1C_2C_3$ cluster between C_2 and C_3 (39a), whereas in Iraqi the cluster is split between C_1 and C_2 (39b).

(39)a. CCC → CC**i**C (Cairene)
b. CCC → C**i**CC (Iraqi)

In both dialects, however, quadriconsonantal $C_1C_2C_3C_4$ clusters are broken up between C_2 and C_3 (40).

(40) CCCC → CC**i**CC (Cairene and Iraqi)

Examples of tri- and quadriconsonantal clusters are given in (41) and (42) below.

(41) *Cairene Epenthesis*: $\emptyset \rightarrow$ i / CC___C

a. Triconsonantal Clusters:

/ʔul-t-l-u/	→ ʔult**i**lu	'I said to him'
/katab-t-l-u/	→ katabt**i**lu	'I wrote to him'
/katab-t dars/	→ katabt**i**dars	'you wrote a lesson'

b. Quadriconsonantal Clusters:

/ʔul-t-l-ha/	→ ʔult**i**lha	'I said to her'
/katab-t-l-ha/	→ katabt**i**lha	'I wrote to her'
/katab-t-l-gawaab/	→ katabt**i**lgawaab	'I wrote the letter'

(42) *Iraqi Epenthesis*: $\emptyset \rightarrow$ i / C___CC

a. Triconsonantal Clusters:

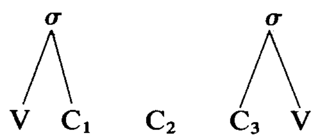
/gil-t-l-a/	→ gil**i**tla	'I said to him'
/triid ktaab/	→ triid**i**ktaab	'you want a book'
/katab-t ma-ktuub/	→ katab**i**tmaktuub	'I wrote a letter'

b. Quadriconsonantal Clusters:

/gil-t-l-ha/	→ gilt**i**lha	'I said to her'
/triid-l-ktaab/	→ triidl**i**ktaab	'you want the book'
/kitab-t-l-maktuub/	→ kitabt**i**lmaktuub	'I wrote the letter'

As is schematically illustrated in (43), after syllabification of a string containing an intervocalic triconsonantal cluster, C_1 is a coda and C_3 an onset, but C_2 cannot belong to any syllable because these Arabic dialects allow neither complex onsets nor complex codas.

(43)

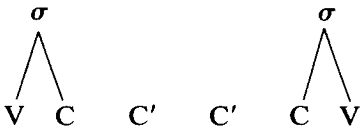


Selkirk (1981) argues compellingly that the difference between the two dialects is whether the unsyllabified consonant is taken as an onset or as a rime of a DEGENERATE SYLLABLE (i.e., a syllable lacking segmental nuclei). Thus in (44a) the stray **t** becomes an onset, whereas in (44b) it becomes a coda:

(44)a. Cairene: [ʔul] t [lu] → [ʔul] ti [lu]
b. Iraqi: [gil] t [la] → [gil] it [la]

However, the Onset/Rime parameter does not by itself predict this result for quadriconsonantal clusters.

(45)

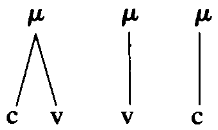


The possibility exists for both stray consonants to be analyzed as onsets (in Cairene) or as rimes (in Iraqi), wrongly resulting in double epenthesis. To avoid this indeterminacy, Selkirk (1981) invokes a principle minimizing the numbers of syllables per string (all else being equal). While Syllable Number Minimization insightfully captures the cross-linguistic pattern whereby each epenthetic vowel rescues as many consonants as possible, it is a rather powerful mechanism comparing candidate syllabification outputs and requiring global computational power. We will see below that the Onset/Rime Parameter and the Syllable Number Minimization Principle, both of which are specifically tailored to the analysis of degenerate syllables, follow from the independently needed prosodic principles of Directionality and Maximality.

As discussed in Section 1.4, the moraic hypothesis has gained some new ground in recent phonological discussions, and here I would like to present further positive consequences of adopting a moraic rather than a segmental CV-skeleton (see Zec (1988) for similar arguments regarding schwa-insertion in Bulgarian). In a Moraic Skeleton Theory it seems necessary to adopt some process of moraification parsing the melodic string into moras. Let us assume that except for geminates, where the moraic values are unpredictable and thus underlyingly marked as moraic (as argued in McCarthy and Prince 1987), moraification operates directionally and maximally as any other prosodic structure construction (see Hayes 1988 for a somewhat different view of moraification).[26]

For the Arabic dialects under consideration, moras are composed of the melodies **cv**, **c**, or **v**, as illustrated in (46), where small letters indicate melodic rather than skeletal elements.

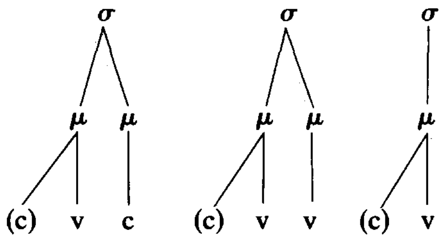
(46) $\mu \rightarrow \left\{ \begin{matrix} \text{(c) v} \\ \text{c} \end{matrix} \right\}$



[26] Notice that in a theory strictly observing underspecification of all predictable values, CV/X-skeletal theories should also maintain a skeleton-melody mapping procedure, since the skeleton is largely predictable from the melodic string.

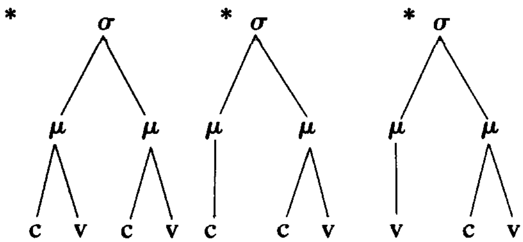
Syllables have the following structural possibilities:

(47) $\sigma \rightarrow \mu(\mu)$



The initial mora always contains the peak of the syllable, and the Sonority Principle disallows structures like (48).

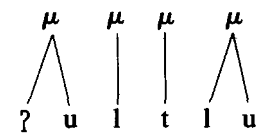
(48)

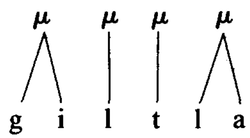


It is impossible for a $_{\mu}$[cv] to be the second mora in a syllable because sonority would inevitably rise in post-peak position.

The result of Moraification (46) (i.e., the mapping of the mora structures) for the Cairene form **?ultilu** and the Iraqi form **gilitla** 'I said to him' appears below in (49).

(49)a. *Cairene* b. *Iraqi*





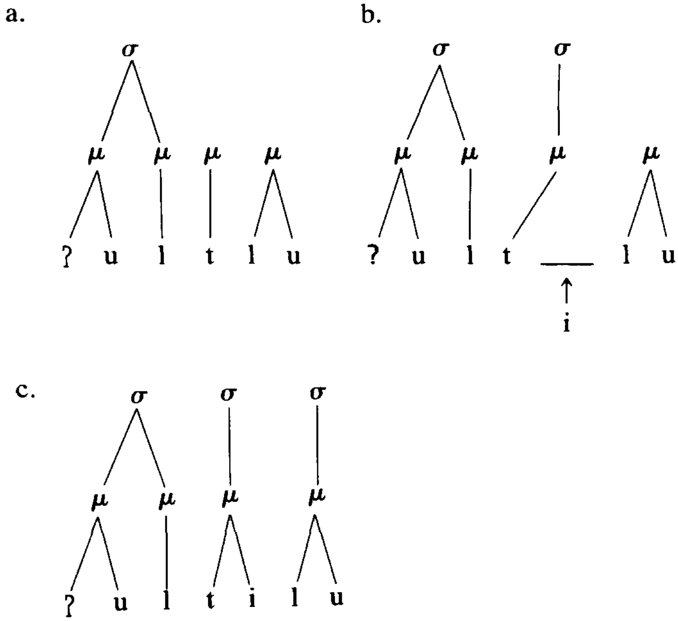
The fact that adjacent **cv**'s are incorporated into a single mora can be attributed to the general prosodic principle of Maximality.[27] Since all prosodic constituents must be maximal up to wellformedness, we expect this to be true for moraic structures as well. This explains why an

[27] A similar point is made in Hyman (1984, 1985), where it is argued that the Onset Creation Rule (Hyman 1985, p. 15), which essentially builds 'CV-moras', establishes an intrinsic connection between the weightlessness of onsets and the onset status of prevocalic consonants.

intervocalic consonant in the segmental sequence **[vcv]** is always syllabically parsed with the following vowel: If morafication has already assigned constituency to the sequence as $_\mu$**[v]**$_\mu$**[cv]**, syllabification is not able to reparse lower levels of prosodic structure.[28]

The two dialects under consideration have the same surface mora and syllable types. What is different, I will argue, is the parameter setting for the directionality of syllabification: left-to-right for Cairene, and right-to-left for Iraqi. Syllabification of the Cairene form in (49) is illustrated in (50).

(50) *Cairene* (*Left-to-Right Syllabification*)



First, the leftmost two moras **[?u]** and **[l]** (50a) are incorporated into the syllable. Syllabification then proceeds to the middle of the string in (50b). Since sonority disallows the next two moras **[t]** and **[lu]** to form a syllable (see (48)), only $_\mu$**[t]** is incorporated and a nuclear vowel (the unmarked vowel **i** or an underspecified vowel melody) is inserted. Finally at the

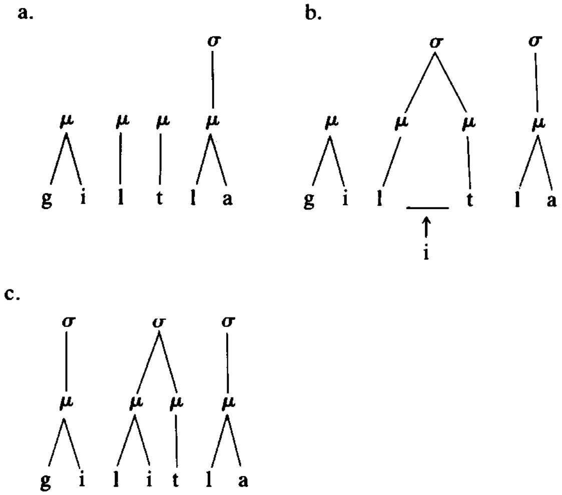
---

[28] Note that this does not mean that the Onset Principle (Section 1.2.2) can be eliminated from Syllable Theory. As pointed out by Paul Kiparsky (private communication) and one reviewer, in languages which have moras of the form $_\mu$**[cvc]** left-to-right maximal assignment should result in moraic parsings like **[cvc][v]**. In such cases, we do need to appeal to the Onset Principle or somehow ensure that moraification proceeds from right to left.

rightmost edge (50c), syllabification is completed by incorporating the final mora [**lu**].

The syllabification for Iraqi proceeds in the opposite direction:

(51) *Iraqi* (*Right-to-Left Syllabification*)



Starting from the right (51a), the first mora is syllabified forming the syllable [**1a**]. Notice that it is not possible to syllabify the last two moras [**tla**] because this would violate sonority. Proceeding to the middle of the string in (51b), two moras [**l**] and [**t**] are mapped onto the syllable and a default vocalic element is inserted into the first mora. Syllabification is completed by matching the leftmost melodies (50c). In the resulting structures, we get the desired difference in the medial syllable: a light syllable for Cairene and a heavy syllable for Iraqi.[29]

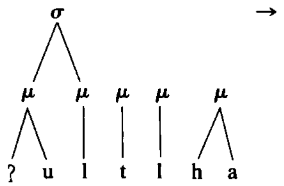
The Directionality parameter is not a mere notational variant of the Onset/Rime parameter but has empirical advantages which become apparent once we look at epenthesis in quadriconsonantal clusters. The directional analysis extends straightforwardly to these cases without necessitating a further principle of Syllable Number Minimization.

Consider the syllabification of quadriconsonantal clusters in (52) and (53).

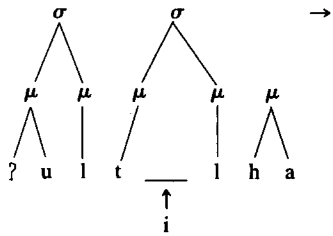
[29] The nonmoraic approach in Itô (1986) requires that left-to-right syllabification be suspended when it conflicts with the Onset Principle. It is an advantage of the moraic analysis presented here that this automatically follows from a more general prohibition against reprosodization of lower prosodic structure.

(52) *Cairene Left to Right Syllabification*:

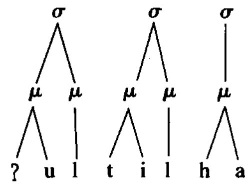
a.



b.

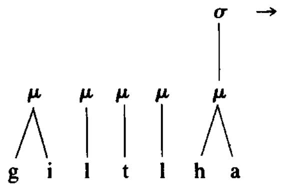


c.

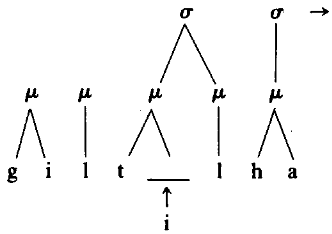


(53) *Iraqi Right to Left Syllabification*:

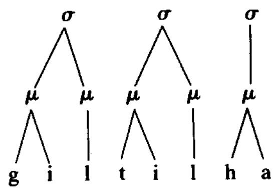
a.



b.



c.



The crucial step in the directional scansion is the formation of the medial syllable. Notice that whether coming from the right as in Iraqi or from the left as in Cairene, the segments **t** and **l** are available for mapping to the syllable at this point. Maximality dictates formation of a heavy syllable in both cases, ensuring that mapping from either direction yields a medial closed syllable. This explains why the two different epenthesis strategies converge on the same result in the case of quadriconsonantal clusters. Locally **maximizing** each prosodic constituent turns out to be equivalent to globally **minimizing** the overall number of constituents of that type in a given string.[30]

It might be argued that, as part of Universal Grammar, the globality of Syllable Number Minimization is neither undersirable nor detrimental and that in fact the principle of Maximality is somewhat similar in computational needs. There is, however, a difference in that Maximality only compares outputs locally for each prosodic constituent while Syllable Minimization must compare the candidate surface outputs for the entire string. Furthermore, the two theories actually differ in their predictions in certain cases. Consider a hypothetical example with five intervocalic consonants, which yields three unsyllabified consonants after initial syllabification (VC]C′C′C′[CV). Although the relevant cases are not attested in Iraqi or Cairene (a comparable case with two epenthesis sites from the language Temiar will be considered in the next section), the directionality approach predicts that such forms will again undergo epenthesis in different ways, depending on the direction of mapping.

(54)	Left-to-Right:	V C] [C___C] [C___] [C V
	Right-to-Left:	V] [C___C] [C___C] [C V

The Onset/Rime analysis, even coupled with the Syllable Number Minimization Principle, is unable to make a choice between the two possible syllabification outputs, since they contain the same number of syllables. More generally, the directional analysis is able to predict that if there is an even number of intervocalic consonants, the epenthetic vowel will occur at the same points in the two dialects. When the number is odd, the difference will be whether the rightmost degenerate syllable is light (left-to-right) or heavy (right-to-left).

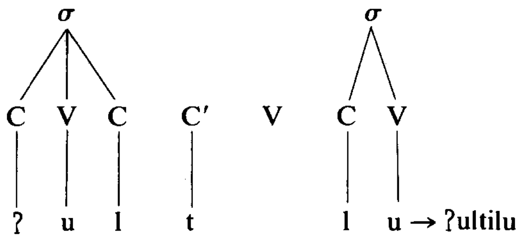
The prosodic analysis makes unambiguous as well as correct predictions in the attested cases, and we are therefore in a position to be able to eliminate the Syllable Minimization Principle from the theory.

[30] Mike Kenstowicz has directed my attention to the fact that Cairene allows final clusters but no initial ones while Iraqi allows many kinds of initial clusters but has a restricted inventory of final clusters. This is typically explained by appeal to extraprosodicity, but under a directional syllable mapping approach it is reminiscent of tonal phenomenon where contour tones pile up at the opposite end from which tone mapping procedure begins. It is also noteworthy that metrical structure building in Cairene and Iraqi is governed by the same directional parameter as syllabification, left-to-right for Cairene and right-to-left for Iraqi (McCarthy 1979a; Broselow 1982). This kind of parallelism, although perhaps accidental, is intriguing and invites a systematic study of parameter setting correlations. We will see another case from Temiar, where syllabification (Section 3.2) and the nonconcatenative morphological system (McCarthy 1982) share right-to-left directionality.

3.2. *Comparison with a Skeletal Rule Approach*

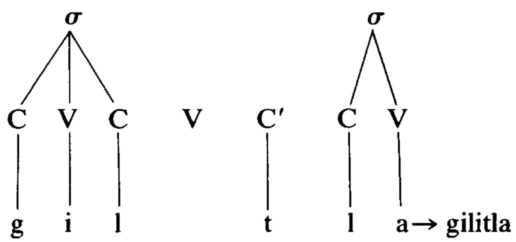
In a CV-skeletal rule approach, the Cairene and Iraqi epenthesis rules would be formulated so as to insert a V adjacent to an unsyllabified C: after the stray C′ in Cairene (55) and before the stray C′ in Iraqi (56).

(55) *Cairene Stray Epenthesis*: $\emptyset \rightarrow V$ / C′___



'I said to him'

(56) *Iraqi Stray Epenthesis*: $\emptyset \rightarrow V$ / ___C′

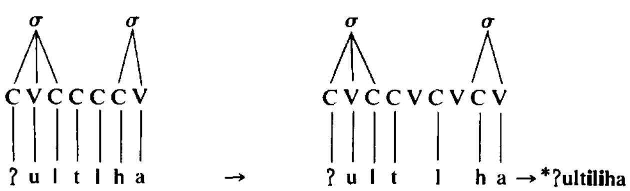


'I said to him'

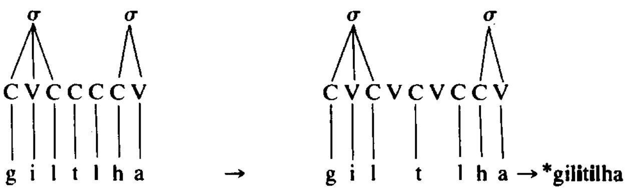
This approach to epenthesis requires that the location of the inserted vowel be encoded in the epenthesis rule itself. Since the prosodic analysis proposed in the previous section sets the directionality parameter, the two theories may at first appear equivalent in that one extra piece of information is needed in either analysis. However, closer scrutiny reveals that the rule approach also needs to encode language-specific directionality of rule application in order to correctly account for the cases with two stray consonants.

As shown in (57), if we adopt the fairly common assumption that syllabification is once-a-cycle, in both Cairene and Iraqi two epenthetic vowels would be inserted when there are two stray consonants, yielding ungrammatical results.

(57)a. *Cairene*



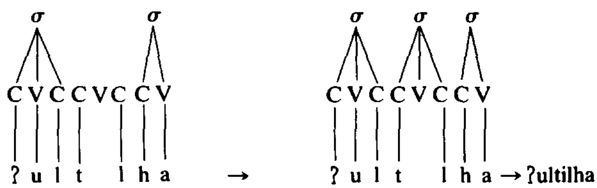
(57)b. *Iraqi*



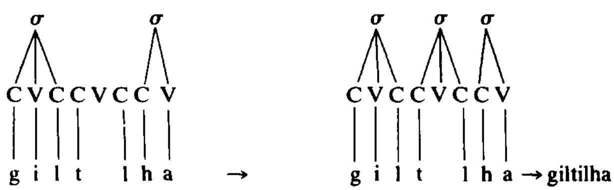
Once-a-cycle syllabification is usually coupled with the idea first argued for in Steriade (1982) where syllable-building rules are considered to be normal phonological rules ordered in the cyclic phonology. The quadriconsonantal cases in (57) provide strong evidence against this once-a-cycle view. Crucially, epenthesis must be able to immediately feed syllabification so that the second application of epenthesis is blocked. This in fact confirms the validity of the position adopted in earlier work on syllable structure (see e.g. McCarthy 1979a): Unlike normal phonological rules, syllabification is **continuous**, applying whenever possible in the derivation.[31]

Immediate syllabification provides only a partial solution, however. It still has to be ensured that epenthesis applies correctly. In order for the output of the epenthesis rules in (58) to insert a vowel between the two stray consonants, the Cairene rule must take the leftmost stray consonant as the environment, and the Iraqi rule the rightmost stray consonant.

(58)a. *Cairene Epenthesis*: $\emptyset \rightarrow V$ / C′___



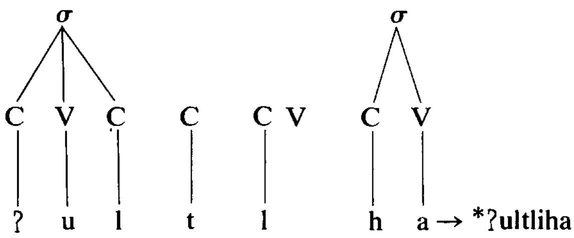
b. *Iraqi Epenthesis*: $\emptyset \rightarrow V$ / ___C′



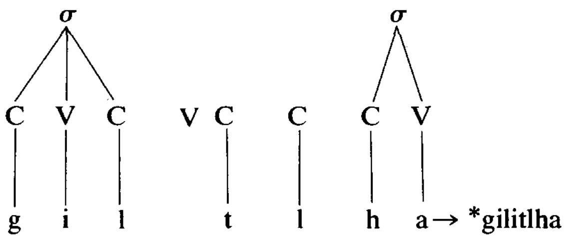
[31] A reviewer points out that in some languages syllabification must precede syncope as well as follow it. Such cases provide further arguments in favor of continuous syllabification.

Taking the opposite stray consonant as the environment would yield the following wrong epenthesis sites, again resulting in unsyllabifiability.

(59)a. *Cairene*



b. *Iraqi*



This shows that skeletal rule application must proceed directionally, and that the direction is language-specific. Notice that the left-right information is needed twice, once in the structural description of the epenthesis rule, and then again in the mode of rule application. These two factors, insertion site and directionality, yield four possible combinations. The insertion site can be to the left or right of the stray consonant, and rule application can proceed from the left or from the right. The choices for Cairene (to the right of the stray consonant and left-to-right application (58a)) and for Iraqi (to the left of the stray consonant and right-to-left application (58b)) result in epenthesis in the middle of the quadriconsonantal cluster. The other two possible combinations result in two applications of epenthesis (as in (57a) and (57b)). In fact, since Syllable Number Minimization appears to be a true descriptive generalization, we do not expect to find such cases of double insertion of vowels – a clear indication that the skeletal rule theory with its two independent left-right parameters is insufficiently restrictive.

The prosodic theory predicts the occurrence of the attested cases of epenthesis and no others, subsuming the Principle of Syllable Number Minimization. Many phonological analyses proposed in the literature contain epenthesis rules applying iteratively in a directional manner, and in general such cases should yield to the prosodic analysis advocated here.

3.2. *Temiar Initial and Medial Epenthesis*

The preceding section has shown how different settings of the directionality parameter account for interlinguistic variation in the location of epenthetic vowels. We still owe an account of intralinguistic variation in epenthesis site.

In the Austroasiatic language Temiar (Benjamin 1976; Diffloth 1976), an epenthetic vowel is inserted in different positions with respect to the stray consonant, depending on whether the stray consonant is word-initial or word-medial.[32] This poses no problem for our theory, once we take into account the fact that the only permissible syllable types in Temiar are [CVC] and [CV], syllables without onsets being disallowed. With the parameter set for the strict version of the Onset Principle (cf. Section 1.2.2 above), Temiar epenthesis can be understood as a straightforward result of right-to-left syllabification.

The most striking usage of epenthesis is found in the Temiar verbal system. Inflection and nominalization of biconsonantal and triconsonantal verbs is expressed by various affixational and reduplicative processes (see McCarthy (1982) for an insightful nonconcatenative analysis of Temiar morphology). Phonemicized forms and their surface manifestations (with epenthetic vowels) are given in (60)–(62). The examples are various inflected and/or normalized forms of the biconsonantal root **kɔ̃w** 'call' and the triconsonantal root **slɔg** 'sleep, marry'. (I follow McCarthy (1982) in assuming that the distinction between the two rounded vowels is [± tense].)

(60) #CC → #CəC

	knɔ̃w	[kənɔ̃w]	active, perfective, nominalized
	trakɔ̃w	[tərakɔ̃w]	causative, simulfactive
	slɔg	[səlɔg]	active, perfective
	snalɔg	[sənalɔg]	active, simulfactive, nominalized
	sralɔg	[səralɔg]	causative, simulfactive

(61) #CCC → #CeCC

	kwkɔ̃w	[kewkɔ̃w]	active, continuative
	kwnɔ̃w	[kewnɔ̃w]	active, continuative, nominalized
	trkɔ̃w	[terkɔ̃w]	causative, perfective
	snlɔg	[senlɔg]	active, perfective, nominalized
	sglɔg	[seglɔg]	active, continuative
	srlɔg	[serlɔg]	causative, perfective

[32] John McCarthy first brought the Temiar epenthesis facts to my attention.

(62) #CCCC → #CəCeCC

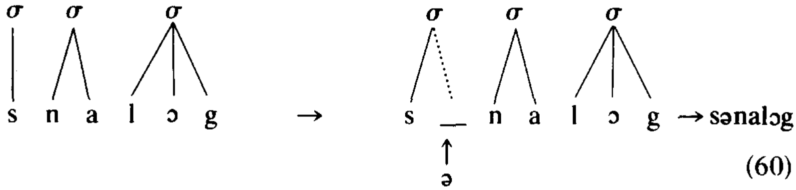
trwkɔ̃w	[tərewkɔ̃w]	causative, continuative
trnkɔ̃w	[tərenkɔ̃w]	causative, continuative, nominalized
snglɔg	[sənеglɔg]	active, continuative, nominalized
srglɔg	[səreglɔg]	causative, continuative
srnlɔg	[sərenlɔg]	causative, continuative, nominalized

An initial biconsonantal cluster is split by schwa in (60), a triconsonantal cluster by [**e**] in (61), and a quadriconsonantal cluster by both schwa and [**e**] (62). Diffloth (1976) provides the clue for the directional analysis in his statement of the rule determining the quality of the epenthetic vowel:

> [...] if we count consonants backwards, starting from the main vowel, /-[**e**]-/ is inserted in front of any consonant which is preceded and followed by another consonant. (Diffloth 1976, p. 234)

This translates in our analysis to right-to-left syllabification. Coupled with the absolute onset requirement, the melodic nature of the inserted vowel is determined by the resulting syllable structure: schwa in open syllables and [**e**] in closed syllables. The Strict Onset Principle ensures that for the cases in (60) the initial stray consonant must become the onset of the degenerate syllable, as illustrated with an example in (63).

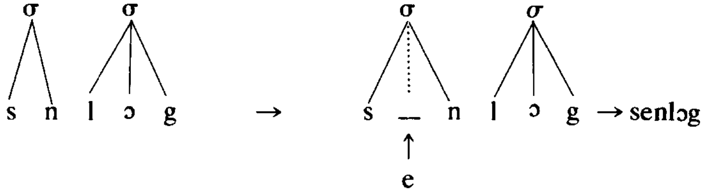
(63)



(60)

Maximality ensures that both unsyllabified consonants in the examples in (61) are mapped onto a single degenerate syllable, forming a closed syllable with an epenthetic [**e**] (64).

(64)

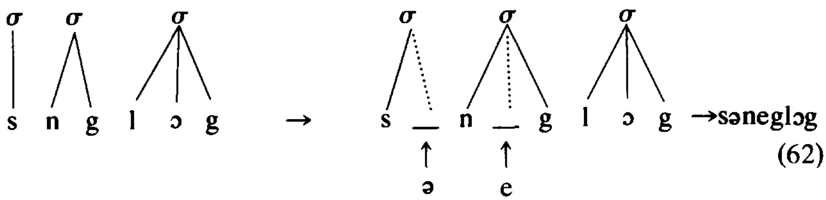


(61)

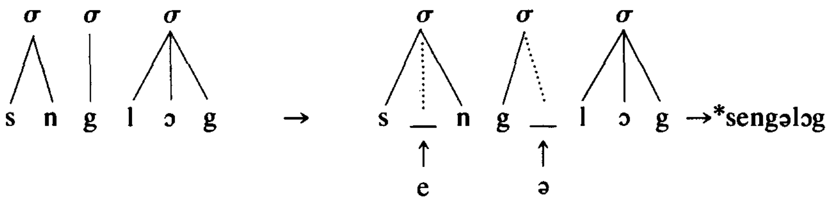
Finally, for the cases in (62) where we find two epenthetic vowels, directionality is essential in determining the correct epenthesis sites.

Right-to-left mapping as shown in (65a) ensures that among the three initial consonants **sng** the two last segments **n** and **g** are first mapped to the syllable, creating a closed syllable **neg**. Left-to-right mapping, as shown in (65b), makes incorrect predictions since the leftmost segments **s** and **n** would first be mapped to the syllable, wrongly resulting in the closed syllable **sen**.

(65)a. *Right-to-Left Syllable Mapping*:



b. *Left-to-Right Syllable Mapping*:



Note that Syllable Number Minimization would not help in this case since it is unable to choose syllabification (65a) over (65b), the number of surface syllables being the same.

A skeletal rule approach needs two epenthesis rules here, medial epenthesis and initial epenthesis, whose structural descriptions are uncollapsible in that the first inserts a V to the right, the second to the left of a stray consonant.

(66) Initial Epenthesis: $\emptyset \rightarrow V \;/\; \#C'\_\_\_$
Medial Epenthesis: $\emptyset \rightarrow V \;/\; \_\_C'$

This again shows that the environment specifications of such skeletal rules can only express the connection to the syllable structure conditions in a conspiratorial manner. Surely, it should be maintained that in order to qualify as an adequate account of epenthesis the theory must minimally be able to capture the recurring intimate relationship between epenthesis and phonotactics in a given linguistic system.

1. Further Consequences and Theoretical Implications

The goal of this paper has been to demonstrate that epenthesis results from interrelated requirements of prosody. Considerations regarding arbitrariness, restrictiveness, and globality all lead to the conclusion that there is no place for a separate theory of skeletal rules to account for syllable-sensitive (and concomitantly prosody-sensitive) processes. Our proposal is also compatible with the view that the skeleton is composed of prosodic units (such as moras) and not segmental CV/X units.

However, maintaining that phonological theory need not countenance skeletal rules does not necessarily entail that there is no segmental skeleton. There is evidence from lexical specification which prima facie seems to defy a straightforward translation into pure prosodic units. Relevant examples include the CV/X-skeletal analyses of, for example, French **h-aspiré** (Clements and Keyser 1983), Seri empty onsets (Marlett and Stemberger 1983), intrusive stop formation (Clements 1987), as well as representational issues regarding initial and final geminates (Mohanan 1982; Levin 1988; Steriade 1988). Before coming to the hasty conclusion that these are compelling cases for the segmental skeleton, it seems important to take into consideration recent results from the study of melody-internal structure (Clements 1985; Mester 1986; Sagey 1986; Schein and Steriade 1986; McCarthy and Prince 1986; McCarthy 1988), which indicate convincingly that some kind of melodic core or root node is necessary in the phonological representation. These considerations suggest that the role previously played by lexically empty skeletal slots can be taken over, wholly or in part, by bare melodic root nodes. These issues are clearly far beyond the scope of this paper and must be left for future study.

It should be pointed out, however, that even granting the existence of a segmental skeleton as part of the phonological representation by no means implies or requires that it actively participate in the statement of rules and conditions. A more restrictive view would be to define the skeleton purely as terminal elements of syllables, as assumed in e.g., Kaye and Lowenstamm (1984), Selkirk (1984) and Prince (1984). From such a viewpoint, the skeleton would have no life of its own, independent 'stray' skeletal slots divorced from their syllable environment would not be possible phonological entities, and no rule could be postulated with a stray segment in its structural description. We have shown that prosody-related cases do not involve such rules, and therefore we are in a position to eliminate all diacritic references to 'strayness'. Operations which seek out unsyllabified melodies should only be those required by Prosodic Licensing – incorporation into higher prosodic structure, or elimination of unincorporable elements by Stray Erasure. This result, I would like to suggest, is a step in phonological theory towards a desirable goal.

References

Abu-Salim Issam M.: 1980, 'Epenthesis and Geminate Consonants in Palestinian Arabic', *Studies in the Linguistic Sciences* **10**, 1–11, University of Illinois, Urbana.

Archangeli, D.: 1984, *Underspecification in Yawelmani Phonology and Morphology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts. Published 1988, by Garland Publishers, New York.

Aronoff, M. and R. Oehrle (eds.): 1984, *Language Sound Structure*, MIT Press, Cambridge, Massachusetts.

Benjamin, G.: 1976, *An Outline of Temiar Grammar*, in Jenner et al. (eds.), pp. 129–87.

Borer, H. and Y. Aoun (eds.): 1981, *Theoretical Issues in the Grammar of Semitic Languages*, MIT Working Papers in Linguistics, Vol. 3.

Borowsky, T.: 1984, 'On Resyllabification in English', in M. Wescoat et al. (eds.), *Proceedings of WCCFL* **3**, 1–15.

———: 1986, *Topics in the Lexical Phonology of English*, Ph.D. dissertation, University of Massachusetts, Amherst.

Borowsky, T., J. Itô and A. Mester: 1984, 'The Formal Representation of Ambisyllabicity: Evidence from Danish', in C. Jones and P. Sells (eds.), *Proceedings of NELS* **14**, 34–48.

Broselow, E.: 1980, 'Syllable Structure in Two Arabic Dialects', *Studies in the Linguistic Sciences* **10**, 13–24.

———: 1982, 'On Predicting the Interaction of Stress and Epenthesis', *Glossa*, Simon Fraser University, Burnaby, B.C., pp. 115–32.

Chomsky, N. and M. Halle: 1968, *The Sound Pattern of English*, Harper & Row, New York.

Christdas, P.: 1988, *The Phonology and Morphology of Tamil*, Ph.D. dissertation, Cornell University, Ithaca, New York.

Clements, G. N.: 1985, 'The Geometry of Phonological Features', in *Phonology Yearbook* **2**, 225–52.

———: 1987, 'Phonological Feature Representation and the Description of Intrusive Stops', in A. Bosch et al. (eds.), *Parasession on Autosegmental and Metrical Phonology*, Vol. 23, Chicago Linguistic Society, pp. 29–50.

———: 1988, 'The Role of the Sonority Cycle in Core Syllabification', to appear in J. Kingston and M. Beckman (eds.), *Papers in Laboratory Phonology* **1**, Cambridge University Press.

Clements, G. N. and S. J. Keyser: 1983, *CV Phonology: A Generative Theory of the Syllable*. MIT Press, Cambridge, Massachusetts.

Dell, F. and M. Elmedlaoui: 1986, 'Syllabic Consonants and Syllabification in Imdlawn Tashihiyt Berber', *Journal of African Linguistics* **7**, 105–30.

Diffloth, G.: 1976, 'Minor-Syllable Vocalism in Senoic Languages', in P. Jenner et al.f(.), 229–47.

Goldsmith, J.: 1976, *Autosegmental Phonology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts. Published 1979, by Garland Publishers, New York.

Halle, M. and J.-R. Vergnaud: 1978, 'Metrical Structures in Phonology', manuscript, MIT, Cambridge, Massachusetts.

Hammond, M.: 1988, 'On Deriving the Well-Formedness Condition', *Linguistic Inquiry* **19**, 319–25.

Harris, J. W.: 1983, *Syllable Structure and Stress in Spanish: A Nonlinear Analysis*, MIT Press, Cambridge, Massachusetts.
Hayes, B.: 1980, *A Metrical Theory of Stress Rules*, Ph.D. dissertation, MIT, Cambridge, Massachusetts. Published 1985, by Garland Publishers, New York.
———: 1982, 'Extrametricality and English Stress', *Linguistic Inquiry* **13**, 227–76.
———: 1986, 'Inalterability in CV Phonology', *Language* **62**, 321–51.
———: 1987, 'A Revised Metrical Theory', *Proceedings of NELS* **17**, 274–89.
———: 1988, 'Compensatory Lengthening in Moraic Phonology', to appear in *Linguistic Inquiry*.
Hooper, J. B.: 1972, 'The Syllable in Phonological Theory', *Language* **48**, 525–40.
———: 1976, *An Introduction to Natural Generative Phonology*, Academic Press, New York.
Hyman, L. M.: 1984, 'On the Weightlessness of Syllable Onsets', *Proceedings of BLS* **10**, 1–14, University of California, Berkeley.
———: 1985, *A Theory of Phonological Weight*, Foris Publications, Dordrecht.
Itô, J.: 1986, *Syllable Theory in Prosodic Phonology*, Ph.D. dissertation, University of Massachusetts, Amherst. Published 1988, by Garland Publishers, New York.
Jenner, P. N., L. C. Thompson and S. Starosta: 1976, *Austroasiatic Studies*, Part I, University Press of Hawaii, Honolulu.
Kahn, D.: 1976, *Syllable-based Generalizations in English Phonology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts, Published 1980, by Garland Publishers, New York.
Kaye, J. and J. Lowenstamm: 1984, 'De la syllabicité', in F. Dell et al. (eds.), *Forme sonore du langage*, Hermann, Paris, pp. 123–61.
Kenstowicz, M.: 1981, 'The Metrical Structure of Arabic Accent', presented at the UCLA-USC Lake Arrowhead Conference on Phonological Theory, manuscript, University of Illinois, Champaign.
———: 1987, 'Notes on Syllable Structure in Three Arabic Dialects', *Revue québécoise de linguistique* **16**, 101–28.
Kenstowicz, M., Y. Bader and R. Benkeddache: 1982, 'The Phonology of State in Kabyle Berber', manuscript, University of Illinois, Champaign.
Kidda, M.: 1985, *Tangale Phonology: a Descriptive Analysis*, Ph.D. dissertation, University of Illinois, Champaign.
Kiparsky, P.: 1979, 'Metrical Structure Assignment is Cyclic', *Linguistic Inquiry* **10**, 421–41.
———: 1982, 'Lexical Phonology and Morphology', in I. S. Yang (ed.), *Linguistics in the Morning Calm*, Linguistic Society of Korea, Hanshin, Seoul.
———: 1984, 'On the Lexical Phonology of Icelandic', *Nordic Prosody III*, Elert et al. (eds.), University of Umeå, pp. 135–60.
———: 1985, 'Some Consequences of Lexical Phonology', in C. J. Ewen and J. M. Anderson (eds.), *Phonology Yearbook* **2**, 85–138.
Kisseberth, C.: 1970, 'On the Functional Unity of Phonological Rules', *Linguistic Inquiry* **1**, 291–306.
Kuryłowicz, J.: 1948, 'Contribution a l'etude de la syllabe', *Esquisses Linguistiques*, Ossolineum, Warsaw.
Lapointe, S. and M. Feinstein: 1982, 'The Role of Vowel Deletion and Epenthesis in the Assignment of Syllable Structure', in H. van der Hulst and N. Smith (eds.), pp. 69–120.
Levin, J.: 1985, *A Metrical Theory of Syllabicity*, Ph.D. dissertation, MIT, Cambridge, Massachusetts.
———: 1988, 'The Autonomy of the Skeleton: Evidence from Micronesian', manuscript, University of Texas, Austin.
Liberman, M. and A. Prince: 1977, 'On Stress and Linguistic Rhythm', *Linguistic Inquiry* **8**, 249–336.
Lowenstamm, J.: 1981, 'On the Maximal Cluster Approach to Syllable Structure', *Linguistic Inquiry* **12**, 575–604.

Marlett, S. A. and J. P. Stemberger: 1983, 'Empty Consonants in Seri', *Linguistic Inquiry* **14**, 617–39.
McCarthy, J.: 1979a, 'Stress and Syllabification', *Linguistic Inquiry* **10**, 443–66.
———: 1979b, *Formal Problems in Semitic Phonology and Morphology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts. Published 1985, by Garland Publishers, New York.
———: 1981, 'A Prosodic Theory of Nonconcatenative Morphology', *Linguistic Inquiry* **12**, 373–413.
———: 1982, 'Prosodic Templates, Morphemic Templates, and Morphemic Tier', in H. van der Hulst and N. Smith (eds.), pp. 191–224.
———: 1983, 'Ponapean Reduplication', manuscript, Bell Laboratories, Murray Hill, New Jersey.
———: 1986, 'OCP Effects: Gemination and Antigemination', *Linguistic Inquiry* **17**, 207–63.
———: 1988, 'Feature Geometry and Dependency', to appear in O. Fujimura (ed.), *Articulatory Organization – From Phonology to Speech Signals*, S. Karger, Basel.
McCarthy, J. and A. Prince: 1986, 'Prosodic Morphology', manuscript. University of Massachusetts, Amherst, and Brandeis University, Waltham.
———: 1987, 'Quantitative Transfer in Reduplicative and Templatic Morphology', to appear in *Linguistics in the Morning Calm* 2 Hanshin, Seoul.
Mester, R. A.: 1986, *Studies in Tier Structure*, Ph.D. dissertation, University of Massachusetts, Amherst. Published 1988, by Garland Publishers, New York.
Mohanan, K. P.: 1982, *Lexical Phonology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts, published under the title *The Theory of Lexical Phonology* (1986), D. Reidel, Dordrecht.
Murray, R. W. and T. Vennemann: 1983, 'Sound Change and Syllable Structure in Germanic Phonology', *Language* **59**, 514–28.
Myers, S.: 1987, 'Vowel Shortening in English', *Natural Language and Linguistic Theory* **5**, 485–518.
Noske, R.: 1985, 'Syllabification and Syllable Changing Processes in Yawelmani', in H. van der Hulst and N. Smith (eds.), pp. 335–62.
Payne, D. L.: 1981, *The Phonology and Morphology of Axininca Campa*, Summer Institute of Linguistics Publications in Linguistics No. 66, University of Texas at Arlington.
Poser, W.: 1984, 'Hypocoristic Formation in Japanese', in M. Westcoat et al. (eds.), Proceedings of WCCFL **3**, 218–29.
Pulleyblank, D.: 1983, *Tone in Lexical Phonology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts, published 1986, D. Reidel, Dordrecht.
Prince, A.: 1980, 'A Metrical Theory for Estonian Quantity', *Linguistic Inquiry* **11**, 511–62.
———: 1983, 'Relating to the Grid', *Linguistic Inquiry* **14**, 19–100.
———: 1984, 'Phonology with Tiers', in M. Aronoff and R. Oehrle (eds.), pp. 234–44.
———: 1985, 'Improving Tree Theory', *Proceedings of BLS* **11**, 471–490, University of California, Berkeley.
Rehg, K. L. and D. G. Sohl: 1979, *Ponapean-English Dictionary*, The University Press of Hawaii, Honolulu, Hawaii.
———: 1981, *Ponapean Reference Grammar*, The University Press of Hawaii, Honolulu, Hawaii.
Sagey, E.: 1986, *The Representation of Features and Relations in Non-Linear Phonology*, Ph.D. dissertation, MIT, Cambridge, Massachusetts.
———: 1988, 'On the Ill-Formedness of Crossing Association Lines', *Linguistic Inquiry* **19**, 109–18.
Schein B. and D. Steriade: 1986, 'On Geminates', *Linguistic Inquiry* **17**, 691–744.
Selkirk, E. O.: 1980, 'The Role of Prosodic Categories and English Word Stress', *Linguistic Inquiry* **11**, 563–606.
———: 1981, 'Epenthesis and Degenerate Syllables in Cairene Arabic', in H. Borer and Y. Aoun (eds.), pp. 209–32.

———: 1982, 'The Syllable', in H. van der Hulst and N. Smith (eds.), pp. 337–84.

———: 1984, 'On the Major Class Features and Syllable Theory', in M. Aronoff and R. Oehrle (eds.), pp. 107–36.

Steriade, D.: 1982, *Greek Prosodies and the Nature of Syllabification*, Ph.D. dissertation, MIT, Cambridge, Massachusetts.

———: 1984, 'Glides and Vowels in Rumanian', *Proceedings of BLS* **10**, 47–64, University of California, Berkeley.

———: 1988, 'Review Article, Clements & Keyser: CV Phonology', *Language* **64**, 118–29.

ter Mors, C.: 1985, 'Empty V-Nodes and their Role in the Klamath Vowel Alternation', in H. van der Hulst and N. Smith (eds.), pp. 313–34.

van der Hulst, H. and N. Smith: 1982, 'An Overview of Autosegmental and Metrical Phonology', in H. van der Hulst and N. Smith (eds.), pp. 1–46.

van der Hulst, H. and N. Smith (eds.): 1982, *The Structure Phonological Representations*, Foris, Dordrecht.

— 1985, *Advances in Nonlinear Phonology*, Foris, Dordrecht.

Vennemann, T.: 1972, 'On the Theory of Syllabic Phonology', *Linguistische Berichte* **18**, 1–18.

Wilkinson, K.: 1988, 'Prosodic Structure and Lardil Phonology', *Linguistic Inquiry* **19**, 325–34.

Yip, M.: 1988, 'The Obligatory Contour Principle and Phonological Rules: A Loss of Identity', *Linguistic Inquiry* **19**, 65–100.

Younes, R.: 1983, 'The Representation of Geminate Consonants', manuscript, University of Texas, Austin.

Zec, D.: 1988, 'Bulgarian Schwa Epenthesis: A Case for Moraic Structure', *Proceedings of NELS* **18**, 553–66.

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