A METRICAL THEORY OF SYLLABICITY

by

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## ABSTRACT

It is the purpose of this work to argue that the sole determinant of
syllabicity in phonological representations is the structural position of the
syllable nucleus. In addition to eliminating redundancy in phonological
representations, such a model differs from one employing the distinctive
feature [·syllabic] on both theoretical and empirical accounts. In theory,
it provides a coherent account of what appear to be syllable sensitive rules,
rules of accent and skeletal tier transformations, without reference to
segmental features. In practise, it does away with an unexplained assymmetry
inherent in systems using a distinctive feature [+syllabic]: within such
systems, segments in languages with glide/vowel alternations must often be
specified underlyingly as [+syllabic], but never as [-syllabic]. In a theory
where syllabicity is a metrical property of the head of a syllable, this is
the result of the fact that designated heads can be marked in underlying
lexical representations, while the property of being a non-head cannot. More
importantly, this theory allows regularities in glide/vowel alternations to
be captured systematically by simple rules of N placement, which are
independently motivated, thus affording greater overall simplicity in rule
systems.

In Chapter 1 we examine the redundant encoding of syllabicity on the
skeletal tier, the segmental tier and the syllable plane. Phonological
evidence from affixation processes in two Micronesian languages argues
strongly for the elimination of syllabicity distinctions on the timing tier.
Viewing skeletal slots as unspecified for syllabicity, we move on to an
elimination of the distinctive feature [+syllabic] on the segmental tier. In
Chapter 2, we propose a Kahnian system of syllabification rules which make no
reference to the feature [+syllabic]. Within this system, syllabicity is
established by N-Placement, where N is the syllable nucleus. N-placement may
be lexical, or it may be determined by redundancy rule or phonological rule.
We argue that syllabicity is either a redundant property of a particular
feature matrix, or that it is a structural property corresponding to the

metrical configurational property "head of a syllable". A primitive version of X-bar theory is shown to be operative within the syllable, and arguments for internal constituents, N, the nucleus, and its projections, N' and N" are presented. Constituency within the syllable is shown to involve projection of N" and N' along with rules of incorporation and adjunction. Incorporation rules are shown to be constrained by language-specific sonority scales and may be iterative or non-iterative. Adjunction, which is limited to maximal projections, may violate relative sonority scales. In the last section of Chapter 2, skeletal templates of the kind evidenced in Semitic morphology are argued to be best represented as instances of lexical N-placement. We conclude from Chapter 2 that a metrical theory of syllabicity is viable, and procede to empirical arguments in support of such a theory.

In Chapter 3 a variety of arguments for the feature [+syllabic] on both the segmental and skeletal tier are reviewed. A metrical theory of syllabicity which capitalizes on the distinction between syllabified and unsyllabified skeletal slots, as well as on the structural distinction between N and N' is not only able to account for each case under review, but appears to have wider empirical coverage in the case of glide/vowel alternations in Klamath and Tigrinya, and tense/lax distinctions in Ancient Greek.

In Chapter 4 we strengthen the X-bar component of the theory by providing evidence of certain phonological rules which refer to the projections N, N' and N", as well as other rules which refer to the categorial distinction between syllable heads and non-heads. The first set of rules are those of accent assignment within a metrical theory of stress. The second class of rules are what we refer to as skeletal-tier transformations. Skeletal-tier transformations are rules which insert or delete X-slots, and include rules of vowel and consonant epenthesis, tonic lengthening and gemination, vowel deletion, and vowel coalescence. We claim that such rules are limited by a set of universal conditions which make specific reference to the distinction between syllable heads and non-heads, thus providing evidence for a categorial component in phonology.


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Dedicated, with love, to my mother and father,
whose youthful passion for knowledge and freedom
is a constant source of inspiration.

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"Of some languages is has been said that their consonants
were comparable to the skeleton and bones of the animal organism,
while their vowels, as the fluid and variable element,
were likened to its soul."

Albert Samuel Gatschet, "Grammar of the Klamath Language",(1890;253)

# Chapter 1

## Representations: Syllables and Syllabicity

Without the syllable, the factors of timing are meaningless.
Haugen(1949;280)

## 1.1 Introduction and Overview

In attempting to answer the question "What does it mean to know a language?", and thereby gain insight into the structure of the human mind, there are countless places to begin. We will begin with a body of linguistic data which is potentially interesting in that it is acquired at a very young age by all individuals within a given linguistic community, yet varies greatly from one language to another. The body of linguistic knowledge in question is that concerned with syllable structure. As far as we know phonetic utterances in all natural human languages are made up of syllables. Thus, we can hypothesize that certain aspects of a theory of syllabicity will make up part of the theory of universal grammar.

Part of what it means to know English is to know that the word 'coral' has two syllables, while 'Karl' has only one. One knows this despite the fact that under certain conditions, the phonetic realizations of both 'coral' and

'Karl' might be identical.[1] Knowledge of English also involves knowing that the words 'acid' and 'rhythm' are bisyllabic, though adding the adjectival suffix /-Ik/ yeilds 'acidic' which has three syllables and 'rhythmic which has only two. While such facts might appear obvious to the native speaker of English, cross-linguistic differences in syllable structure make it not at all obvious to the native speaker of Fijian attempting to acquire English. The Fijian speaker will not readily perceive differences in syllabicity between 'coral' and 'Karl' or the [m] in 'rhythm' versus 'rhythmic', and will have difficulty establishing such distinctions.

While syllable structure in one's native language may make perception of syllabicity distinctions in other languages difficult, children in early stages of language acquisition appear to be quite sensitive to such distinctions. 20 month old children acquiring English who are offered the word 'porcupine' in the phonetic form of [pɔr.kyʌ.payn], will attempt to produce a phonetic equivalent, though they will usually come up short. Of particular interest to us is the fact that, though children may produce strings which are segmentally deficient, the utterance is rarely short in terms of syllable count. Transcribed utterances include the following:

(1)

  [pɔh.hyə.pah], [pɔʔ.yəʔ.payh] and [pɔh.yʌ.phay]

but not *[pɔk], *[payn], or *[pɔhpayn], which were all within the means of

---

1. In the author's dialect of Northern-New-Jersey English, these two words are both pronounced as [karl] when unstressed.

production of these children.[2] What does the 20 month old child know which enables it to perceive the word 'porcupine' as trisyllabic, as evidenced by trisyllabic segmentally deficient imitations? What does it mean to "know" that 'coral' has two syllables while 'Karl' has one or that the [m] of 'rythm' is syllabic, while that in 'rythmic' is not?

These questions are at the core of our investigation. Rephrased slightly, we ask first "What aspects of syllable structure are part of universal grammar?" and secondly, "What rules and principles determine cross-linguistic variation in syllable types?". In answer to these questions we propose a universal characterization of syllabicity in terms of metrical constituents, constituents which are themselves generated via a primitive version of X-bar theory. Column I in (2) lists the universal components of this particular theory of syllabicity, while column II summarizes language particular instantiations or parameter settings involved in syllabicity and

_ _____

2. Data here was provided, both sollicited and unsollicited, by Daniel and Sara Burke-Levin, twins of 20 months old. The twins at this point were just entering the two word stage. Their mono- and bisyllabic utterances included such strings as [may],[kak],[piys], [bI?.bərD], [bərtiy],[kaeyf^l],[kwaek^] and much more.

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syllabification distinctions.

(2) A Metrical Theory of Syllabicity

| I. Universal Grammar | II. Language Specific Parametrization |
|---|---|
| A. X-bar theory | |
| i.Categorial Component | |
| a. N-Placement ---------- ---------- | Lexical and/or Rule-governed |
| b. Complex-N --------------------- | Yes/No |
| ii. Projection | |
| a. Project N" | |
| b. Project N'--------------------- | Yes/No |
| iii. Incorporation | |
| a. Incorporate into N"----- --------- | Yes/No Iterative/Non-iterative |
| b. Incorporate into N'------------ | Yes/No Iterative/non-iterative |
| iv. Adjunction (to N") --------------- | Yes/No Left/Right Iterative/non-iterative |
| B. Condition on Structure- Dependant Rules | |
| C. Sonority Hierarchy------------------ | Sonority Scale Minimal Sonority Distance |

Given a three-dimensional system of phonological representations, syllable structure is represented on a plane of its own. Syllable structure is universally of an X-bar type so that each syllable which is a maximal projection contains one and only one endocentric head. The structural property "head of the syllable" is the sole determinant of syllabicity. The determination of what elements can act as syllable heads, part of the categorial component in phonology, is learned, though for each $N^o$, projection of N" is universal. N'-projection is subject to cross-linguistic variation.

In sum, part of what a 20 month old child knows when it knows that the word 'porcupine' has three syllables is part of universal grammar. The child knows a system of phonological representation in which syllable structure is represented on a separate phonological plane, generated by principles of X-bar theory. On this plane there are three maximal projections, as shown below:

(3)
```
        N"        N"      N"
       /|        /|      /|\
      / N\      / N    / N \
     / | \    / |  / |\ \
    X  X X X  X X  X X X
    |  | | |\ | |  | | |
    p  ɔ r ky ʌ p  a y n
```
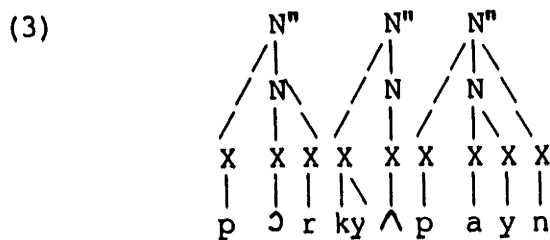
On the other hand, part of what an English speaker must know in differentiating 'Karl' from 'coral' or deriving rhythmic from rhythm must be learned. One must learn that /l/ and /m/ are both possible syllable heads in English, and one must learn the environments where they must or must not function as syllabic nuclei. Such knowledge might take the form of predetermined structure in the lexical entry, as in the underlying representation for the word 'coral' given in (4.a) versus that in (4.b).

(4) a. 'coral'                    b. 'Karl'
```
         N
         |
    X X X X              X X X X
    | | | |              | | | |
    k a r l              k a r l
```
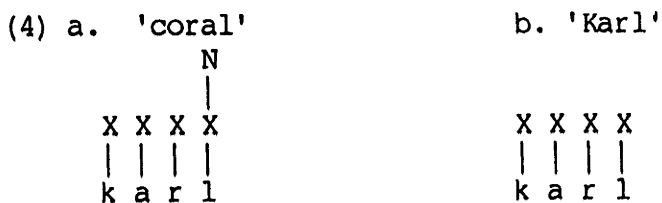
If it is not marked as such, the regular rules of syllabification in English will treat the final /l/ as non-syllabic, just as it is treated in a word like 'call'. Such knowledge however may also take the form of a phonological rule. As we will show, a phonological rule is responsible for

the syllabic status of [m] in 'rhythm', and its non-syllabic realization in 'rhythmic'. In English, [+consonantal] sonorants may act as syllable heads in the event that they are not properly syllablifiable via projection, incorporation and/or adjunction rules. Such a rule explains the illformedness of a word like [kal] in English. A sonorant will never act as syllable head post-vocalically given that English instantiates the N'-projection.

While the vast array of cross-linguistic variation in syllabicity and possible syllable types makes it clear that any theory of syllabicity must incorporate a number of language-specific properties, the degree of variation is limited in certain non-trivial ways. For example, mono-segmental geminates, if subject to rules of N-placement will always result in single syllable heads. We argue that such a property is derivable from a version of a more general condition on structure dependent rules. Or, take the more obvious fact that there is no language in which the sequence [..VCCCV..] consists of a single syllable. This property is directly derivative of X-bar theory where heads are endocentric and the fact that $X^0$s are not subject to rules of adjunction or incorporation. Such constraints on possible syllable types are certainly operative in delimiting the set of well-formed phonological representations, and as we will see, can be formulated independently of language-specific parameterization of possible syllabic segments. Whether or not a metrical theory of syllabicity is viable is, in the end, an empirical question. With no end in sight, we turn to an exploration of the form and content of such a theory for the representation of linguistic knowledge.

1.1.1 Historical Perspective

Questions involving the nature of syllabicity have long intrigued the phonological world. Questions invariably fall into two types. The first involves the distinction between syllabic and non syllabic sounds, and the second involves the internal structure of constituents defined by syllabic sounds, otherwise known as syllables.

The separation of syllabics from non-syllabics seems ageless. Within the Semitic tradition, distinction between vocalism and consonantism, so apparent in the morphology, is reflected in orthography where vocalism is omitted its components being, in part, predictable.

The Sanskrit grammarians divided sounds into vowels and consonants, where vowels were all and only those segments which were syllabic. Thus, along with the vowels /a,i,u,e,o/ there were also the /r,l/ vowels. Whitney(1889) describes these segments as follows:

> The vowel r is simply a smooth or untrilled r-sound assuming a
> vocalic office in syllable-making -- as, by a like abbreviation,
> it has done also in certain Slavonic languages. The vowel l is
> an l-sound similarly uttered -- like the English l-vowel is such
> words as **able,angle, addle**.(p.11)

Not only were syllabic and non syllabic segments distinguished, but various syllable types in Sanskrit were described as well. The grammarians split syllables into two types: heavy (**guru**) and light (**laghu**). A heavy syllable was defined as a syllable with a long vowel, or a short vowel followed by more than one consonant ("long by position"), whereas all other syllables were light. This distinction played a role not only in grammatical

descriptions, but also in verse, where the weight of the last syllable of each pa:da (primary division of verse) was counted.

Within more recent history, linguists including Kurylowicz(1948), Pike and Pike(1948), and Hockett(1955), have continued to talk of syllabics and non-syllabics in quite general terms. Yet their proposals for internal syllable structure are quite specific, taking the general form of the tree shown in (5), where syllabics are just those elements which occupy the terminal positions under the Nucleus node.

(5)
```
                    Syllable
                    /\
                   /  \
                  /    \
                 /      \
                /        Rime
               /         /\
            Onset       /  \
            /\         /    \
           /  \       /      \
          /    \   Nucleus   Coda
         /      \    /\       /\
        /        \  /  \     /  \
       X  .   .   X...    X...
```
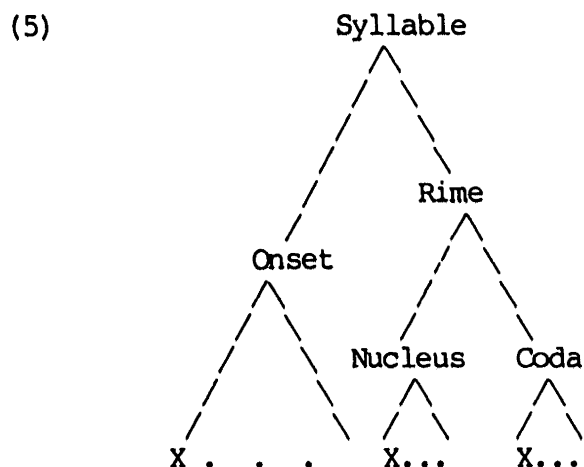
While evidence for the reality of certain phonologically distinctive features such as round, grave, high, etc. was slowly being amassed, the nature of syllabicity continued to elude the linguist. In Pike's own words "the most basic, characteristic, and universal distinction made in phonetic classification is that between consonant and vowel. Its delineation is one of the least satisfactory.(1943:66)"

Hockett does not offer a formal distinction between syllabic and non-syllabic segments, but rather phrases it as a difference between glide vocoid and peak vocoid, which is informally associated with length, chest

pulse, and other acoustic effects.

Firth(1948), on the other hand, viewed syllabicity as a property that must be defined on a language specific basis, rather than on phonetic grounds:

> Speaking quite generally of the relations of consonants and vowels to prosodic or syllabic structure, we must first be prepared to enumerate the consonants and vowels of any particular language for that language, and not rely on any general definitions of vowel and consonant universally applicable.(p.131)

In attempts to delineate this property more satisfactorily, a number of ideas were advanced. Some suggested, albeit pretheoretically, that syllabicity was more akin to a metrical or relational property than a segmental one. Haugen(1949), in a short but incisive article on the nature of 'suprasegmental' or 'prosodic phonemes', suggests what might be viewed as a precursor to autosegmental theory: "...any significant sound feature whose overlap of other features is temporally correlated to syllabic contour should be called a prosodeme, and should be treated by itself, in a manner appropriate to its special nature(p.282)."

Haugen, then, as early as 1949, was suggesting that tone, stress, and duration be treated as autosegments, with lives of their own independent of the segmental string, and that syllables somehow be seen as their anchors. But what of syllabicity? Was it a "prosodeme"? The honesty and insightfuless of Haugen's words make them well worth repeating:

> I am not unmindful that Bloch in his postulates for phonemic analysis was unable or unwilling to include a definition of the syllable. I am not at the moment prepared to solve a problem that has baffled the best linguistic minds. But I would go so far as to declare that I do not believe a valid analysis of prosodic phenomena can be made without some implicit or explicit definition of the syllable. Without the syllable, the factors of timing are meaningless. Its reality to the native speaker is pragmatically undeniable, at least in the languages with which I

am familiar. It does not seem to me that we have to wait for a complete clarification of its physiological nature, its correlation to the chest pulse, for instance. The phenomena of timing which we have observed force us to assume some such recurrent unit to account for their uniform behaviour. Stress, pitch, duration, and juncture,--all of them are somehow related to the syllable. Its effects are visible whether we can see it or not. It is nothing less that the METRONOME of human speech. It is the segment with which the prosodemes are indeed simultaneous, and by means of which they can be measured. Recognizing that it may, like other linguistic terms, have a different significance in different languages, I shall tentatively define the syllable as that recurrent sequence of sounds, in terms of which the phenomena of linguistic timing can be described.(pp.280-281)

The solution offered by Haugen, that the syllable be defined language-specifically relative to other phenomena such as tone, stress and length, will be given a firm footing in Chapter 2, where language specific rules of N-Placement are proposed, and in Chapter 4, where rules of stress are argued to have access solely to the syllable plane. However, within the confines of American structuralism, such ideas were left behind, as the search for the ultimate typology of syllabic segments and syllable types continued.

Though such work did not directly address such questions as "What does it mean to know a language?", it did provide a broad empirical foundation for those interested in such questions. In fact, much of the descriptive terminology proposed in Hockett's(1955) "A Manual of Phonology", one of the most detailed investigations of syllable structure among the American descriptivists, is still in use today, including the consituent structure shown in (5), and the node-labels onset, rime, nucleus and coda. With respect to the structure in (5) two lines of investigation have emerged. One line, found in Selkirk(1980) and Kaye and Lowenstam(1981), posits such structure as a type of template with node-labels like onset and rime as

primitves within the theory. A different approach, such as that discussed in McCarthy(1979) and Kiparsky(1978,1979,1981) treats the tree in (5) as a derived relational structure, whose properties are derivative of a more general theory of metrical structure. This second approach is the direct precursor of the view of internal constituency explored in this work.

Getting back to the question of syllabicity then, have we progressed at all in solving "a problem that has baffled the best linguistic minds?" A positive answer appears to lie in the extension of phonological representations. Following closely the model laid out in Chomsky and Halle(1968) (henceforth SPE), work in generative phonology into the early nineteen seventies concerned itself with properties of phonological rules and rule systems as conceived of as operations on linear strings of segments. This view of phonological rules, however, changed substantially with the work on tone of Williams(1971) and Goldsmith(1976). In this work, tones and segments are treated as separate but equal entities, each with its own plane, or level of representation. The association between tone and segment is guided by universal principles as well as language particular rules.

Building on such work, Kahn(1976) argued that syllables exist as independent constituents, and that they are best represented, not as boundaries delimiting segmental strings, but as autosegmental units superimposed on the segmental string. Viewing phonological representations as non-linear objects has led to non-linear accounts of stress (Liberman and Prince,1977), vowel harmony (Clements,1977), non-concatenative morphology (McCarthy,1979), and the behaviour of complex and geminate segments (Steriade,1982; Schein and Steriade,1984).

Much of this work will be presupposed. In particular, we will view phonological representations as three-dimensional objects, consisting in a number of half-planes, all of which intersect in a single line of timing slots which we will call the skeleton. In (6) we see a partial representation of the English word 'syllable'.

(6)

```
                ____  _____
                \   /            /
          P-3    \ /   N  N  N  / P--2
                  V   / /  /  /
              X X X X X X X
             /\  \ \ \ \ \ \
    P-4    /  \   s I l ^ b l \ P-1
          /    \              \
         /_____\
```
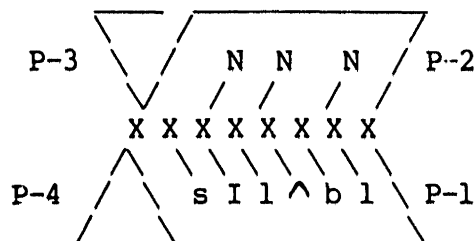
The skeleton is represented as a string of empty slots which may or may not project to a given autosegmental or structural plane. We follow Archangeli(1985b) in distinguishing planes, defined by structure anchored in the core-skeleton, from tiers, which are plane-internal sequences of matrices which run parallel to the skeleton. In the following section we will present evidence which argues that skeletal slots are devoid of any intrinsic feature specifications. In this way, the X tier is not merely a notational variant of a skeleton made up of Cs and Vs, since such elements embody distinctive feature values.[3]

The planes in (6) are of two general types. One type, like the segmental or melodic P-1 in English above, is non-null at all stages of the derivation, while the syllable plane, P-2, on which syllable structure is represented,

_____

3. From this point on, to eliminate confusion, labels like C, V, X, X', N, N', etc. are inflected without the use of an apostrophe: Cs, Vs, Xs, X's, Ns, N's, etc.

may be constructed through the course of the derivation. What will be referred to as metrical structure throughout this work is the structural information encoded on planes which involves structure distinct from simple association lines. Planes linked to the skeleton via simple association lines are referred to as autosegmental planes.

Though in many cases metrical structure is derived, while autosegmental planes are predetermined in the lexicon, there appears to be no intrinsic relationship between underlying and derived planes and the information encoded on ῌuch planes. In English, the segmental plane is pre-associated to the skeleton in the lexicon, from which a syllable plane is generated, while in Semitic languages, skeletons with partially pre-specified syllable-planes are provided by the morphological component, with the segmental plane "derived" via association of root consonants and aspectual vocalism to the skeleton. Aspects of the three-dimensional representation in (6) which relate specifically to syllable structure are discussed in the following sections.

1.1.2 Multi-Planar Representations of Syllabicity

Here we will focus on the relationship between three levels of phonological representation: the level at which distinctive features are represented, the level at which syllable structure is represented, and the level commonly referred to as the CV-tier, the skeletal-tier, or simply the core or skeleton, which is seen to mediate between the two. The point to be made is that syllabicity appears to be redundantly encoded at each level of representation.

As noted earlier, the notion of delimiting syllables by juncture was viewed by early generative phonologists as cumbersome and unintuitive, and was for the most part avoided. Such was the case in SPE, where most of the issues addressed could be handled straightforwardly without mention of syllables.[4] The sole exception to this in SPE was the statement of the English stress rule. Without direct reference to a distinction between branching and non-branching rimes, Chomsky and Halle were led to the somewhat opaque characterization of nonbranching rimes given below in part of the main stress rule(SPE,p.240):

(7) Part of Main Stress Rule: English

$$V \longrightarrow [\text{1 stress}] \; / \; \left[ X \; \underline{\quad} \; C_0 \; \left( \begin{bmatrix} V \\ -\text{tense} \\ \gamma \; \text{stress} \end{bmatrix} C_0 \; ([\beta \text{voc}, \alpha \text{cons}, -\text{ant}]) \right) \right]^1$$

Though the majority of segmental rules discussed in SPE did not require reference to syllable structure, or the feature [+syllabic], formulation of rules of elision and liaison in French were shown to be simplified if the feature [vocalic] was replaced by [syllabic], a suggestion of Milner and Bailey(1967). By replacing [vocalic] with [syllabic], the three rules in (8) required to account for native and foreign words could be collapsed to the two rules in (9).

(8) a. [-αvoc,αcons] ---> ∅ / __ # [αcons,-foreign]
    b. [+voc,-cons]  ---> ∅ / __ # [+voc,-cons,+foreign]
    c. [-voc,+cons]  ---> ∅ / __ # {[-voc],[+cons]}[+foreign]

(9) a. [-αsyll,αcons] ---> ∅ / __ # [αcons,-foreign]
    b. [-αsyll,αcons] ---> ∅ / __ # [-αsyll,+foreign]

---

4. Or perhaps, more accurately, there was insufficient evidence justifying yet another instance of juncture, in light of which syllable juncture was abanndonned in SPE.

The definition of the distinctive feature [+syllabic] was adopted from work of Milner and Bailey(1967). This definition is given in (10), and its distribution among major class features is shown in (11).

(10)  SPE Definition of [+syllabic] (p.354)
      " ... a feature 'syllabic' which would characterize
      all segments constituting a syllabic peak."

(11) SPE Major class features

|  | sonorant | syllabic | consonantal |
|---|---|---|---|
| vowels | + | + | − |
| syllabic liquids | + | + | + |
| syllabic nasals | + | + | + |
| nonsyllabic liquids | + | − | + |
| nonsyllabic nasals | + | − | + |
| glides:w,y,h,? | + | − | − |
| obstruents | − | − | + |

Due to the lack of correspondence between the feature [+syllabic] and a characterizable set of acoustic or articulatory properties, the SPE definition has remained for the most part unchanged to this day.

However, further phonological properties of the syllable were soon to be discovered. The work of Williams(1971) and Goldsmith(1976), in which tones were argued to be separate autosegmental units associated by rule or convention to the segmental string, had a profound influence on syllabic phonology. Once phonological representations could be treated as three-dimensional objects rather than strings of linear sequences, it was possible to delimit syllables without use of juncture. Working within an autosegmental framework, Kahn(1976) argued that syllables could be claimed to

exist as phonological constituents in the form of autosegmental structure.[5]

In (12) we see representations of the sort used by Kahn in his analysis of syllable-sensitive rules of English, where phonemes represent sets of distinctive features (as they will throughout unless noted otherwise)

(12) Syllable as phonological constituent (Kahn,1976)

```
    Hockett                    hock it (slow speech)
    ‾‾‾‾‾‾                     ‾‾‾‾
    h a k   I t                h a k   I t
    \ | /\ | /                 \ | /  | /
     \|/ \|/                    \|/   |/
      S   S                      S   S
```
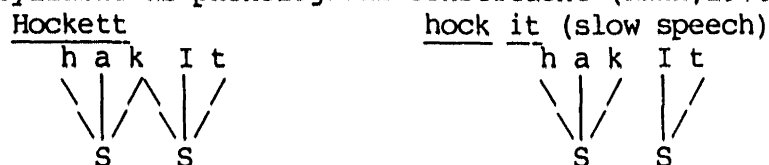
The syllables proposed by Kahn lacked any internal structure. Such syllables were accessed in phonological rules of the type shown in (13), typically rules involving the tauto- or hetero-syllabicity of segments, or the peripheral/non-peripheral position of a segment.

(13)  Syllable sensitive rules (Kahn,1976)

```
    a.    [-cons]  [-cont,+stiff VC,+cor] ---> [+constr GL]
           \      /\
            \    /  \
             \/      x      i.e. non-syllable-initial /t/ is
             S              glottalized following a non-consonant.


    b.    [-cont, +stiff VC] ---> [+spread GL]
          /\
          x  \          i.e. /p,t,k/ are aspirated in and
           x  \         only if they are both syllable-initial
            ‾‾S         and non-syllable-final.
```
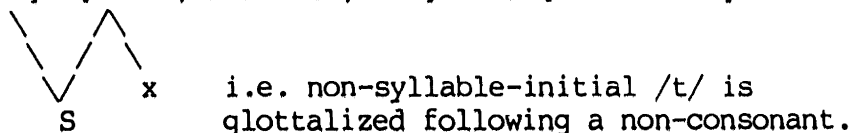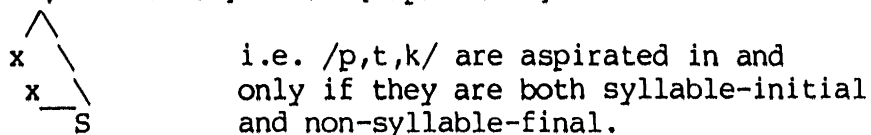
McCarthy(1979), extending the realm of autosegmental phonology, argued that segmental information be separated from syllabic information in the form of morphological templates which were encoded with values for [syllabic] and/or

––––––– ·–––––

5. Kahn's arguments for ambisyllabicity required that syllable structure be autosegmental rather than metrical, since constituency of ambisyllabic segments would result in improper bracketing.

[consonantal].[6] In his anaylsis of Classical Arabic verbal morphology, CV-skeletons are shown to act as morphemes themselves, lending semantic content to roots from which they borrow phonemic melodies. In (14) we see the system of formal representations adopted by McCarthy.

(14) CV-Templates (McCarthy,1979)
```
        root              kt b              'to write'
                          || |\
        9th binyan        CCVCVC            verbs of color or bodily defect
                          | /
        Tense             | /
                          a
        diathesis                           perfective active
        Surface:          [ktabab]
```

Within this system, C and V slots encode the features [-syllabic] and [+syllabic] respectively.[7] Autosegments are asssociated from left to right to "appropriate" slots of the template.

To ensure proper linking of feature complexes to the skeleton the features [+syllabic] are also represented on the melodic tier. Such linking can then be constrained by allowing only feature complexes containing the feature [-syllabic] to be linked to C slots, while feature complexes containing the feature [+syllabic] may only be linked to V slots. The basic Conditions on

----------

6. McCarthy is explicit as to the intrinsic value of C's and V's of the prosodic-template when he states that "...it is strictly the case that the features [syll] and [cons] are represented on the prosodic template and not on the autosegmental tier(p.247)." In subsequent work, C's and V's have been interpreted as encoding only [-syll] and [+syll] respectively

7. As noted above, this was implicit in McCarthy's original proposal, since [+consonantal] ---> [-syllabic], and was the interpretation of CV-skeletons adopted by Marantz(1982), Yip(1982), Steriade(1982), as well as McCarthy(1983).

Association are given in (15).

(15) Conditions on Association
    a.  Every unit on one level must be associated with at least
        one unit on every other level.
    b.  Autosegments are associated one-to-one from left to right
        with appropriate slots of the template.
    c.  Association lines may not cross.


Marantz(1982) extended the work of McCarthy(1979), showing that
reduplication could be viewed as affixation of CV-skeletal morphemes, where
C's and V's encode the features [-syllabic] and [+syllabic] respectively. In
(16) we see Marantz's model of CVC- prefixation in Aztec.

(16) CV-Skeletons in Reduplication: Aztec (Marantz,1982)

| I. | Stem | | Reduplicate | |
|---|---|---|---|---|
| a. | woman | 'to bark at' | womwoman | 'he is barking at' |
| b. | čikna | to shiver' | čikčikna | ' is shivering' |

II. a.
```
  w o m a n      w o m a n      b. č i k n a      č i k n a
  | | |          | | | | |         | | |          | | | | |
  C V C    +     C V C V C         C V C    +     C V C C V
```

Within his system, the phonemic melody of the stem is copied, and linked to
the CV-skeleton in accordance with a modified version of (15). In
particular, autosegmental elements can remain unassociated, while skeletal
slots cannot. In addition, direction of linking left-to-right or
right-to-left is argued to be a language specific parameter.

Combining the segmental tier à la SPE, the skeletal tier proposed by
McCarthy, and the syllable tier as originally proposed by Kahn (with the peak
or nucleus as a subconstituent of the syllable in Hockett's original sense),
one essentially ends up with a multiplanar representation such as that shown

in (17), where syllabicity appears to be redundantly encoded at each level.

(17) Multi-Planar Representations

```
Melody      /─────────────────────/
Plane      /     s I l ^ b l     /   [+syllabic] <==> V
          /      | | | | | |    /
Skeleton  ·  ·  C -V C -V C -V - - -    V <==> [+syllabic], N
          \      \ | /\ | \ |     \
Syllable   \      \N / \N   \N      \   N(nucleus) <==> V
Plane       \      o-   o-   o-      \
             ─ ───── ──────────── ───────
```
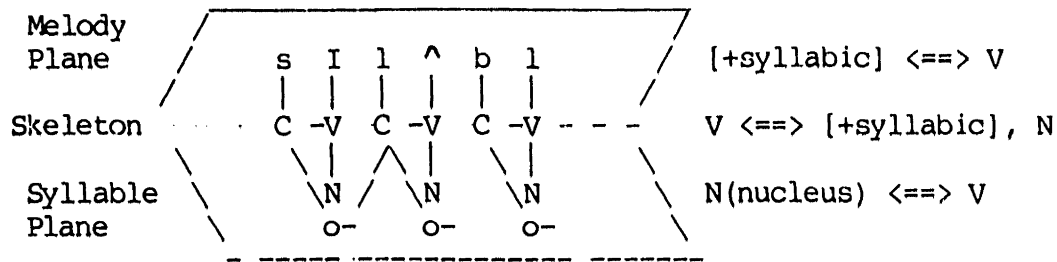
On the surface, the feature [+syllabic] on the segmental plane is universally non-distinctive, as [+syllabic] matrices will only appear linked to slots dominated by the nucleus of the syllable. In fact, [+syllabic] appears to be the only distinctive feature which is never distinctive in surface representations, making the redundancy encoded in (17) not only suspect, but also undesirable.

The feature matrices for /I/, /^/ and /l/ in (17) all contain the feature [+syllabic] on the surface, requiring that they be linked to V-slots in the skeleton.[8] C and V- slots are endowed with the features [-syllabic] and [+syllabic] respectively again to ensure proper linking in the case of Semitic morphology and reduplicate affixes. We also see that skeletal slots marked as V's are those and only those dominated by the nucleus (or head) of a syllable, while those marked as C are not. The structural label N then, which marks the rime-intial skeletal-slot, is in a biuniqueness relation with

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8. Shortly we will see that the CV-theory does allow [+syllabic] elements to link to C-slots under special conditions, though the unmarked linking is [+syllabic] to V-slot. In a language like English where linking does not play a role in the phonology, we assume that associations to the skeleton are of the unmarked type.

the feature [+syllabic], whether represented on the skeleton or on the segmental plane.

As a preliminary step at eliminating such redundancy, we will present arguments that the skeleton is unspecified for syllabicity.[9] Having done this, we turn, in Chapter 2, to a proposal in which the segmental feature [+syllabic] is superfluous. An investigation of the status of empirical arguments for the distinctive feature [+syllabic] in Chapter 3 leads us to conclude that in all cases, such a feature can be eliminated, leaving the metrical property "head of a syllable" as the sole determinant of syllabicity.

We now turn to evidence which requires that at least some slots of the skeleton be unspecified for the feature [¬syllabic]. We will then motivate a generalization of this finding to all skeletal slots, arguing that syllabicity is, in all cases, derivable from the content of a segmental matrix, or from the metrical property "head of a syllable". The adoption of a featureless skeleton requires a reformulation of bare skeletal templates as sequences of X-slots with some marked as syllable heads. The notion of syllable head, and projections of the head are made explicit and empirical results are explored in following chapters.

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9. Part of this discussion is an extended version of Levin(1983).

## 1.2 Eliminating Redundancy

### 1.2.1 From the Skeleton

We will adopt, with minor revisions, the formulation of the skeleton
proposed by Levin(1983), in which this level consists of a sequence of empty
slots, notated herein as X's.[10] Each slot represents a single timing unit.
We will uphold, and provide further evidence for the hypothesis that every
slot on the skeletal tier is intrinsically featureless. Linking of a feature
or feature matrix to a slot on the skeletal tier will involve no more than an
encoding of that association. That is, linking will not involve percolation
of any features to the empty slot. Skeletal slots may or may not correspond
to terminal eleme.. ꞩ of syllabic trees. Furthermore skeletal slots need not
be linked to feature matrices. Thus, the skeletal tier must have independent
status, since it is not always derivable from either the phonemic melody or
the syllabic structure. A single example will suffice to illustrate these
points.

Evidence from affixation processes in Mokilese, a Micronesian language,
argues for leaving at least some skeletal slots unspecified in terms of
syllabicity and segmental information, since both consonants and vowels are

---

10. See Levin(1983) for a comparison of this version of the skeleton, where
slots are independent of syllable structure, and that proposed by Kaye and
Lowenstamm(1981), where slots are no more than terminal elements of syllabic
templates.

seen to link to these slots under predictable phonological conditions (all data is taken from Harrison(1976),(1977) and Harrison and Albert(1977). We will first examine what Harrison and Albert refer to as "loose suffixes". Loose suffixes differ from other affixes in that they trigger a phenomenon of boundary lengthening. Vowel-initial loose suffixes will trigger gemination of a preceding consonant, while consonant initial loose suffixes trigger lengthening of a preceding vowel. In (18) a list of the loose suffixes is given. In (19) we see the effect of loose suffixes on both consonant- and vowel- final stems.[11]

(18) Mokilese Loose Suffixes

| I. Determiners | | II. Directionals and Prepositions | |
|---|---|---|---|
| a. -pas | 'a' | a. -do | 'towards the speaker' |
| b. -wa | 'the' | b. -we | 'towards the hearer' |
| c. -o | 'that' | c. -la | 'away from the speaker' |
| d. -e | 'this' | d. -di | 'down |
| e. -kai | 'these' | e. -da | 'up' |
| f. -kan | 'those' | f. -ki | 'with' |
| g. -ɔw | 'a,one' | g. -ɔn | 'to' |
| h. -ɔwe | 'this very' | h. -jan | 'from' |
|  | (ɔw + e ) |  |  |

(19) Boundary Lengthening

| a. wɔl | 'man' | pwo | 'pole' |
|---|---|---|---|
| b. wɔlle | 'this man' | pwo:y | 'this pole' |
| c. wɔllo | 'that man' | pwo:w | 'that pole' |
| d. wɔlkay | 'these men' | pwo:kay | 'these poles' |
| e. wɔlkan | 'those men' | pwo:kan | 'those poles' |

Ignoring for the moment the glide/vowel alternations in the second column of (19.b,c), we see that the vowel-initial loose suffixes lengthen both a preceding vowel or consonant, while consonant-initial loose suffixes appear to have no effect on preceding consonants. Given the simple association rule

--------

11. Mokilese phonemes include the labio-velars /mw,pw/ which are monosegmental, /j/ a palatal stop, and the lower-mid front and back vowels /E/ and /ɔ/.

in (20), the formulation of which will also be supported by facts from reduplication, we can analyze the loose suffixes in Mokilese as just those suffixes which contain initial unspecified skeletal slots.

(20) Multiple Association Rule

$$
\begin{array}{l}
[\alpha F] \\
\quad |\diagdown \\
\quad | \quad \diagdown \\
\quad X \quad \circledX
\end{array}
\qquad \text{(Where X is an unspecified slot)}
$$

In (21) we see posited underlying representations of loose suffixes.[12]

(21)  a.   e     b.   o    c.   k a y    d.   k a n

         |             |         | | |       | | |

     -X V     -X V    -X C V C    -X C V C
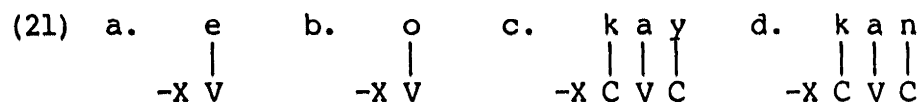
Here we have an example of a morpheme initial element which exists independently of the segmental tier and the syllable tier. The fact that the inital skeletal slots of the suffixes are unspecified for syllabicity allows both + and - syllabic segments to link to them. In (22) we see sample

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12. An alternative analysis of loose-affixation seems possible where in fact the X slot is not part of the suffix, but rather where it is an autonomous element inserted in a particular syntactic environment, namely between an X'-projection and a Specifier. All the suffixes in (18.I) attach to N', while those in (18.II) can be viewed as affixes to V'. While we do not have enough available evidence to pursue X-infixation as a syntactically conditionned rule, such an analysis would only strengthen the claims made here: first that the skeleton is independent of the segmental and syllable planes, not only phonologically, but morphologically as well, and second, that it is not inherently specified for syllabicity.

derivations of the surface forms given in (19.c,e).

(22)　　a.　w ɔ l　　o　　　　b.　pw o　　o
Rule(9)　　| | |\　|　　　　　　| |\　|
　　　　　　C V C-X V　　　　　　C　V-X V
Syll.　　　\|/　\|　　　　　　　\ |/ /
　　　　　　o-　　o-　　　　　　　　o-
Surface　[wɔllo]　　　　　　　[pwo:w]

　　　　c.　w ɔ l　k a n　　d.　pw o　k a n
Rule(9)　　| | |\ | | |　　　　| |\ | | |
　　　　　　C V C-X C V C　　　　C　V-X C V C
Syll.　　　\|/　　\|/　　　　　\ |/　\|/
　　　　　　o-　　o-　　　　　　　o-　　o-
Surface　[w^lkan]　　　　　　　[pwo:kan]
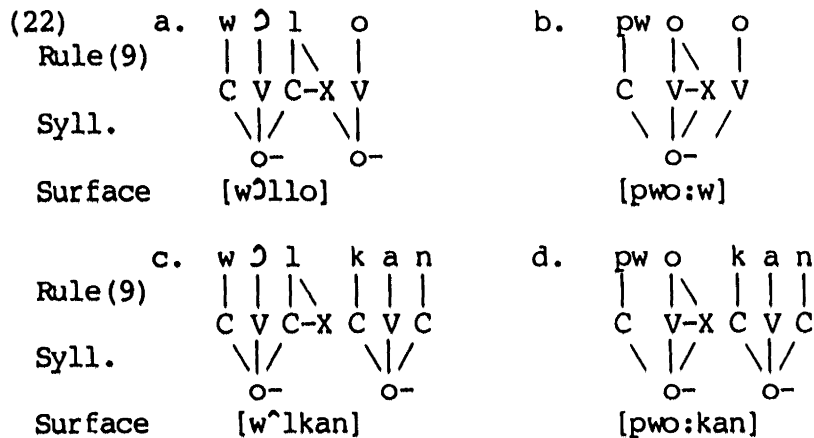
The fact that a geminate consonant does not surface in (11.c) is due to the syllabification rules of Mokilese which do not permit superheavy syllables of the form CVCC in native words.[13]

Notice the extent to which such an analysis is complicated by assuming skeletal slots to be specified as C's and V's. First, we must arbitrarily choose values for X-slots in writing the multiple association rule:

(23) A.　[$\alpha$F]　　B.　[$\alpha$F]　　C. [$\alpha$F]　　D.　[$\alpha$F]
　　　　　|\　　　　　　|\　　　　　　|\　　　　　　|\
　　　　　| \　　　　　| \　　　　　| \　　　　　| \
　　　　　C V　　　　　C C　　　　　V C　　　　　V V

_____
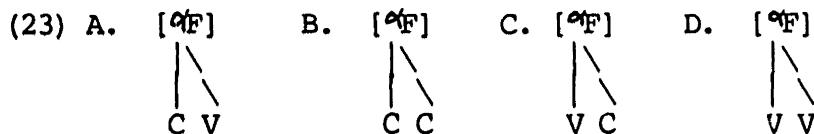
13. CVVC syllables do occur word internally in native words, so we have re:n 'day', and re:nnɔwe 'today'. If long vowels are treated as branching Nuclei, then both CVC and CVVC syllables will be generated by N'-Projection, a rule which generates an N'-projection by sister-adjoining an unsyllabified slot to an existing N$^o$. CV(V)CC syllables, as far as I can tell, only appear in word-final position of non-native words. Some examples are aispwɔks 'icebox' (<Eng.), wi:nj 'winch' (<Eng.), and klo:ra:ks 'bleach' (<Eng.). These words necessitate an additional rule of non-iterative rightwards adjunction to N", a rule which applies in word final position to a non-native subset of the lexicon. This rule and a statement of Project N' rule are formulated in the next section, and such rules are presented in detail in Chapter 2.

First notice that rules A and C of (23) require use of a "special proviso" which allows linking of [-syllabic] matrices to V-slots and [+syllabic] matrices to C-slots.[14] Depending on the specific proposal, such linking will or will not invoke a change of a V slot to a C slot or the inverse. Allowing the use of variable notation within the CV-theory will allow us to collapse either rules A. and D., or B. and C. as shown below.

(24) A.  [^F]     B.  [^F]
         |\           |\
         | \          | \     where X ranges over values for
         X Ⓥ          X Ⓒ     C and V.
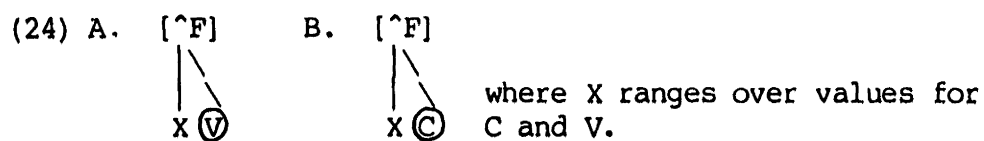
Choosing a single rule from the two in (24) is not difficult. Though both require a special proviso, only the representations derived by (24.B) are consistent with surface syllabification. If (24.A) is chosen, and slots retain their original identity after linking, illformed derivations like that shown below will result.

(25)          w ɔ l   k a n
              | | |\  | | |
              C V C V C V C
Syll.          \| \ | \ | /
              o-  o-  o-

Surface  *[wɔllkan]
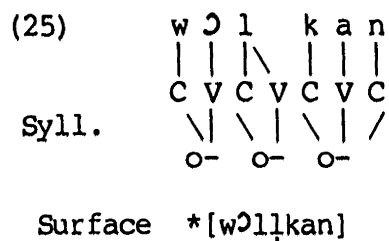
(24.B) then is posited to account for lengthening under loose-suffixation, with invocation of the "special proviso". The special proviso can be stated

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14. See McCarthy(1983) for a thorough discussion of the problems related to the "special proviso". In this work, McCarthy appears convinced of the existance of X-slots, but stills sees template morphology as a challenge for such a system. See Section 2.2 for an account of template morphology without Cs and Vs, which is a essentially a revised version of that proposed in Levin(1983) and Archangeli(1984).

as follows:

(26) Special Proviso
Where association of segmental matrices to skeletal slots
is rule-governed,(i.e. is not a result of the universal
association conventions), linking of [-syllabic] to C-slots
and [+syllabic] to V-slots may be overriden.

In this case we not only complicate the grammar by addition of the special proviso, but also by positing underlying initial CC-clusters in loose-suffixes, but nowhere else in the native vocabulary of Mokilese.[15] Now, let us compare rule (24.B) to rule (20) above:

(27)  (20)                    (24.B)

          $[^\alpha F]$              $[^\alpha F]$
           $|\backslash$               $|\backslash$
          X Ⓧ                {V,C} Ⓒ
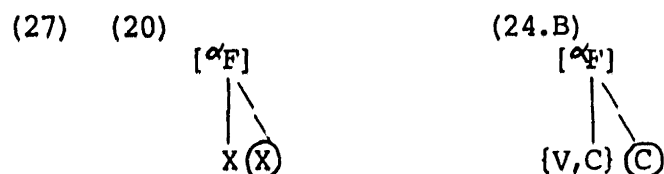
The use of X-slots does away once and for all with the "special proviso" which was seen to override a universal condition on linking. Furthermore, it allows us to do away with the conjunction {V,C} above. We are thus able to choose rule (20) over alternative formulations on grounds of simplicity.

However, the CV-analysis is able to handle such cases. Thus, evidence from loose-affixation suggests, but does not necessitate, the existence of unspecified slots. We now turn to further evidence in Mokilese which argues convincingly for rule (20) above, and for the existence of skeletal slots which are independent of both syllable structure and segmental content. If, via rule (20), they are associated to a [+syllabic] matrix, they will surface as vowels, and if associated to [-syllabic] segments, they will surface as

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15. Note that this ceases to be a problem if a syntactic analysis such as the one suggested in fn.(12) turns out to be correct.

consonants or glides.

The evidence in question concerns Mokilese reduplication, where X-slots as opposed to C or V-slots appear to be necessary in phonological representations. In this case, a CV analysis is not possible. In (28) we see the progressive forms of a number of verbs, where progressive is indicated by a prefix of the form XXX-:[16]

```
(28) Stem        Progressive  Skeleton      Gloss
  a. pɔdok       pɔdpɔdok     XXX- CVC-     'to be planting'
  b. kasɔ        kaskasɔ      XXX- CVC-     'to be throwing'
  c. pa          pa:pa        XXX- CVV-     'to be weaving'
  d. wia         wi:wia       XXX- CVV-     'to be doing'
  e. ca:k        ca:ca:k      XXX- CVV-     'to be bending'
  f. onop        onnonop      XXX- VCC-     'to be preparing'
  g. andip       andandip     XXX- VCC-     'to be spitting'
```

Provided that the prefix is monosyllabic, it may be realized with Cs or Vs in any position. In (28.a,b) we have a CVC prefix, in c.-e. a CVV prefix, and in f. and g., a VCC prefix. Positing the reduplicative schema in (29) below, where a featureless skeleton of the form [$_{\sigma}$XXX]- is prefixed to the stem, linking will be governed by the universal association convention. In the event of an unassociated slot, we can invoke the Multiple Association

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16. A prefix of the same sort is used in the formation of stative verbs derived from monosyllabic nouns with non-high stem vowels, for example lɔnglɔng 'full of flies' from lɔng 'fly', as well as in the formation of intransitive verbs from their transitive stems, but since both of these processes are limited to particular subsets of the lexicon, and also involve other phonological processes of vowel insertion and deletion, we use the progressive forms exclusively in the examples. XXX- prefixation should not be confused with a form of XX- reduplication which derives intransitive verbs from transitives. This detransitive prefix is limited to a handful of monosyllabic verb roots of the shape CV, CVV(C): dɔ 'to sew something', dɔdɔ 'to sew'; mwa:l 'bad', mwamwa:l 'to treat badly'; kaik 'to scratch something', kɔkɔik 'to scratch.' There is no indication by Harrison that this is a productive process.

rule (20) to account for the surface long vowels in (28.c,d) as well as the
geminate consonant in (28.f). Derivations resulting in CVC-, CVV-, and VCC-
prefixes are given in (30):

(29) Mokilese Reduplication
    A.  Prefix [XXX]-
                o-
    B.  Copy stem melody
    C.  Universal Association Convention:
           Associate autosegments to segment-bearing units
           one-to-one, left-to-right, where association
           lines may not cross.
    ----------
    D.  Rule (20)


(30) By universal association conventions:
```
a. p ɔ d o k   p ɔ d o k    b. k a s ɔ   k a s ɔ    g. a n d i p   a n d i p
   | | |       | | | | |        | | |     | | | |        | | |       | | | | |
  [X X X]  -  C V C V C        [X X X] - C V C V       [X X X]      V C C V C
   o-                           o-                      o-
By universal association conventions and rule (20):
c. p a     p a    d. w i a    w i a    f. o n o p   o n o p
   | |\    | |        | |\     | | |        | |\      | | | |
  [X X X]- C V      [X X X]- C V V       [X X X]··  V C V C
   o-               o-                   o-
```

In (30.d,f) above, the specification of the reduplicate prefix as a single
syllable results in blocking of the universal association convention, since
linking of the third segment in each case would result in a bisyllabic
prefix. Once the universal association convention is blocked, special rules
of linking come into play. Rule (20) then applies, resulting in the surface
long vowel and geminate consonants shown above. However, the reader will
notice that the reduplicate ca:ca:k from ca:k is not what we would expect,
given this analysis. One-to-one left-to-right linking should result in

*cakca:k as shown below[17]:

```
(31)    * c a k     c a k
          | | |      | |\ |
        [X X X] - X  X X X
        o-
```

Such data, in which the multiple associations of stem segments is preserved under reduplication, is consistant with a recent proposal of Clements(1985), which concerns what he refers to as the problem of non-linear transfer. In short, Clements suggests that reduplication is most accurately represented as a type of across-the-board rule application (cf.Williams,1978), with subsequent linearization, rather than linear prefixation followed by linking. The schema proposed by Clements, and an illustrative example are provided below:

(32) i.  Affixation: adjoin a reduplicative affix in parallel to
         the CV tier of the base.
    ii.  Reduplication:
         a. associate Cs to Cs and Vs to Vs on the adjecent CV tiers.
         b. transfer the melody of the base to the associated
            portion of the affix.
         c. sequence the affix skeleton to the base skeleton as a
            prefix, infix, or suffix.

```
(33)                                       b u l
                                           | | |
     C V C          C V C          C V C          C V C + C V C V
            --->    | | |    --->   | | |   --->   | | |   | | | |
     C V C V        C V C V         C V C V        C V C   C V C V
     | | | |        | | | |         | | | |        | | |   | | | |
     b u l a        b u l a         b u l a        b u l   b u l a

     (affixation)   (association)   (transfer)     (sequencing)
```

The major feature which distinguishes Clements' model from that originally

_____

17. Note that this problem arises regardless of whether one proposes an
X-skeleton or a CV-skeleton.

proposed by Marantz(1982) is that there is no process of melody copy. Association is from skeleton to skeleton, not from melody to skeleton. One prediction made by such a theory is that multiple associations of the stem melody will be "transferred" to the reduplicate prefix.[18] Abstracting away from Clements use of Cs and Vs, we see that the surface retention of stem vowel length in the reduplicate form ca:ca:k is predicted by non-linear transfer. The derivation within this system is given below:

(34)
```
                                       c a
                                       | |\
   [X X X]        [X X X]         [X X X]
   o-       --->  | | |    --->   | | |    --->
    X X X X        X X X X         X X X X       [X X X] + X X X X
    | |/ |         | |/ |          | |/ |         | |/     | |/ |
    c a  k         c a  k          c a  k         c a      c a  k

 (affixation)   (association)    (transfer)      (sequencing)
```
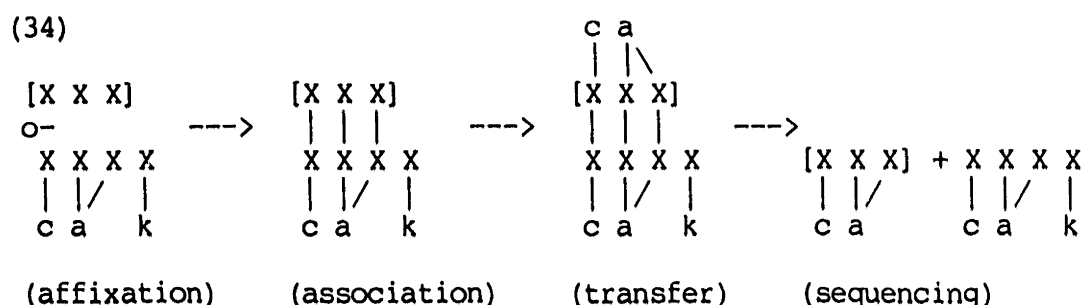
Adopting this system of linear transfer, we can state the rules of reduplication in Mokilese as follows:

(35) Mokilese Reduplication
    i. item: [X X X]
             o-
   ii. base: verb stem
  iii. direction: left to right
   iv. insertion sight: prefix

---

18. A second prediction made by this theory is that syllabicity distinctions will remain constant in stem and reduplicate prefix since it is stated that Cs associate to Cs and Vs to Vs. However, there are cases again, like Mokilese where a special proviso must be invoked. If it is true that syllabicity distinctions are unaltered under reduplication, both linear and non-linear models must state this convention independent of association conventions. See Clements(1985) for further discussion of these issues and their empirical basis. For possible counter-evidence to a non-linear approach which appears to show alterability of syllabicity distinctions under reduplication, see Steriade's(1985) detailed account of Sanskrit reduplication and ablaut.

After linearization, rule (20) will apply, as shown in (34) above. As a result of the unspecified X-slots in the monosyllabic prefix, the phonological form of the prefix may show up as CVC, CVV or VCC.

How would the CV-theory account for such facts? If the progressive prefix is viewed as a single phonological form, it appears that the choice of a skeleton is arbitrary. A CVC- prefix, with invocation of the special proviso will produce the correct forms for consonant initial stems, but what of vowel intial forms? Here the special proviso must be invoked but in a stronger version, for it must override appropriate linking not in the case of a language specific rule, but in the standard association convention, as shown in (36.a) below:

(36) Special proviso at work
```
  a. Linear                    b. Non-linear
     a n d i p    a n d i p          C V C
    *|*| |      | | | | |          *|*| |
     C V C      V C C V C           V C C V C
                                    | | | | |
                                    a n d i p
```

Whether association is linear or non-linear, it is altogether unconventional. In fact, in this case it makes encoding of the CV-tier vacuous, since whether a slot is C or V does not play a role in association.

Nevertheless, there is one possibility of saving the CV- analysis for the vowel-initial stems, a version of which was given in Levin(1983). Under this account, the vowel initial stems are preceded by initial empty C-slots in underlying representation. Thus, the VCC- forms like **andandip** are a result of association to a CVC- skeleton plus the stem-initial empty slot:

```
(37)          a n d...a n d i p      o  n...o n o p
               \ \ \  | | | | |       \  |\ | | | |
               C V C-C V C C V C      C V C-C V C V C
```

However, other forms involving prefixation do not lend support to this analysis. Two fairly productive prefixes, /ka-/ a causative prefix, and /ak-/ which is glossed as 'display of' (in a derogatory sense), should undergo vowel-lengthening and gemination respectively when prefixed to vowel initial stems, if such stems contain an empty C-slot. (Recall that vowels may link to C-slots by rule as in the reduplicate form pa:pa). Unfortunately, /ak-/ was only found prefixed to C-initial stems: aklaplap 'cocky' (<laplap 'important'); akpwung 'to self-justify' (<pwuŋ 'correct'); aksiksik 'humble' (<siksik 'small'). /ka-/ on the other hand, is found with vowel initial stems, but in such cases, no lengthening occurs, indicating that vowel initial stems are not preceded by empty skeletal slots. Some examples are given in (38):

(38) /ka-/ causative prefix
| | | | |
|---|---|---|---|
| ka:danki | 'to name' | adanki | 'named' |
| kaimwjekla | 'to finish' | imwjekla | 'finished' |
| kainene | 'to straighten' | inen | 'straight, upright' |
| kairɔki | 'to line up' | irɔk | 'lined up' |
| kauru:r | 'to be funny' | uru:r | 'to laugh' |

Compounds also fail to exhibit lengthening at boundaries: ukeng 'windy' (<uk 'to blow' eng 'wind'); jo:ninsing 'Secretary'(<jo:n 'person of' + insing 'to write'). This fact cannot be attributed to ordering of rule (20) before compounding, since boundary lengthening is, we recall, a phrasal phenomenon: jo:ninsingngo 'that secretary' (jo:n-insing-o).

We conclude that vowel-initial stems are not preceded by empty skeletal slots, and that therefore the CV-analysis is untenable. Given that the sole reason for encoding skeletal slots as Cs or Vs (McCarthy,1979) is to ensure proper association of segmental autosegments, the reduplicate prefix in

Mokilese is most simply stated as a monosyllabic sequence of unlabelled timing slots.

Looking back at the derivations in (30.d,f), we stated that the reduplicative prefix must be specified as a single syllable. In both instances a vowel is not able to link to the available X-slot since this would result in a bisyllabic sequence. The specification of the Mokilese reduplicative prefix as a single syllable is evidence that syllable structure exists independent of segmental information since, in this case, no segmental information is prespecified in the prefix.

Up to this point then, the loose suffixes and the morphology and phonology of reduplication in Mokilese have together provided evidence for skeletal slots unspecified for syllabicity. Such empty slots in the loose suffixes require that the skeleton be independent of both the segmental and syllabic planes. In addition, we have seen that the syllable-plane, or the bracketing encoded on such a plane, exists independently of the segmental plane, as illustrated by the monosyllabic representation of the Mokiliese reduplicative prefix. While the analysis of loose suffixation lends itself to a possible CV-analysis along the lines discussed above, the analogous facts concerning reduplication necessitate strings of unlabelled slots, making a CV analysis, at least useless, if not untenable.

Before moving on to a generalization of this finding, we will quickly examine further supporting evidence for unspecified X-slots in reduplicative prefixes, and the non-linear transfer model proposed by Clements(1985). Reduplication in Ponapean(Rehg and Sole,1981), another Micronesian language, provides further evidence for strings of unlabelled timing slots. The

durative form of verbs in Ponapean is formed via reduplication. On the surface, there appear to be eleven different types of durative prefixes, with each type determined by the phonological form of the stem.[19] In the

---

19. For an extensive autosegmental treatment of phonological and morphological processes, as well as an alternative account of reduplication in Ponapean, see McCarthy(forthcoming).

following chart, we give several examples of each pattern:[20]

(39) Ponapean Reduplication (where $\underline{X}$ = X, N = syllable nucleus)
|
N

|       | Stem    | Durative   | Skeleton  | Gloss                    |
|-------|---------|------------|-----------|--------------------------|
| I.    | lal     | lallal     | XXX- CVC- | 'to make a sound'        |
|       | pap     | pampap     | XXX- CVC- | 'to swim'                |
|       | pei     | peipei     | XXX- CVC- | 'to float'               |
| II.   | pa      | pa:pa      | XXX- CVG- | 'to weave'               |
|       | du      | du:du      | XXX- CVV- | 'to dive'                |
| III.  | el      | ele:l      | XXX- VCV- | 'to rub or massage'      |
|       | uk      | uku:k      | XXX- VCV- | 'fast'                   |
| VII.  | alu     | alialu     | XXX- VC-  | 'to walk'                |
|       | urak    | uru:rak    | X̄XX- VC-  | 'to wade'                |
| VIII. | liya:n  | li:liya:n  | X̄XX- CVV- | 'outgoing'               |
|       | riya:la | ri:riya:la | X̄XX- CVV- | 'to be cursed'           |
| X.    | ŋmed    | ŋmimmed    | X̄XX- VC-  | 'full'                   |
|       | ŋda     | ŋdinda     | X̄XX- VC-  | 'to say'                 |
| XI.   | rere    | rerrere    | X̄XX- CVC- | 'to skin,peel'           |
|       | dune    | dundune    | X̄XX- CVC- | 'to attach in sequence'  |
|       | deyed   | deydeyed   | X̄XX- CVG- | 'to eat breakfast'       |
|       | dilip   | dindilip   | X̄XX- CVC- | 'to mend thatch'         |
|       | pepe    | pempepe    | X̄XX- CVC- | 'to swim'                |
|       | siped   | sipisiped  | X̄XX- CVC- | 'to shake out'           |
| IV.   | a:n     | aya:n      | XX- V     | 'to be accustomed to'    |
|       | e:d     | eye:d      | XX̄- V-    | 'to strip off'           |
| V.    | wa      | wewa       | XX̄- GV-   | 'to carry'               |
|       | ian     | ieian      | XX̄- GV-   | 'to accompany'           |
| VI.   | duup    | duduup     | XX̄- CV-   | 'to dive'                |
|       | miik    | mimiip     | XX̄- CV-   | 'to suck'                |
|       | pain    | papain     | XX̄- CV-   | 'to incite'              |
|       | pei     | pepei      | XX̄- CV-   | 'to fight'               |
|       | kens    | kekens     | XX̄- CV-   | 'to ulcerate'            |
| IX.   | ma:sa:s | mama:sa:s  | XX̄- CV-   | 'cleared of vegetation   |
|       | to:ro:r | toto:ro:r  | XX̄- CV-   | 'to be independent'      |

---------

20. Clusters which result from the pattern in I. are subject to a number of phonological processes including nasal dissimilation as in **dindid** (<**did** 'build a wall', total assimilation as in **nunnur** (<**nur** 'contract'),and epenthesis as in **parapar** (<**par** 'to cut') and **pediped** (<**ped** 'to be squeezed'). In this last case, epenthesis inserts an empty X-slot which is filled by the underlying floating final vowel of the ⁻stem /ped-i/. McCarthy's analysis relies on a CVCV- prefix in these cases with C's and V's left empty where necessary.

McCarthy(forthcoming) lends a crucial insight into the above data, noting that the mora count of the prefix appears to be determined by the mora count of the stem.

First, McCarthy argues that nouns in Ponapean must contain at least two moras on the surface. Monosyllabic nouns which do not meet this condition undergo a rule of lengthening when uninflected. Stems with underlying long vowels or final CC clusters do not undergo this lengthening rule. Examples are given below:

(40) Underlying stem    Uninflected Noun    Gloss
  a. $p^w$il+i          $p^w$i:l            'gum'
  b. nen+i              ne:n                'spirit'
  c. sap$^w$+E          sa:p$^w$            'land'

  d. ke:p               ke:p                'yam'
  e. ra:n               ra:n                'day'

  f. emp                emp                 'coconut crab'
  g. mall               mall                'grassy area'

From such facts, McCarthy concludes that Ponopean has a general rule of extrametricality. He writes the rule as follows:

(41) Final Extrasyllabicity
    C ---> [+extrasyllabic] / __#

Following the extrametricality rule, monomoraic lengthening applies:

(42) Monomoraic Noun Lengthening (McCarthy,p.42))
                      X
    Ø ---> V/ [..._...]
                      Noun
    where V is a nucleus element, and X is the lowest level
    of the metrical grid.

The rule as stated will distinguish between the nouns /kau/ 'harmful magic, sorcery' which does not undergo lengthening, and /dau/ 'anus,

vagina(polite)', which does undergo lengthening, by representing the first as

CVV and the second as CVC:

(43)         a.    k a u                  b.   d a   u
                   | | |                        | |   |
Rule(41)           C V V                        C V V(C)
Rule(42)                                             |


Anticipating further discussion, it should be pointed out that rules (41) and

(42) can be stated without any reference to C's and V's simply by referring

to syllable structure.  Reformulations using the X-notation are given below:

(44) Final Extrametricality
     X ---> [+extrametrical] / ___#
                               |
                               N'(= rime)


(45) Monomoraic Noun Lengthening
     ∅ ---> X/ [[...X___...]]
               σ-  |      Noun
                   N
                   |
                   N'


The rule in (45) requires that neither N nor N' branch.  Given these two

rules, the distinction between the forms in (43) above is represented as a

difference in internal syllable structure:[21]

```
(46)        a.  k a u              b.  d a   u
                | | |                  | |   |
Rule(41)        X X X                  X X  (X)
                 |/                    |   /
                 N                     N  /
                                       |/
                                       N' (=rime)
                                       |
                                       N" (=o-)
```
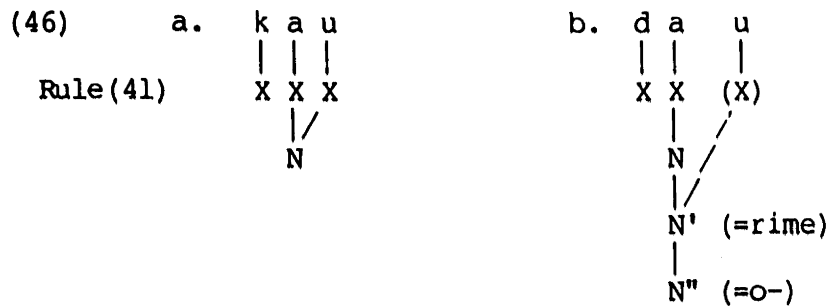
While mora count clearly plays a role in the nominal morphology, as shown above, McCarthy notes that it also appears to determine the phonological form of the reduplicate prefix. Where moras are just those elements dominated by the syllable rime, after extrametricality, stems taking the prefix XXX- are monomoraic, those taking the prefix XXX- are multimoraic with inital monomoraic syllables, and those taking XX- are multimoraic with initial multimoraic syllables. A minimal pair illustrating the interaction between mora count and reduplicate prefix is provided below:

```
(47) a.  pei 'to float'          b.  pei  'to fight'

     p e i   p e i                    p e i   p e i
      \ \ \  | | |                     \ \    | | |
       X X X + X X (X)                  X X + X X X
           |   /                        |     |/
           N  /                         N     N
           |/
           N'
```
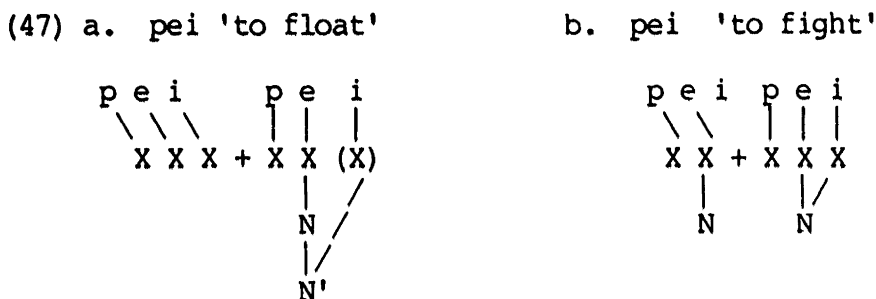
The eleven surface forms of the Ponapean reduplicate can be simplifed to

---

21. See 2.1 for further examples of such distinctions. In Ponapean, (46.a) is the only possible representation for word-internal [au] sequences in closed syllables, since syllabification of /u/ under N' would leave a following consonant unsyllabified. Add to this the segmental extrametricality rule, and it appears that (46.b) will be limited to word-final position.

three skeletal prefixes, the choice of which is dependent on the mora count

of the stem and that of the initial stem syllable:

(48) Ponapean Durative
   a.

       XXX-  /__  [[...X...]]
                o-  |      Verb
                     N
                     |
                     N'

Elsewhere:
   b.     XXX-    / __[[...X]...   c.  XX-   / _  [[...XX...]..
         |             | o-        |            |   o-
         N             N         N            N

In (48.a), as in Mokilese, there is no sense to marking slots as Cs or Vs

since, in all cases, association will proceed one-to-one left-to-right

regardless of the skeletal specifications. For the forms in (39.II,III) we

posit the following mirror image rule, which spreads a vowel to an adjacent

unassociated skeltal slot:

(49)  [$\alpha$F ]
       |\
       X X  %
       |
       N

For the stems which select (48.b), and begin with syllabic segments,

something more must be said. Here again, the non-linear model of

reduplication, under a specific interpretation, is superior to the linear

model in predicting stable values of syllabicity. Replacing Clements' Vs

with syllable heads, notated as $\underset{\sim}{X}$s, all we need say is that categorial as

well as segmental features are transferred.[22] Derivations for ndinda

--------

22. It is possible to stipulate in the linear model as well that categorial
features remain stable under association. Again, the question of whether or
not syllabicity distinctions remain constant under reduplication is still an

'saying' and **li:liya:n** 'being cursed' are given below:

```
(50)                                   n d
                                       | |
   X X X          X X X         X X X
          --->    | |    --->   | |    --->
   X X X          X X X         X X X      X X X + X X X
   | | |          | | |         | | |      | |    | | |
   n d a          n d a         n d a      n d    n d a
(affixation)    (association)  (transfer)   (sequencing)
                                   l i
                                   | |\
   X X X          X X X         X X X
          --->    | | |  --->   | | |    --->
   X X X X X X    X X X X X X    X X X X X X    X X X +X X X X X X
   | |/ |/ |      | |/ |/ |      | |/ |/ |      | |/ | |/ |/ |
   l i  a  n      l i  a  n      l i  a  n      l i  l i  a  n
```
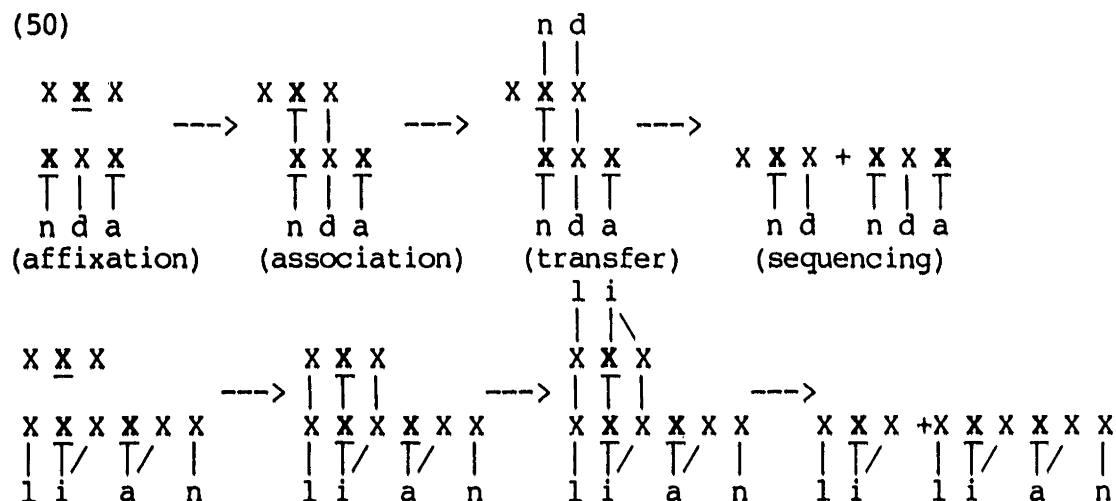
Epenthesis follows linearization in the derivation of [ndinda]. A linear model must rely on marking of segments like the initial /n/ of /nda/ as [+syllabic] in order to restrict their association to skeletal slots which are themsevles marked as [+syllabic]. The non-linear model, as illustrated above, need not mention the feature [+syllabic], provided that access to a minimal amount of syllable structure, namely Nucleus position, is available.

In McCarthy(forthcoming), the prefixes are represented as CVCV- CVx and CV-. The second and third correspond exactly to the skeletons proposed here, where any element can link to a slot labelled 'x'. The CVCV- prefix necessitates special linking conditions. McCarthy relies on the ability to skip over skeletal slots, and on the condition that if an element (like a syllabic nasal) is linked to a V in the stem, then it must link to a V in the prefix as well. The analysis offerred above, involves left to right associations without skipping sequential slots or sequential segments. When

---

open one. If they do not, evaluation of linear versus non-linear models will depend crucially on the ability of each theory to account for over- and under- application of phonological rules.

implemented within the non-linear model proposed by Clements(1985) retention of syllabicity distinctions is just one general feature of transfer, rather than the global condition necessary in the linear model which requires that if A was linked to a V-slot in the stem, then A must link to a V-slot in the prefix. Furthermore, it again appears that the labelling of timing slots as either C or V is rendered superfluous, in particular for the forms taking the XXX- prefix (48.a).

Having established the existence of unspecified skeletal slots, let us now look back a moment at the biconditional statements in (17), repeated below.

(51) Redundancy: [+syllabic]
```
                |             i.   [+syllabic] <---> V
                V            ii.               V <---> N
                |           iii.  [+syllabic] <---> N
                N
```

There we remarked that the status of a skeletal slot is entirely predictable from either the segmental matrix to which it is linked, or by whether or not it is dominated by N on the syllable tier. In the majority of languages in the world, including Mokilese, segmental melodies are prelinked to the skeletal tier in the lexicon. For instance, the length differences of vowels and consonants in (52) are distinctive, and therefore are marked in the

lexicon by different associations to the skeletal tier[23]:

(52) Underlying Length Distinctions in Mokilese
```
    a. r o s      'darkness'    r   o   s     'flower'
       | | |                    |   |\  |
       X X X                    X   X X X

    b. l i k ^    'chapped'     l i k   ɔ     'clothes'
       | | | |                  | | |\  |
       X X X X                  X X X X X
```

In languages like Mokilese, English, Klamath, and many more, marking the features [+syllabic] on the skeletal tier is redundant, since this feature is merely a copy of the feature on the segmental tier. In other words, syllabification in such languages is mainly determined by the character of the phonological string.

In languages with template morphology like Semitic(McCarthy,1981) and Yawelmani(Archangeli,1984) as well as in many cases of reduplication like the ones just examined, skeletal-templates void of segmental material, may be listed in the lexicon. For example the first and third binyanim in Classical Arabic may be specified in the lexicon as follows:[24]

```
(53) I binyan                III binyan
     X X X X X                X X X X X X
       |   |                    |/    |
       N   N                    N     N
```

Should we choose to label slots as Cs and Vs, we see that given the

---

23. Arguments for the monosegmental character of these geminates include the fact that as consonants, they cannot be split by epenthesis(cf.Guerssel,1979; Schein,1980) and as vowels, they are consistently tautosyllabic (cf.Levin,1983).

24. See 2.2 for further discussion of the representation of templates and conditions on association.

biconditionals in (51), the skeletal tier is also marked redundantly for syllabicity, since such specifications are given by predetermined structure on the syllable tier, as shown above. In such languages, it appears that syllabification, at least in part, is determined by the morphology.

While syllabicity may be lexically encoded on the segmental tier or on the syllable tier, in either case, specifying skeletal slots as [+syllabic] leads to redundancy. Furthermore, we have just seen that certain phonological analyses require reference to skeletal slots which are crucially unspecified for syllabicity.

If we posit unmarked skeletal slots in addition to Cs and Vs, as has been suggested in work of McCarthy(forthcoming) and Hayes(1985), we in essence take a step backwards in terms of the elimination of redundancy.[25] As we see from N <---> [+syllabic], if there is any skeletal slot which is redundantly specified, it is the nuclear V, not the post-nuclear slot. Furthermore, if syllabification of unsyllabified skeletal slots immediately preceding the nucleus as syllable onsets is universal, as proposed, for example in Steriade(1982), then such slots are also predictably non-syllabic and thus need not be marked as C's. We are left with specification of syllabicity precisely where it is not needed.[26] Thus, a theory with Cs, Vs, and Xs in no more or less redundant than one with just Cs and Vs, though it appears to be descriptively sound. As a first step then in eliminating the redundant

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25. Of course, a CVX theory might be empirically motivated. Empirical arguments are evaluated in Chapter 3.1.

26. See 2.1 for development of syllabification algorithms which instantiate these claims.

surface-encoding of syllabicity expressed in (51), we propose that the skeleton consists solely of unspecified timing slots. This proposal immediately eliminates the formal redundancy of the skeleton in all langauges. In addition, it allows for the simplest statement of the phonological processes just seen in Mokilese.

## 1.2.2 From the Segmental Plane: A Plan

Adopting a featureless skeleton, we have taken a first step towards eliminating the surface redundant encoding of syllabicity. However, a biconditional relationship between the feature [+syllabic] on the segmental plane, and the node N, nucleus, on the syllable plane remains. The next step of our argument involves elimination of the feature [+syllabic] on the segmental tier, arriving thus at a non-redundant encoding of syllabicity as a metrical property of phonological representations.

A precise statement of the redundancy we are attempting to eliminate is given in (54):

(54)

```
        _ _ _ _ _ _
      / [+syllabic] /
     /    /        /
   - - x^k - - -        <--->      - - x^k - -
                                    \   \     \
                                     \   N     \
                                      _ _ _ _ _
```
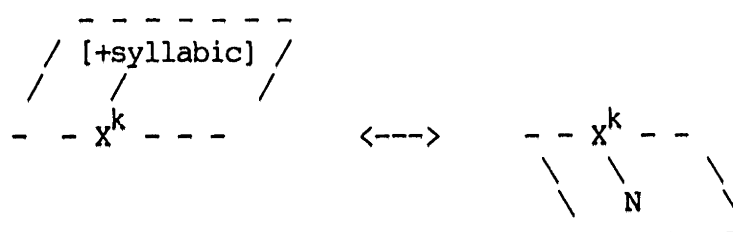
(Where, for all X, X <---> X is an identity rule, and where k ≥ 1.)

(54) is a formal statement of the biconditional noted earlier; namely that every slot linked to a [+syllabic] segment is dominated by N, and every N must be linked to a [+syllabic] matrix. It also incorporates a one to one

mapping between syllabic features and Ns, disallowing for instance, a truly

long vowel, such as the one in (52.a) from being syllabified as two separate

syllables.[27]

Elimination of the redundancy in (54) could take one of two forms. One

could argue that the feature [+syllabic] is necessary in phonological theory,

with syllabification occuring as a parasitic phenomenon. On the other hand,

one might argue that the syllable, and in particular the nucleus of the

syllable, is necessary and, moreover, primitive in phonological theory, with

syllabicity viewed as a metrical property of those segments dominated by the

nucleus. This second hypothesis, spurned on by the evident role of the

syllable in phonological systems, has been explored in previous work

(Kiparsky,1979; Levin,1983; Walli,1984), but with somewhat inconclusive

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27. The original formulation of the one-to-one relationship between Nucleus
and [+syllabic] was formulated in Levin(1983) as a separate condition, the
CSS-II, stated as follows:

$$
\begin{array}{ccc}
[^{\alpha}F] & & [^{\alpha}F] \\
\wedge & & \wedge \\
X \quad X \longrightarrow & X \quad X \\
| & & \vee \\
R & & R
\end{array}
$$
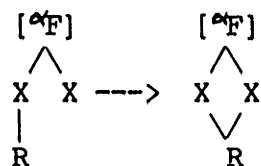
This condition is not inherent in the statement N< -->[+syllabic] since such
a biconditional could be satisfied by a representation like the following,
where the relation is not one of biuniqueness:

$$
\begin{array}{c}
[+syllabic,\ldots] \\
\wedge \\
X \quad X \\
| \quad | \\
N \quad N
\end{array}
$$
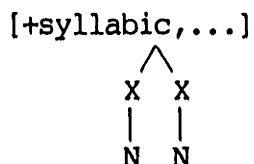
We argue in 2.1 that the relation of biuniqueness, which for the moment is
encoded in (54) is a consequence of a more general condition on structure
dependent rules.

results.[28] In particular, studies in which syllabicity is argued to be a metrical or relational property rather than a segmental property of absolute value, have not, as yet, provided positive answers to the following questions, and thus proved themselves as a viable alternative:

(55)
Questions for a Metrical Theory of Syllabicity

1. Within a Kahnian version of syllabification algorithms, can such algorithms be devised without mention of the feature [+syllabic]?

2. Is the proper representation of lexically predetermined syllable structure, such as that evidenced in Semitic morphological templates, a representation of structural information on the syllable plane? If so, what conditions hold on association?

3. Can other evidence pointing to a feature [+syllabic] be adequately dealt with by referring to other features, or structural properties of the syllable?

In the following two chapters we make a metrical theory of syllabicity feasible by providing positive answers to the three questions above. The relation shown in (54) is reduced to a one-to-one mapping between feature matrices which form part of what we will call the categorial component, and the node N itself. After outlining an X-bar theory of the syllable, we show how, given rules of N-placement and a modified version of the Applicability Condition proposed by Steriade & Schein(1985), the requirement of a one-to-one mapping need not be stated in the grammar, leaving us with a coherent system of N-placement rules, which are needed independently, rather

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28. Studies of syllabicity as a derived relational property rather than an inherent segmental property include Rischel(1964), Kiparsky(1978,1979,1981), Kaye and Lowenstamm(1979), McCarthy(1979), Levin(1983,1984) Archangeli(1984) and Walli(1984). In none of these works are the points listed in (55) addressed in any detail, or where addressed, extended to more than one language. We attempt to remedy this situation in the following chapter.

than the redundancy encoded by [+syllabic] <---> N.

We now turn to Chapter 2 where the first two questions in (55) are discussed: first we show how syllabification algorithms can be devised without reference to a feature [+syllabic]. This involves not only Nucleus placement, but incorporation of other elements into the syllable as well. We also attempt to capture what appear to be universal conditions on the formation of complex nuclei, and on the statements of rules of incorporation and adjunction. We then turn to a discussion of skeletal templates as anchors of a minimal degree of syllable structure. Chapter 3 is devoted to an assessment of the third question in (55) and evaluates arguments for the feature [+syllabic] in analyses of underlying representations, empty skeletal positions, glide/vowel alternations and reduplication. In the remainder of this work, we explore consequences of a metrical theory of syllabicity in which the structural property, N, is the sole determinant of syllabicity.

# Chapter 2

## Syllabicity as a Metrical Property: N and the N-Projection

"L oreille percoit dans toute chaine parlée la division en syllabes, et dans toute syllable une sonante. Ces deux faits sont connus, mais on peut se demander quelle est leur raison d'être."(de Saussure,1897;88)

Just as X-bar theories of syntax represent individual lexical items as $X^0$'s, which as heads in the syntax, project their categorial features and subcategorization frame throughout the syntax, we will argue that within the phonological component a more primitive version of X-bar theory is operative. The categorial component will determine what elements are obligatory, possible or impossible syllable heads within a given language. Lexical redundancy rules as well as language-specific N-placement rules will be seen to determine categorial status of segmental matrices. After establishing the range of terminal (or lexical) $N^0$s, we turn to the structural categories defined by N, namely the projections of N, N', N".

In Chapter 4, we argue that phonological rules are stated in terms of features of the categorial component and that they also necessitate use of the prime notation, thus motivating N as a primitive, and providing further evidence for the elimination of [+syllabic] as a distinctive feature. This final point, that phonological rules, and conditions on such rules are stated in terms of X vs. X or N, N' and N", justifies the existence of such systems

in phonology, and allows us to investigate the formal properties of such systems.

## 2.1 Syllabification without [+syllabic]

### 2.1.1 Foundations cf X-bar Theory

In extending a primitive version of X-bar theory to phonology, an attempt is made to follow Jackendoff(1977) in adhering to Chomsky's original research strategy:

> Precisely constructed models for linguistic structure can play an important role, both negative and positive, in the process of discovery itself. By pushing precise but inadequate formulation to an unacceptable conclusion, we can often expose the exact source of this inadequacy and consequently gain a deep understanding of the linguistic data. More positively, a formalized theory may automatically provide solutions for many problems other than those for which it was explicitly designed. (Chomsky,1957;5)

The X-bar convention in syntax (cf. Jackendoff,1977) as a theory of syntactic categories in universal grammar, makes three basic claims which have remained essentially intact to this day. The first claim of X-bar theory is that Universal Grammar (UG) includes a set of syntactic distinctive features which defines the possible lexical categories of human languages. Such features include at least [+N], [+V], and perhaps others. The second claim is that each lexical category X defines a set of syntactic categories X', X" etc., syntactic projections of X. A universal rule schema like that in (56) is proposed, with parameterization of such things as head-first/head-last.

(56)     $X^n \longrightarrow \ldots X^{n-1} \ldots$

The third claim is that rules of grammar are stated in terms of syntactic feature complexes, and the prime notation. For instance, it appears that the feature [+V] determines the class of proper governers within Government and Binding theory (cf.Chomsky,1981), while [+N] appears linked to optionality of subject position. Syntactic movement rules such as wh-movement, are stated in terms of $X^{max}$s, while processes such as Noun-Incorporation refer to $X^0$s(cf.Baker,1985). Definitions of c-command define intermediate projections (V', N', I', etc.) as domains for binding theory, case assigment, and government. The fact that such rules exist justifies and unifies the argument that categorial distinctions and X-bar projections are fundamental properties of the grammar. With this in mind, we turn to an X-bar theory of the syllable.[1] As a starting point, we will attempt to define a categorial component, that is, a system which determines the class of syllable heads within a given language.

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1. The intuition that the nucleus is, in some sense, the head of the syllable, and that syllables exhibit parallel properties with phrases, is suggested in the "theory of prosodic government" of Lowenstamm and Kaye(1983,to appear): "...One could, for instance speculate that the Nucleus is the head of the Rime constituent. We could, then, go on to say that this element must in some sense, govern, its sister constituents of the Rime. This relationship would be defined, at least in part, configurationally and could explain why long vowels and diphthongs are not found in closed syllables in languages for which such a constraint holds. It is not our purpose to furnish a complete discussion of such a theory, but only to suggest in very general terms what form it might take.(p.27)" Within a framework in which syllabification is present in the lexicon, Lowenstamm and Kaye attempt to limit the distribution of putative null elements within the syllable in a principled fashion by introducing a notion of prosodic government. Our proposal, framed within a system of Kahnian syllabification algorithms, makes explicit a different aspect of configurationality, namely the role of categories and bar-projections within the syllable.

## 2.1.2 A Categorial Component in Phonology


### 2.1.2.1 Features: Distinctive and Categorial

A categorial component in phonology has two important goals: to determine the universal set of distinctive features in phonology, and to account for the head properties of segments determined by particular subsets of distinctive features. Within the system we propose, it is precisely the system of distinctive features which is used to define categories of obligatory, possible and impossible syllable heads on a language specific basis.

Treating syllabicity as a categorial distinction between syllable heads and syllable non-heads has a number of advantages over a theory in which syllabicity is posited as a distinctive feature. First, it eliminates the puzzling fact that unlike other distinctive features, [+syllabic] is never distinctive in surface phonological representations, since this feature is always associated with the structural property Nucleus, or syllable head.[2] Every syllable will be defined by a unique head or nucleus, and every nucleus will define a unique syllable. Second, in contrast to a theory in which [+syllabic] is on par with [+coronal], it predicts that any segmental matrix can function as a syllable head, while only certain segments satisfy articulatory and acoustic parameters which define say, [+coronal]. This prediction, as we will see, appears to be born out. Thirdly, in unlike a

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2. I believe this observation is originally due to Guerssel(1984).

theory allowing +,- and 0 feature values, categorial distinctions, as structurally defined, are inherently binary: an X-slot is either dominated by $N^0$ and categorized as a head, or it is not.[3] If it is not N-dominated, then it may be either syllabified or unsyllabified, but in either case, it is a member of the class of non-heads. It follows then that reference to unsyllabified skeletal slots which are inherently non-heads (Cs within a CV theory) is not possible. Finally, identifying rules of categorial assignment with rules of syllabification accounts for the fact that, unlike other segmental properties, syllabicity appears to be a relative property, often predictable from the position of a segment within a string. There are three other universal properties of syllable nuclei that we will attempt to formalize in this section. One is that nuclei, or syllabic elements, must in some cases be marked in the lexicon. However, as far as we know, no further structure is ever necessary in underlying representations. Another point developed is that nuclei appear to be limited in most cases to at most two skeletal slots. Finally, we tie this to a further aspect of the nucleus, the fact that the Sonority Sequencing Generalization of Selkirk(1982) may be violated at the periphery of the syllable though it is never violated within the nucleus itself:

(57) Sonority Sequencing Generalization (Selkirk,1982)
     In any syllable there is a segment constituting a
     sonority peak which is preceded and/or followed by
     a sequence of segments with progressively decreasing
     sonority values.

All of these properties hold of segments which are designated as nuclei, and

--------

3. For instantiation of a ternary valued feature system including the feature [+syllabic], see Steriade(1985).

we will attempt to show that they are intimately connected with the view of the nucleus as an $N^0$ within X-bar theory.

Just as a lexical/semantic construct like 'RAIN' functions categorically as a noun in Russian, a verb in Passamaquody, and both a noun and verb in English, so we find that a phonological segment like [-cons,+hi,+back,+round] may function as a vowel in Niuean, a consonant in Axininca Campa, and both a vowel and consonant in Klamath.[4] While it appears to be the case that certain concepts like 'HILL' are more likely to function as nouns than others, 'hill' is expressed as a verb in Passamaquody. Likewise, it seems that certain phonological segments like /a/ are more likely to function as syllable heads than others, though in Chinese(Pulleyblank,1984), /a/ may also function as a non-head within the syllable. One property then, which distinguishes categorial from distinctive features, is that their association with particular segments is, in some sense arbitrary.

Categorial features are inherent within this system, or they are assigned by redundancy or phonological rules. The categorial component is limited to syllable heads and syllable non-heads, as shown in (58):

(58) Categorial Component
    A. Syllable Head                B. Syllable Non-head
       N
       |
       X                           X

From this point on, we will use the following specific notation in reference to the categorial status of skeletal slots and their relation to the syllable

----------

4. Thanks to Ken Hale for discussion of categorial features in syntax.

plane:

(59) Notation
A. N
   |
   X  =  $\underline{X}$  =  $[_N X]$  =  syllable head

B. X                        = syllable non-head

C. X'                       = unsyllabified X

D. X]                       = syllabified X

E. Ⓧ, Ⓧ                     = X  $\underline{X}$  unassociated to segmental plane

F. |X|                      = {X, $\underline{X}$}

Treating syllabicity as a categorial feature leaves us with the system of major class features shown in (60).

(60)

| Major Class Features | V | G | R | N | T | | |
|---|---|---|---|---|---|---|---|
| Consonantal | | | + | + | + | V=vowel | N=nasal |
| Sonorant | + | + | + | + | | G=glide | T=obstruent |
| | | | | | | R=liquid | |

This system differs conspicuously from an SPE-like system with [+vocalic] or [+syllabic] in that there is no distinctive major class feature which distinguishes vowels from glides.

As proposed by Steriade(1982), we assume that major class features along with other distinctive features define language particular sonority scales. Based on evidence from Sanskrit and Mycenaean, Steriade argues that no single universal sonority scale of the type proposed by Selkirk(1984) with a language specific minimal sonority distance(MSD) is able to account for the possible and impossible initial clusters in both languages. Steriade proposes to constrain relative sonority scales in three ways: first, the hierarchy of features is fixed universally. Second, the sonority difference

between [+F] and [-F] is universal. And third, within a language-particular sonority scale, a feature cannot be introduced in only part of the scale. The only two parameters on which two languages may differ then is on the inclusion of features in the scale, and on the MSD for a given language. We will modify Steriade's schema slightly in the following sections. The major innovations we suggest are threefold. First we show that a distinct MSD is necessary for the distinct projections N' and N". Second we illustrate that consonantal place features like [+corononal], [+anterior], etc., do not appear to be orderable with respect to a universal sonority hierarchy, a fact which suggests that they are not part of the universal hierarchy. Finally, we illustrate a case in which a feature is introduced in only one half of the scale, necessiating a slight revision of Steriade's third constraint referred to above.

The universal hierarchy of features which we adopt in this work is given in (61), where the left branch is more sonorous than the right branch:

(61) Universal Sonority Hierarchy

```
            / \
      [-high] [+high]
             / \
       [-cons] [+cons]
               / \
         [+son]  [-son]
                 / \
           [+cont] [-cont]
                   / \
             [+voice] [-voice]
```

```
[+ant] > [-ant]
[+cor] > [-cor]
```
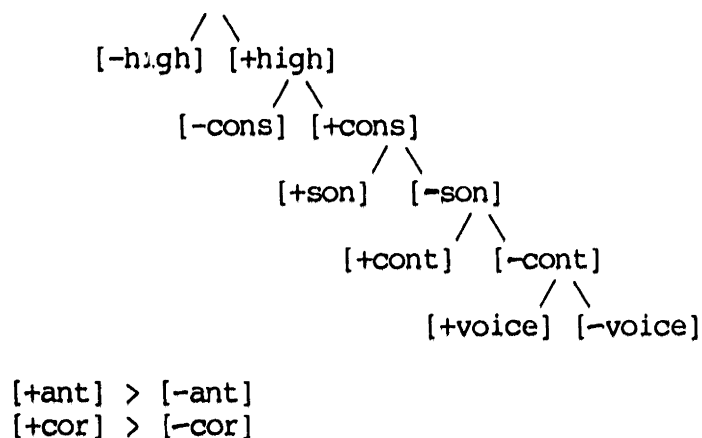
This is essentially the hierarchy of features evidenced in Steriade(1982) with the addition of [+anterior], which is motivated by final clusters in

Klamath discussed in Section 2.1.5. As noted above, the place features [anterior] and [coronal] are not represented in the universal hierarchy. Rather, the claim is that they may be entered at any point in a language particular scale.

There are a variety of features not mentionned in (61), including the glottal specifications [+constricted GL] and [+spread GL]. The ability of such features to occur within what appear to be branching segments (see Section 2.1.3) leads us to propose that surface segments /ʔ,h/ are not phonologically specified for supralaryngeal features. We assume that the status of /ʔ/ and /h/ as [-consonantal,+sonorant] on the universal sonority hierarchy in (61) is a default assignment, closely linked with the anchoring requirements of such features.[5] We speculate here that the universal redundancy rules in (62) associated with [+constricted GL] and [+spread GL] are only relevant to elements represented on other than the glottal tier, and that such rules may result in changes of features higher up on the sonority hierarchy in (61), changes indcated by the rules in (62.C):

(62) Universal Redundancy Rules for Glottal Features
    A. [    ] ——> [-continuant]/ [+constricted glottis]
                                  ‾‾‾‾‾
    B. [    ] ---> [-voice]     / [+spread glottis]
                                  ‾‾‾‾‾
    C. i.  [...]    ---> [-son]
      ii.  [...]    ---> [+cons]
     iii.  [...]    ---> [+high]

If say a [-cons,+son] like /w/ is specified as [+constricted GL], and undergoes the rules in (62.A), it may drop to the [-continuant] specification

—⸱⸱ ⸱——⸱——— —

5. See Kingston(1985) for a theory of glottal anchoring.

in (61), which is redundantly [-sonorant]. We tentatively view this as a consequence of the fact that, whereas it is generally the case that [-consonantal] segments will be redundantly [+voice], [+contintuant], the redundancy rules in (62) may precede redundancy rules for [-consonantal] segments, and will lead to changes in values for features higher up, as noted in (62.C). Put more simply, we are suggesting that values for the features [sonorant] and [consonantal] may be relative to the presence or absence of glottal features. This appears to be the case in Klamath, where glottalized sonorants act as obstruents with respect to the rule of deglottalization/deaspiration.[6] The consequences of such an analysis are twofold. First, as a result of their lack of supralaryngeal feature specifications, [+constricted GL], [+spread GL] will function as default [-consonantal] segments with respect to the universal sonority hierarchy given in (61), though they will not be represented distinctly within language specific sonority scales which are feature based. This fact, as we will see, is also instrumental in explaining the inability of /ʔ,h/ themselves to act as syllable heads via rules of N-Placement. Secondly, as already mentionned, the rules in (62) may trigger reanalysis of glottalized or voiceless sonorants as obstruents.

## 2.1.2.2 Underspecification and Redundancy Rules

In addition to the system of categorial and major class features above,

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6. See Levin(1984b) for a detailed discussion of the relationship between glottal features and values for the distinctive features [+sonorant], [+consonantal].

with language specific sonority scales, we adopt a theory of underspecification which is similar, though not identical to Underspecification Theory(UT) as proposed by Archangeli(1984). Within UT, features have binary values, though only a single value of each feature is represented in underlying representation.[7] Other features are supplied by redundancy or phonological rule. The distinction between redundancy rules and phonological rules is one we will make use of throughout. Archangeli(1984) distinguishes redundancy rules which fill in features or create structure, from phonological rules,which either change feature values or change structure. Formally, Archangeli defines redundancy rules as those which do not obligatorily have feature/structure on the focus while phonological rules obligatorily require such specified focii. Feature redundancy rules are all of the form:

(63)  [ ] ---> [aF] / X__Y , where a is + or - and F is a feature.

Possible ternary instantiations of binary valued feature systems as discussed in Stanley(1967) are eliminated by Redundancy-Rule Ordering Constraint, which reads as follows:

(64) The Redundancy-Rule Ordering Constraint (Archangeli, 1984)
     A redundancy rule assigning "a" to F, where "a" is "+" or
     "-", is automatically ordered prior to the first rule
     referring to [aF] in its structural description.

This constraint requires that both values + and - of a feature F be filled in

------------

7. One outstanding problem for such a theory is the account of vowel harmony systems in which both values of a single feature appear to be necessary in underlying representation as for example in the analysis of Turkish vowel harmony in Clements and Sezer(1983). However, current work, for instance, Lumsden(1985), on harmony in Khalkha Mongolian, suggests that some such problems can be dealt with within UT.

before a rule mentioning either value of F in its structural description applies. In this way, the Redundancy Rule Ordering Constraint (RROC) also rules out zero feature values as a context for phonological rules. The RROC is to be interpreted then as imposing a partial ordering on a set of rules. Thus given rules {R1, R2, ...} the RROC might order R2 before R1. This partial ordering is independent of any particular instance of rule application.[8] We will argue that rules assigning categorial features as well as those assigning distinctive features are subject to the RROC, motivating the rephrasing given below:

(65) Revised Redundancy-Rule Ordering Constraint
A redundancy rule assigning ("a" to) F, where "a" is "+"
or "-" and F is a feature, is automatically
ordered prior to the first rule referring to [(a)F] in its
structural description.

The revised RROC (ROC from hereon) will order redundancy rules specifying categorial features before rules which refer to such categories. We illustrate this in due course, but first two notes on binary valued feature systems within UT.

Because we will make use of the revised RROC, it will be instructive at this point to consider several objections which have been raised with respect to this constraint. As pointed out by Dresher(1984) with respect to empty consonants in Seri, the existence of empty skeletal positions, may give rise to ternary distinctions whose consequences are non-trivial. Dresher provides

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8. We make this explicit so as not to incur non-trivial computational problems, brought to my attention by Noam Chomsky, which would result from a global ordering constraint.

the following illustrative example[9]:

(66) Ternary Feature Values with Empty Skeletal positions
   a. Initial Representations

```
    A.  R     O         B.  R     O           C.  R     O
        |     |             |     |               |     |
        X     X             X     X               X     X
        |     |             |                     |     |
       ⎡-G⎤  [+F]          ⎡-G⎤                  ⎡-G⎤  [-F]
       ⎣-H⎦                ⎣-H⎦                  ⎣-H⎦
```

   b. Phonological Rules
```
                              R     O
                              |     |
   1.  [-G] ---> [+G] /       X     X
                              |     |
                             ___   [+F]


                              R     O
                              |     |
   2.  [-H] ---> [+H] /       X     X
                              |     |
                             ___   [-F]
```

   c. Derived Representations
```
    A.  R     O         B.  R     O           C.  R     O
        |     |             |     |               |     |
        X     X             X     X               X     X
        |     |             |                     |     |
       ⎡+G⎤  [+F]          ⎡-G⎤                  ⎡-G⎤  [-F]
       ⎣-H⎦                ⎣-H⎦                  ⎣+H⎦
```

Under Dresher's interpretation, by invoking the Redundancy Rule Ordering Constraint, the default value of [F] will be supplied to the empty X-slot before the application of rules 1. and 2. eliminating a ternary distinction. This leads him to conclude that "an empty slot cannot remain empty after the assignment of any default value(p.15)." The empty X-slot in Seri, however, does not surface as a default consonant. In fact, it does not surface at all

-------------

9. Cs and Vs have been replaced by Xs

unless gemination has applied:

(67) Ternary Distinctions in Seri

|  | [+cons]-Initial | [-cons]-Initial | X-Initial |
|---|---|---|---|
| a. Vowel del. | /yo+meke/ | /yo+eme/ | /yo+amWx/ |
|  | [yomeke] | [yo:me] | [yoamWx] |
| b. Epenthesis | /?+ka/ | /?+eme/ | /?+amWx/ |
|  | [i?ka] | [?eme] | [i?amWx] |
| c. Gemination | /t+meke/ | /t+eme/ | /t+aX/ |
|  | [tmeke] | [teme] | [ttaX] |

While such facts lead Dresher to posit an "abstract consonant" in UR, as shown below, another solution is possible.

(68) UR of /-aX-/

$$
\begin{array}{ccc}
X & X & X \\
| & | & | \\
\end{array}
$$

$$
\begin{bmatrix}
aF1 \\
bF2 \\
\cdot \\
\cdot \\
xFn
\end{bmatrix}\,a\ X
$$
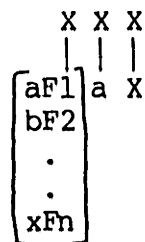
Namely, suppose that languages differ as to whether or not slots project to the segmental plane. In Seri, skeletal slots which are not syllable heads, do not project onto the segmental plane, while those that are do. Before post-lexical rules apply, phonological representations are "maximalized" as shown below:

(69) Maximalization

        a. Universal (Seri)          b. Language Specific (Berber)
           Ⓧ ---> X                      Ⓧ ---> X
               T                             |
Segmental Plane  [  ]                          [  ]

Maximalization involves projection of skeletal slots onto all tiers available within a representational system of a given language. In (69) we show this process for the segmental tier alone. As far as we know, there are languages such as Finnish(Keyser and Kiparsky,1982) and Sanskrit(Steriade,1985) in which "empty vowels" are posited in underlying representation. However, we

know of no case where such vowels are parallel to Seri consonants in that they do not undergo projection to the segmental plane. This is directly related to the status of X as a head. (69.a) then, the projection of syllable heads to the segmental plane (and in fact, to all planes) is posited as a universal aspect of maximalization. Unlike Seri, in which Xs do not project to the segmental plane, and surface only as a result of gemination in other languages, like Berber, empty slots are projected to the segmetal tier, and later filled in by redundancy rules. In Berber, as will be discussed in Chapter 3, an intervocalic inserted X-slot surfaces as [y].

Thus, as an aside, we disagree with Dresher that the logical conclusion one draws from application of the RROC, is that "empty" or unspecified consonants, are most accurately represented as in (68). The RROC will force ordering of the default rule for [F] before the application of the phonological rules in b. However, given a redundancy rule of the form [ ]--->[aF], the rule will not apply to X-slots which do not project at all to the segmental tier. These skeletal slots have no empty matrices to be filled. We suggest that such skeletal slots in Seri are not linked to the segmental plane at all, and only become associated to this plane as a result of the language specific rule of consonant gemination.

Returning now to the problem of ternary valued features, as presented by Dresher in (66), we see that, given our argument above, the ternary opposition is, in theory, allowed to arise. That is, Dresher's argument is valid, leading us to ask first whether there is empirical evidence which in fact supports ternary distinctions between [aF], [-aF] and no representation for F, and secondly, whether rules schemas like that given in (66) ever

occur?[10] While finding a single rule which necessitates ternary distinctions is difficult, there is ample evidence that slots unassociated to the segmental plane($|X|$s) must be distinguished from those linked to empty feature matrices, in rules which simultaneously make reference to specific feature values. For instance, take the rule of [-cons]-Spread given in (70), which refers to both an unassociated X-slot and the feature [-consonantal] in its structural description.[11]

(70) Klamath [-consonantal]-Spread
```
      [-cons]
       / |
      /  |
   [ X   X ]    %
         N' (=Rime of the syllable)
```
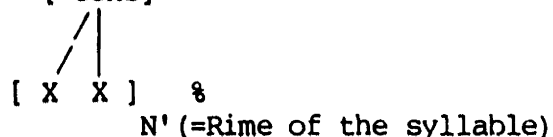
The unassociated skeletal slot in (70) may be the result of epenthesis, feature-delinking under affixation, or glottal delinking. In any case, reference to the feature [-cons] in the rule in (70) clearly instantiates a binary distinction, whether it be [-cons]/[0cons] or [-cons,+cons]. Epethesis before a stem-final glide yeilds a long vowel (/dewy/'fires a gun once'--->dew$\underline{X}$y --->[dewi:]), while epenthesis before [+consonantal] segments eventually results in a surface [^] (/gaẃl/'find'--->gaẃ$\underline{X}$l --->[gaẃəl]. However, at the same time, we must distinguish $\underline{X}$,which eventually surfaces as [ə], from the unmarked vowel in Klamath, /a/, which also surfaces as [ə] in closed syllables(/yawq'al/ bald eagle --->[yəwq̇əl]; /balbalẃ'am/'wokas

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10. The phonological rules of Vowel Deletion and Epenthesis in Seri are both rules which need not mention information on the segmental tier. See 4.2.

11. See 3.1 for motivation of this rule, which accounts for long-vowel variants of underlying glides after a rule of pre-glide epenthesis, and also for arguments that /a/ is unspecified for all features in underlying representation.

leaves'--->[bəLbəLw'əm]);    /sway̌/'red    deer'--->[swəʔyʸ].)    The    ternary

distinction suggested is shown below for [+cons], [-cons], and an X-slot

unassociated with the segmental plane:

(71) Ternary Distinction  [aF], [-aF], Absence of F
        [-cons]                    [+cons]
          /|                          |
         / |                          |
a.      (X) X          b.  (.) X   c.  X  (X)
  ----------------------     ----------------------------
      [-cons] [-cons]
         |      |
d.       X      X
      [+cons] [-cons]
         |      |
e.       X      X
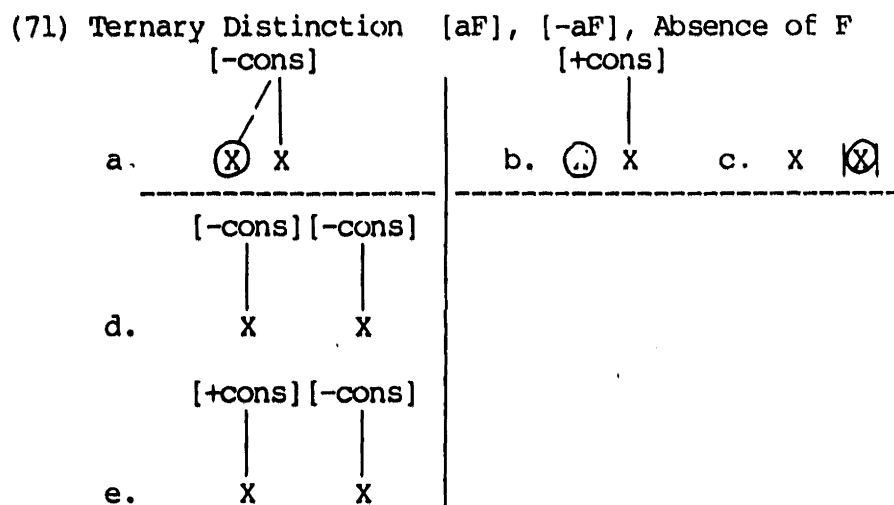
The rule in (70) distinguishes between environments a. versus d.,e. by the

presence or absence of an association to the segmental plane. If a slot is

associated to any value of [consonantal] (including Ø), spreading will not

take place. On the other hand, the rule must distinguish between [-cons] and

[+cons], since glides and vowels are subject to the rule, but nasals, liquids

and obstruents are not. By transitivity, then, the rule of

[-consonantal] spread necessitates a ternary distinction in its structural

description. Given such a rule, we predict that rules of the type described

by Dresher as resulting in ternary distinctions will exist, and conclude that

the RROC is strong enough to inhibit ternary distinctions within a given

tier, but weak enough to allow a binary oppositions between presence or

absence of a plane or tier, all which appear to be empirically motivated.[12]

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12. See Borowsky(1985) for an argument from French for the presence of empty
skeletal slots linked and unlinked to the segmental tier in underlying

The question of whether or not X, as opposed to [aF], [-aF] will ever give rise to a ternary distinction of the kind Dresher refers to appears then to remain an empirical issue. That is, given the absence of such rules, we are left what they would look like if they did, in fact exist. This question is clearly one which begs for further study.

In summary, we have tried to illustrate in this excursus that the statement of the Redundancy Rule Ordering Constraint is quite specific. It will order redundancy rules filling in values of [aF] before rules which mention [aF] in their structural description iff there is an empty feature matrix on the tier in question; that is, it will only apply if a skeletal slot projects to the feature tier. In order for a slot unassociated to the segmental plane to undergo redundancy rules, it must be projected or associated to the segmental plane, either by language specific rule or universal convention (69.a). Finally, a binary distinction between presence or absence of association (lines) to a given plane is motivated in phonological systems.

The specificity of the RROC makes it inapplicable to structure building rules. However, the revised ROC will order rules assigning a categorial or structural feature before the assignment of that feature or structure. Imagine a language E, a proper subset of English, with a vowel /a/, a liquid /l/ and a stop /k/. In this language, /a/ surfaces without fail as a syllabic segment, while /k/ can never function as a syllable head. The syllabicity of /l/ is variable, depending on its position in the string. Possible rules determining the syllabicity of /a/ and /l/ in E are given in

representations.

(72), where N = the syllable nucleus:

(72)

```
  A.  a          a        B.  1          1
      |          |            |          |
     |X|  --->   X           X'   --->   X
                 |                       |
                 N                       N
```
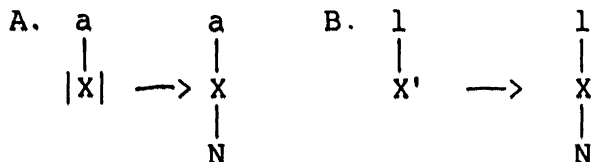
Although, on the surface, a distinction between syllabic and non-syllabic [1] exits, while no such distinctions occur at any level for [a], the rules in (72) are both defined as redundancy rules within the system proposed by Archangeli, since they both build structure but are not structure-changing. In the system we propose, rule A. above is defined as a redundancy rule as it is assigns a category label, but does not change category. Rule B. above on the other hand is defined as a phonological rule since it changes an element from the category non-head, to the category syllable head.

In E, syllables have optional onsets and codas, as captured by the following rules:[13]

```
(73)   a. Project N"                    b.   Project N'
          (X')  X --->  (X)  X              X  X' --->  X  X
                |            \  |            |  |        | /
                N             \ N            N           N /
                               \ |                       |/
                                \|                       N'
                                 \N"
```
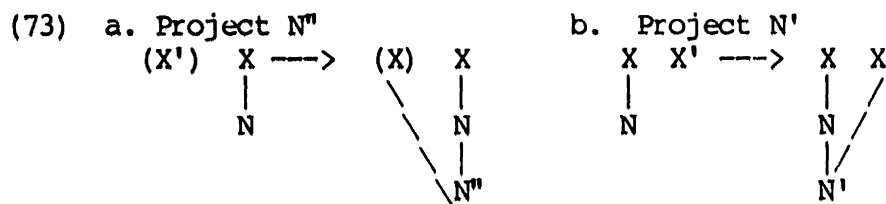
To see why we view rule (72.B) above as a structure- or feature- changing rule, let us examine the forms of E in (74) below. The surface syllabification suggests that the rules above are ordered A.,a.,b.,B. Only

---

13. Within the X-bar system proposed in this chapter, labels like onset and coda are dispensed with. When used, they are merely an informal reference to segments preceding the head and following the head respectively.

after the formation of CVC syllables, will rule B. apply.

(74) a.l    a  k    b. k    a  l    c. k    a  k    l
      |     |  |       |    |  |       |    |  |    |
      X     X  X       X    X  X       X    X  X    X
       \    | /         \   | /         \   | /     |
        \   N/           \  N/           \  N/      N
         \  |/            \ |/            \ |/       |
          \ N'             \N'             \N'       |
           \|               \|              \|       |
            N"               N"              N"       N"
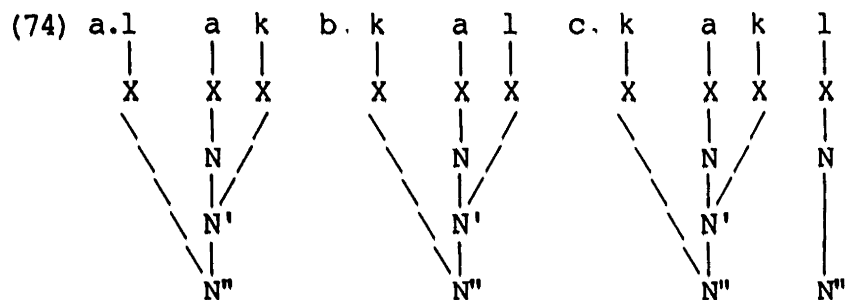
Both rules of syllabification in (72) mention N in their structural description. If N is viewed as a categorial feature "syllable-head", and rule (72.B) is treated as a redundancy rule rather than a feature changing rule, then the ROC will require that a rule (72.B) apply before the rules in (73). Not only is this ordering incorrect, but in general, the notation X' required in rules of N-Placement and epenthesis. is a derived notation in that it indicates an unsyllabified X-slot after rules of syllabification have taken place. Either (72.B) is not a redundancy rule, or the ROC must be interpreted in such a way as to treat (72.A) as a redundancy rule, and (72.B) as a phonological rule.

Note that the notation X' is not isomorphic with a zero feature value for [syllabic]. In the case of epenthesis rules, we must refer to X', where X' may be clearly an impossible syllable head. The fact, then, that a skeletal slot is stray might lead to a rule of incorporation, N-placement, or epenthesis, but these rules cannot be seen to affect only [0 syllabic] elements.

The theory being developed treats X versus X as a binary categorial distinction which may be represented in underlying representation. Furthermore, the only possible representations on the syllable tier in

underlying representations are marked $N^0$s. X], a syllabified slot, and X',
an unsyllabified slot are non-distinct in UR, where all Xs are X'. Only
after rules like N"-projection and N'-projection, rules which are made
explicit in the following sections, is the distinction between X] and X'
instantiated. We see then that mention of X' in rule(72.B), as distinct from
X], along with the fact that the rule is category-changing, classifiy this
rule as a phonological rule. As such, it will always apply after redundant
rules of N-placement like that given in (72.A).

We will consistantly distinguish between rules like (72) A. and B. and
assume that their intrinsic ordering with respect to each other is a
consequence of the ROC. We furthermore see X' as a derived feature, since it
becomes distinct from X] only via rules of projection, incorporation, and
adjunction. Rules referring specifically to X', then, must apply after
structure-building redundancy rules. In particular, rules like (72.A), true
redundancy rules, will always constitute the first step of syllabification.
Rules like (72.B), which are defined as phonological rules in light of their
reference to X' categorial structural change, will always be preceded at
least by the formation of CV syllables, that is, by rules like (73.a), since
such a rule creates a distinction between X' and X]. The version of onset
formation or Project-N" assumed from here on is given below:

(75) Project N"
```
   (X')  X   ———>  (X)  X
         |            \  |
         N             \ N
                        \|
                        N"  (= σ)
```
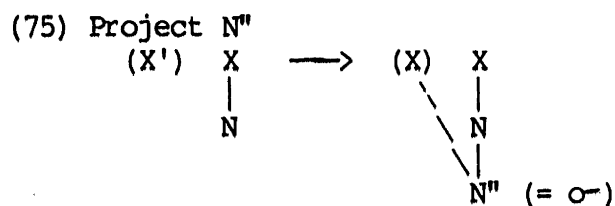
(75), universally the first rule of syllabification after N-placement, is

needed to capture the universal syllabification of pre-nuclear unsyllabified

`lots as onsets.[14]

Before moving on to rules of syllabification, a remark is in order concerning the posited existence of language-specific sonority scales of the kind proposed by Steriade(1982), and representations within a theory of underspecification of the kind argued for by Archangeli. The sonority scale posited by Steriade(1982;98) for Greek is given in (76), where minimal sonority distance is 4:

(76) Greek Sonority Scale
     [-son,-cont,-voice]     p, t, k
     [-son,-cont,+voice]    b, d, g
     [-son,+cont,-voice]    s
     [-son,+cont,+voice]    z
     [+son,-cont,+nas]      m,n
     [+son,+cont,-nas,+lat]  l
     [+son,+cont,-nas,-lat]  r

If only one value for features [voice],[nasal],[continuant] etc. is specified in UR, and furthermore, if, as appears to be the case, syllabification is relatively early in the phonological derivation,(cf. Kahn(1976); Kiparsky(1978,1979); Harris(1978); Steriade(1982)), then, does a sonority scale, like that given in (76), require that all values of mentioned features be specified by redundancy rule at the time syllabification applies? One would hope not, since such a requirement would rob UT of almost all its empirical content. As a preliminary step in coming to terms with what appears to be a quite global ordering paradox, we will allow sonority

------------

14. (75) is essentially a rewrite of the CV-version of the rule given in Steriade(1982), where V has been replaced by X, o- by N", Rime by N, and an intermediate node O(nset) has been eliminated.

scales to refer to distinctions between specified and unspecified feature values as shown below in column I. which can be rewritten as in column II:

(77) Greek Sonority Scale

| I. | | II. |
|---|---|---|
| [-son,-cont,0voice] | p, t, k | 1 [+cons,-son,-cont] |
| [-son,-cont,+voice] | b  d, g | 2 [+cons,-son -cont,+voice] |
| [-son,0cont,0voice] | s | 3 [+cons,-son] |
| [ son,0cont,+voice] | z | 4 [+cons,-son,+voice] |
| [0son,-cont,+nas] | m,n | 5 [+cons,+nas,-cont] |
| [0son,0cont,0nas,+lat] | l | 6 [+cons,+lat] |
| [0son,0cont,0nas,0lat] | r | 7 [+cons] |

Given a scale like that in II. above we must require that features within matrices be matched with a particular position on the scale. If /s/ is underlyingly specified only as [+cons,-son], it cannot be matched with level 4, since it not specified as [+voice], furthermore, it cannot match with level 2 since it is not specified as [-cont], therefore, it can only be included at level 3. In other words, a feature matrix is matched maximally with a sonority scale like that in II., where matching involves identity of particular feature specifications. If feature values change within a derivation, they will automatically be reassessed in accordance with the sonority scale. In this way, we can view the sonority scales not only as conditionning rule application, but as filters on the output of syllabification rules as well.

2.1.3 N-Placement

Given the major class features in (60), the categories head and non-head, and a theory of underspecification in which redundant information is not present in underlying representations, we turn to the question of what distinguishes syllabic segments from non-syllabic segments. Given the

biconditional [+syllabic] <---> N in surface phonological representations, we propose that distinctions in syllabicity are wholly determined by head (N) placement. Within UT this means that we need not posit features [+vocalic] or [+syllabic] underlyingly, if we can determine N-placement by some other means such as redundancy rules, or phonological rules. This approach then predicts that given a feature matrix [αF], syllabicity is derived in one of the following three ways:

(78) A. Redundancy Rule  B. Phonological Rule C. Lexically Marked
```
    [αF]        [αF]              [αF]        [αF]          [αF] (in UR)
     |    --->   |  / Y__Z         |    --->   |  / Y__Z        |
     X           X                 X'          X               X
                 |                             |               |
                 N                             N               N
```
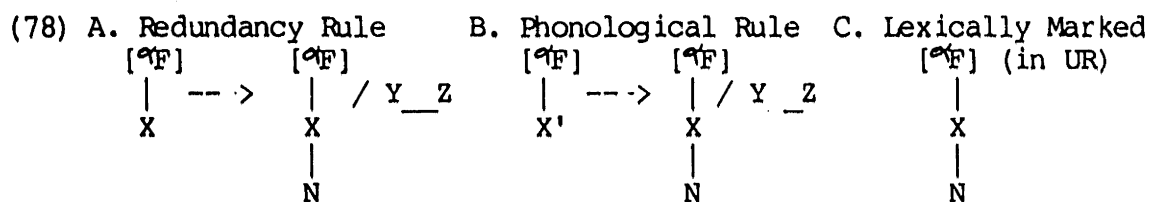
(78.A) is a redundancy rule specifying a skeletal slot linked to [^F] as an obligatory syllable head, regardless of whether or not that slot is syllabified. (78.B) is a phonological rule of N-placement which assigns a skeletal slot linked to [αF] head status provided it is unsyllabified. Finally, (78.C) is the case where head status is marked in underlying representation. At this point it should be noted that the apparent availability of (78.C) in underlying representation allows for underlying distinctions in syllabicity. An example from Klamath is given below:

(79) a. [+high] 'noun formant'  b. [+high] 'during,while'
```
                 |                                      |
                 X                                      X
                                                        |
                                                        N
```
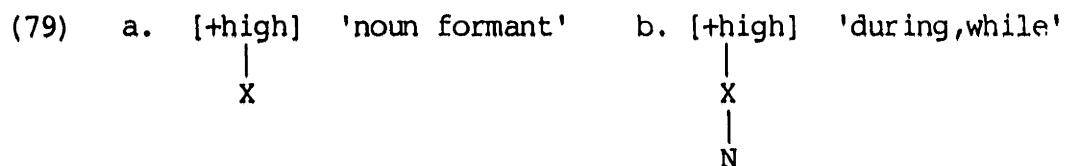
The noun formant in (79.a) has the surface alternants [y]~[i]~[iː] while

(79.b) surfaces consistently as [i].[15]  [+high] segments in Klamath will

surface as glides as a result of N"-projection or N'-projection if they are

immediately followed or preceded by a non-high [-consonantal] segment

respectively. These segments are obligatory syllable heads in Klamath, as

stated in (80.a). They will surface as syllabic as a result of the

phonological rule of N-placement in (80.b):

(80) a.  [-high]      [-high]        b. [+high]          [+high]
          |            |                |                  |
          X    --->    X                X'   --->          X / X' _
                       |                                   |
                       N                                   N
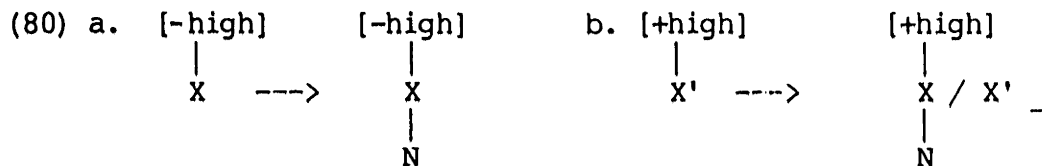
The lexical specification of (79.b) as a syllable head makes it impervious to

N"-projection or N'-projection since it is not an X', but rather is

syllabified in the lexicon. As a result, it will never surface as a

glide.[16]

Such cases, that is, where syllabicity is phonemic, fall into two classes:

that typified by Klamath above, where a phonological rule of N-Placement may

be overriden by N-placement in the lexicon, and that typified by Usarufa

below, a language of the Eastern New Guinea Highlands, where neither a

redundancy rule nor a phonological rule of N-placement exists for [+high]

--------

15. See 3.2 for a detailed analysis of Klamath glide/vowel alternations.

16. This is a language particular property of Klamath, where sequences of the
form X X are subject to a rule of vowel deletion. In some languages, as we
discuss further on, projection of N" appears to be structure changing in that
it applies to |X|, and will, in some cases cause deletion of a preceding
Nucleus. So for example, Sanskrit [iti [asti]] ---> [ityasti]
(Whitney,1889). We argue in Chapter 4 that such rules are conditioned by the
configuration X X.

segments:

(81) Usarufa     a. a   u   e          b. a   u   e
                    |   |   |              |   |   |
                    X   X   X              X   X   X
                        |
                        N
                   [aue]                 [awe]
                   'It is flesh'         'Wait'
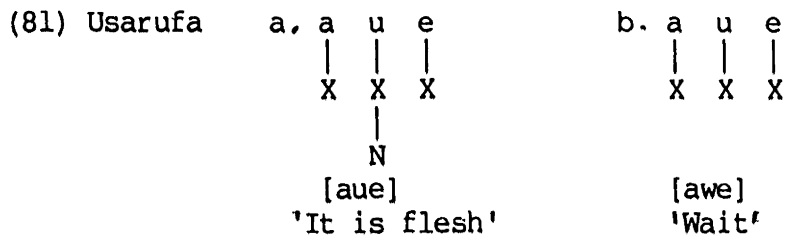
Thus, we allow for underlying distinctions in syllabicity if and only if 1) such N-placement is seen to override a phonological rule of N-placement; or 2) a language contains no rules, redundancy or phonological, of N-placement, for the particular feature matrix in question.

## 2.1.3.1 Phonemic ≠ Distinctive

The fact that, in certain languages, syllabicity is phonemic, does not require that it be encoded as a distinctive feature. To make this point, we need only look briefly at the metrical theory of stress.

A metrical-arboreal theory of stress such as that proposed by Hayes(1981) and modified by Hammond(1984) vastly reduces the number of possible grammars by positing a finite number of foot-construction algorithms, directionality parameters, and extrametricality. We summarize a partial schema of the

metrical theory as follows:[17]


(82) A metrical theory of stress
     A. binary vs. unbounded feet
     B. unbounded word trees
     C. left/right dominant feet/word-trees
     D. quantity sensitive vs. quantity insensitive feet
     E. Extrametricality (yes/no; left/right-edge)
     F  Pruning (yes/no)


The fact that a certain language exhibits morphemes which are stressed regardless of the fact that metrical rules predict them to be unstressed, does not lead one to propose that stress is a segmental rather than a metrical property. Thus, though Aklan appears to accent all closed syllables, the fact that two open syllabled prefixes, **ka**, a nominal prefix, and **ga**, a verbal progressive prefix, are also accented does not lead one to propose that [+accent] is a distinctive feature. Rather, such cases are treated as lexical exceptions. These prefixes are marked in the lexicon with accents.[18] Such predetermined accents override the regular rules of stress assignment.

Furthermore, there are languages in which stress is clearly distinctive in underlying representation. For example, in Russian, stress determines

------------

17. We refer to an arboreal theory of stress assignment rather then a grid-only schema in anticipation of our arguments that not only do metrical constituents exist in the domain of stress, but that inner constituency in metrical theory, whether the domain be stress or syllabicity, is governed by the same rules. See 2.1.7 for discussion.

18. A theory of accent is presented in Chapter 4. Accent is viewed in the same way as N-placement; it is a rule of head placement for later rules of foot construction. Within a grid theory, accent may be viewed as a tick on the metrical grid. See Prince(1983) and Halle and Vergnaud(forthcoming) for a discussion of accent as a grid mark.

underlying minimal pairs as shown in (83)[19]:

(83) Lexical Accent: Russian

     /                                    /
  a. zamok     'castle'    b. zamok    'lock'
     /                                      /
  c. muka      'torture'   d. muka     'flour'
     /                                      /
  e. slova     'word,gen.   f. slova    'word,nom.,pl.'
                   sg.,neut.'

Stress, or accent, in Russian must be marked in underlying representations. But again, this fact does not argue against a metrical treatment of stress in favor of a segmental one. It merely illustrates that in certain languages, like Aklan, stress is rule-governed, while in other languages, like Russian, it is not.

The analogy then is the following: the fact that a language like Klamath exhibits certain lexical exceptions, as shown in (79.b) to what appear to be structurally predicted alternations in syllabicity, in no way suggests that syllabicity is a segmental rather than a metrical property. Likewise, the fact that in Usarufa syllabicity of [+high] segments is phonemic and is not rule-governed does not argue that syllabicity is to be represented as a distinctive feature rather than a metrical property, head of a syllable. With this in mind, we outline a metrical approach to syllabicity, beginning with a study of obligatory, possible and impossible syllable nuclei.

Just as categorial features in the syntax can be either part of a particular lexical entry (destroy [+V, N])) or derived by morphological

---

19. On the surface these are not minimal pairs, since unstressed vowels are reduced, and are thus distinct from their stressed counterparts.

process (destruction[+N,-V)), so may the categorial status of a distinctive feature matrix. In (84) we see the tripartite division of N-placement rules, repeated from (78) above.

(84) The Categorial Component: Rules of N-Placement

```
    A. Redundancy Rule       B. Phonological Rule       C. Lexical
       [αF]      [αF]           [αF]      [αF]              [αF] (in UR)
        |  --->   | / Y__Z       |  --->   | / Y__Z           |
        X         X              X'        X                  X
                  |                        |                  |
                  N                        N                  N
```
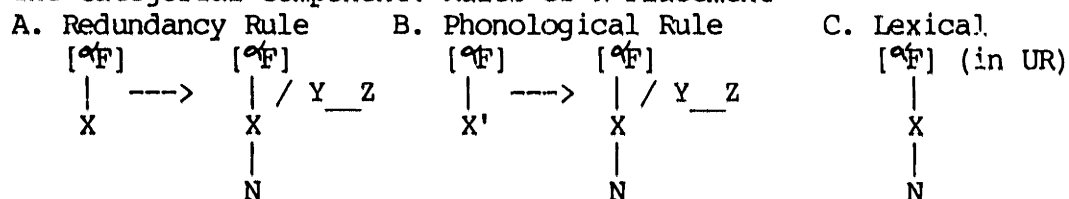
## 2.1.3.2 N-Placement and a Condition on Structure Dependent Rules

Niuean, a Polynesian langauge of the Tongic subgroup, is a language in which all N-placement is determined by a redundancy rule of the type given in (84.A). The vowels /a, e, i, o, u/ function only as syllabic nuclei, whereas the consonants in this language /f, h, k, l, m, n, n, p, t, v/ never occur as syllabic segments.[20] For Niuean, then, we posit the following rule of N-Placement:

(85)  N-Placement in Niuean

```
              [-cons]   [-cons]
                 |         |
              X ---->    X
                           |
                           N
```
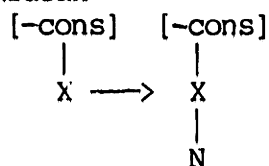
This rule is a structure building rule, and feeds other rules of syllabification. In Niuean, it is followed by N"-projection to yield

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20 As we remarked earlier, the absence of supralaryngeal features for the laryngeal sonorants /h/ and /?/, leaves them outside of both sonority scales as well as rules of N-Placement like the one given in (85).

maximally well-formed syllables as shown in (86)[21]

(86)      a.  h  a  k  u    b.  h  a  k  u    c.  h  a  a  k  u

              |  |  |  |        |  |\ |  |        |  |  |  |  |
              X  X  X  X        X  X  X  X        X  X  X  X  X

N-Placement    \  |  \  |        \  |/  \  |        \  |  |  \  |
                \ N   \ N         \ N    \ N         \ N  N   \ N

N″-Projection   \|    \|          \|     \|          \|   |   \|
                 N″    N″          N″     N″          N″  N″   N″

                /                 /                  /
              haku              ha:ku              haaku
            'swordfish'         'my,mine'          'my,mine'
                               (prenominal)       (post-nominal)

As illustrated by (86.b), the redundancy rule of N-placement is subject to a specific interpretation which rules out the possibility of a structure such as that shown in i. below, but requiring as output the representation in ii.:

(87)
      i.  * [^F]       ii.  [^F]
           / \              / \
          X   X            X   X
          |   |             \ /
          N   N              N

While one could stipulate that the relationship between N and the features it dominates be one of biuniqueness, as proposed in Levin(1983), we will attempt to relate the illformedness of i. above to general properties of geminate structures.

Geminates have long been known to resist the application of certain rules which affect their adjacency or identity. In the most recent studies, the

----  --------

21. Stress in Niuean falls on the penultimate syllable. Thus the difference between the tautosyllabic long vowel in (86.b) and the heterosyllabic sequence in (86.c) results in different surface stress patterns, as illustrated. [ha:ku] is used before the noun only and must occur with an article. According to McEwen(1970) it is more "definice" than [haaku].

fact that geminates resist both epenthesis and certain segmental rules is
attributed to two distinct conditions. Neither of these conditions will
block the application of N placement as in (87.i), since neither adjacency
nor identity is altered. Rather, a rule is restricted to applying only once
to a geminate structure. This observation, it turns out, is the key to a
single constraint on geminate structures, allowing for a unified account of
the resistance of geminates to rules of epenthesis, certain segmental rules,
and multiple applications of a single rule.

The first generalization that geminates cannot be split by epenthesis, was
established by Kenstowicz and Pyle(1973) and further strengthened by
Guerssel(1978). Kaye (p.c. cited in Halle and Vergnaud 1982), and
Kenstowicz et alii(1982), have suggested independently that this is due to
the universal association convention in which association lines may not
cross. A vowel inserted by epenthesis is claimed to give rise to an
ill formed representation such as the one shown below:

(88)        [^F] [BG]
             /  \/
            /   /\
           X   X   X

Two assumptions required by this explanation, made explicit in Kenstowicz et
alii(1982) and Steriade(1982), are that inserted vowel segments belong to the
same tier as the consonantal segments into which they are inserted, and that
epenthesis does not consist of simply inserting an X- or X- slot into the
skeleton which is later filled in on the segmental plane.

The second of these assumptions is somewhat inconsistent with much work

concerning the eventual segmental realization of epenthetic vowels.[22] In Archangeli(1984), a theory of underspecification is developed in which the epenthetic vowel is the vowel which has no feature specifications in underlying representation. Rules of epenthesis, such as that given below for Yawelmani, are viewed as rules inserting skeletal positions, and nothing more.

(89) Epenthesis in Yawelmani (Archangeli,1984)
```
    0 ---> X / ___ X'      (where X = X)
           |               |
```

The inserted X-slot is later projected onto the segmental plane, and given features in accordance with the vowel harmony and redundancy rules of the language.[23] Given such arguments, it is no longer possible to claim that the inability of geminates to undergo epenthesis is simply a result of the output of epenthesis rules as shown in (88) which violates the no-crossing constraint on association lines. Rather, the output of epenthesis will look

---

22. The reason for qualifying this inconsistancy concerns a proposal of Steriade(1984), Levin(1984) and Steriade & Schein(1985), where the condition N<-->[^syllabic], ^=(-) is proposed as a condition on the output of all phonological rules. With such a condition, the representation in (88) will always result from epenthesis. If the feature [syllabic] is independently motivated, then such a biconditional appears sound. However, if, as we find in Chapter 3, arguments for a distinctive feature [syllabic] are highly questionable, this biconditionnal is motivated solely by theory-internal reasons namely the resistance of geminates to a certain class of rules which change feature values.

23. Much of this work (cf. Chapter 4.2) will also be devoted to arguing that rules of epenthesis insert X-slots which have no predetermined segmental feature values.

as follows:

(90)  Output of epenthesis on Geminate structures:
```
        [^F]
        / \
       /   \
      /     \
     X  X  X
        |
        N
```

Turning now to the second generalization concerning geminate structures,
they appear to resist the application of certain segmental rules. This
condition has most recently been formalized by Steriade & Schein(1984) (S&S)
as follows:

(91) Applicability Constraint(Steriade & Schein,1984)
     A rule can affect a segmental matrix by deleting or
     changing feature specifications contained in the
     matrix just in case all skeletal slots associated
     with it meet the description of the rule.(p.41)

This constraint operates within a system in which rules which refer to
segmental matrices alone do not automatically have access to skeletal
associations, a point made explicit in S&S's Tier Locality condition:

(92)  Tier Locality (S&S)
      In the application of a rule, skeletal information is
      accessible just in case the structural description of
      the rule makes reference to the skeleton or to syllabic
      structure.(p.42)

In order for the Applicability Constraint (AC) to have any effect at all on
rules of N-placement, N-placement must be seen as a rule which changes
feature specifications of a segmental matrix. For Steriade & Schein
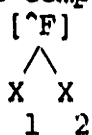N-placement is a rule which may change the value of a distinctive feature

[syllabic].[24] Given that syllabicity is a categorial or structurally determined feature within a metrical theory of syllabicity, it appears that we must somehow extend the AC to all feature-changing rules, distinctive as well as categorial.

However, even if we extend the AC to rules of N-placement, it will not block a structure like (87.i), since both halves of the geminate structure do satisfy the structural description of the rule. Rather, it appears that something more must be said about the structural change involved. The rules investigated by Steriade & Schein are all feature changing (or feature deletion) rules, and as a result, each rule can apply once, at most, to the geminate structure since it involves only a single doubley linked matrix. It could be the case then, that the AC is not only a condition that both halves of a geminate satisfy the structural description of a structure dependent rule, but also that both halves of a geminate satisfy the structural change of a structure dependent rule.

With this in mind, we propose the following preliminary modification of the AC:

(93) Condition on Structure Dependent Rules (CSD)
     A structure-dependent phonological rule R will fail to affect
     the internal feature composition of the form G:
                    $[\hat{\ }F]$
                    $\bigwedge$
                    X  X
                    1  2
     unless both $X_1$ and $X_2$ meet the structural description
     of R, and in the output of R to G, both $X_1$ and $X_2$ meet
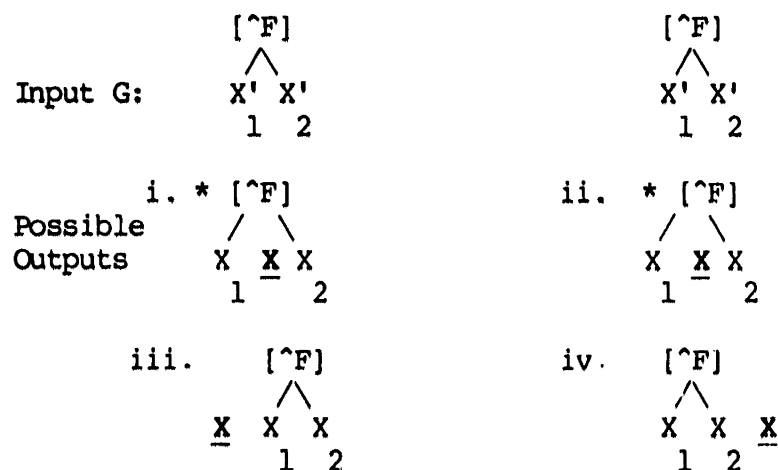     structural change of R.

————————

24. See 3.2 for further discussion of the AC and syllabicity in Tigrinya.

Rules of linking and delinking are rules which have no affect on internal feature composition, but rather affect the association of G to various planes and tiers within those planes. N-Placement, if viewed as a rule of the categorial component, affects the internal categorial status of the geminate. The above reformulation of the AC accounts for the integrity of geminates when faced with structure-dependent rules of all types, including epenthesis, feature-changing rules, and rules of N-placement.

Where epenthesis rules are stated as insertion of X-slots in a given environment, the output of epenthesis will inevitably result in a violation of the CSD as given above, even in the event that both skeletal slots satisfy the structural description of the rule. In (94) we see two cannonical rules of epenthesis and their application to geminate structures.

(94)  Epenthesis blocked by CSD

Rule R: a. 0 ──> $\underline{X}$ / ___ X'        b. 0 ──> $\underline{X}$ / X'___

```
                [^F]                      [^F]
                 /\                        /\
Input G:        X'  X'                    X'  X'
                1   2                     1   2


          i. *  [^F]              ii. *  [^F]
Possible      /  \                     /  \
Outputs      X  X  X                  X  X  X
             1      2                  1      2


       iii.    [^F]              iv.    [^F]
                /\                       /\
           X   X   X                 X   X   X
           1   2                     1   2
```

The output structures in i. and ii. of (94) are ruled out by the CSD since, in this case, epenthesis has affected the internal structure of the geminate, by inserting a skeletal slot internal to the structure. However, in the

output of the rule both $X_1$ and $X_2$ do not meet the structural change of R. The output of epenthesis in (94 iii,iv) above is well-formed since the internal structure of the geminate has not been affected, and thus, the instance of rule application is not subject to the CSD.

As for feature changing rules, the CSD is trivially satisfied. The structural change designated by a feature changing rule will always effect both halves of the geminate simultaneously, and thus will not be blocked.

Finally, we suggest that N-placement, a rule of the categorial component, is subject to the CSD. Given a geminate structure where both halves satisfy the structural description of the rule, the output of the rule must involve simultaneous structural change to both halves of the geminate. The only application of N-placement to a geminate structure consistant with the CSD is

one in which a branching N results:[25]

(95) Output of Single Application of N-Placement

```
     i.   *  [^F]     *  [^F]           ii.   [^F]
            / \          / \                   / \
           X   X        X   X                 X   X
           |            |                      \ /
           N            N                       N
```
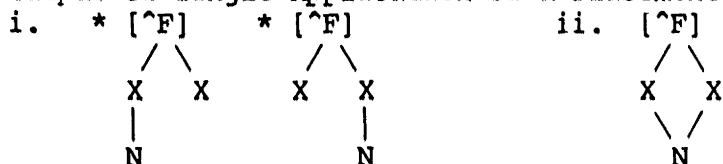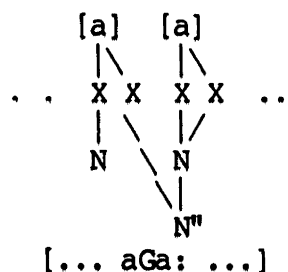
The N-placement rules seen thus far have allowed us to designate certain skeletal slots as syllable heads without mention of the feature [+syllabic]. Such rules have been seen to shed light on the resistance of geminate structures to a subclass of phonological rules. We now turn to a more complex case of N-placement where surface distinctions in syllabicity are apparent.

## 2.1.3.3 A Phonological rule of N-Placement

Mokilese differs only slightly from Niuean in that a redundancy rule like that in (84.A) is combined with a rule of N-Placement for [+high,-cons] segments. In (96) we see underlying inventory of [-consonantal] segments in

----------

25. Note that branching matrices derived after rules of N-placement have applied need not be syllabified as branching nuclei. A case in point would be for instance back glides in Axininca Campa (see Section 2.3.2) derived via spreading of an adjacent vowel to an empty X-slot:

```
          [a]   [a]
           |\    |\
     . .   X X   X X   ..
           | \   |/
           N  \  N
               \ |
                N"
        [... aGa: ...]
```

Here the skeletal slot has already been syllabified as an onset, making N-Placement (and its subjection to the CSD) inapplicable.
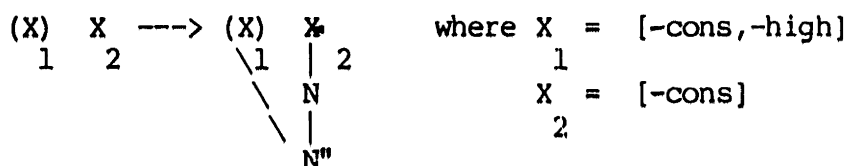
Mokilese.[26]

(96) Mokilese [-cons] matrices

|       | i | e | ɨ | u | o | O | a |
|-------|---|---|---|---|---|---|---|
| Back  |   |   |   | + | + | + | + |
| High  |   | − | − |   | − | − | − |
| Tense |   |   | − |   |   | − | − |

In Mokilese, all [-consonantal] segments can function as syllable heads. In addition, all segments with the exception of [-cons -hi] segments can occur as pre-nuclear elements under N‴. It follows then that syllabicity for all segments which are either [+cons] or [-cons,-hi] can be determined without reference to a feature [+syllabic]. For [+high] segments, syllabicity is determined by position of the segment in the linear string, as expressed by the rule of N-placement in (97) below[27]:

(97) Mokilese N-Placement (left to right)

```
(X)  X  ---> (X)  X      where X  = [-cons,-high]
 1   2        \1 | 2            1
               \ N             X  = [-cons]
                \ |            2
                  N‴
```

The rule of N-placement in Mokilese is then combined with the projection of N‴ as shown above.

After N-Placement, a rule of devocalization or N-deletion may apply to a segment which is preceded by one of greater or equal sonority. When

---

26. The reasons for the choice of this particular system over other possibilities hinges on the fact that the epenthetic vowels in Mokilese are [i] and [I], a high central non round vowel. For discussion of the unspecified vowel as the epenthetic vowel, see Archangeli(1984) and our Chapter 4.

27. This analysis follows closely that of Steriade(1984) for Latin.

resyllabified as coda of the preceding N, the segment will surface as a glide as a result of being in a non-head position of the syllable. Thus we have /ra + o/ branch-that' ---> ra:o ---> [ra:w]. In post-vocalic positions, any [-lo] segment may surface as a glide as a result of this rule. We state the rule of devocalization as follows:

(98) Mokilese Devocalization

```
X   X    --->    X    X
|1  |2           |1 / 2
N   N            N /     where X₁ is more
                 |/      sonorous than X₂.
                 N'
```

where $X_1$ is more sonorous than $X_2$.

This captures Harrison's(1977) description of the distribution of [y] and [w] respectively:

The glide [y] is written i and occurs in the following environments:

    i) # __ V or V __ {C,#}, as in ia 'where' [ya],
                                woi 'turtle' [woy],
                                mwein 'male' [m'eyn]
   ii) V __ V, in which case it is pronounced geminate, as
           in pahioa his spouse' [pa:yy^]

The glide [w] is found in the same environments... Medial w is not pronounced geminate unless written ww.(pμ.13-14)

The rule of N-Placement in (97) precedes all other syllabification rules,

as illustrated by the following derivations:[28]

(99)    a.  m ɔ Y    b.  W j W    c.  k Y a m    d.  W Y a
            | | |        | | |        | | | |        | | |
            X X X        X X X        X X X X        X X X
            \ | |        | \ |        \ | | /        \ | |
N-Plac.(97)  \ N N        N \ N        \ N N /        \ N N
             \| |         |  \|         \| N'          \| |
             N"N"         N"   N"        N"N"          N"N"

            m ɔ Y        W j W        k Y a m        W Y a
            | | |        | | |        | | | |        | | |
Devoc. (98) X X X        X X X        X X X X        X X X
            \ | /        | \ |        \ | | /        \ | |
             \ N /        N \ N        \ N N /        \ N N
             \N'          |  \|         \| N'          \| |
              N"          N"   N"        N"N"          N"N"

Other rules
Surface     [mɔy]        [uju]        [kiyyam]       [wiyya]
            'breadfruit' 'star'       'basket'       'to do'

In Mokilese, there are no examples of pre- or post-vocalic [+high] segments which do not alternate according to the rules given thus far. That is to say, there appear to be no cases of lexical N-placement in Mokilese.[29]

---

28. The symbols Y,W are used here to indicate underlying [+high] segments which are unspecified for syllabicity. Recall that /j/ is a palatal affricate.

29. Two possible exceptions are the forms [iwi] 'moist(of meat);fat(from fish)' and [iwi:wi] 'fish,sp.,scaleless'. If the underlying forms are /YWY/ and /YWY:WY/, we expect *yuy and *yui:wi respectively. The fact that such forms do not surface could be the result of a surface filter of the form *[yu] or a consequence of the following lexical representations:

```
Y W Y            Y W Y  W Y
| | |            | | |\ | |
X X X            X X XX X X
|                |
N                N
```

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## 2.1.3.4 Lexical N-Placement

Finally, we exemplify the case of N-placement in the lexicon. We already gave a brief illustration of one such system from Usarufa(Bee and Glasgow 1973), a language of the Eastern New Guinea highlands. In this language there are no glide vowel alternations. Rather, [+high] segments appear as syllabic or non-syllabic in any position. Thus we have a redundancy rule for [-high] segments:

(100) [-cons,-high]      [ cons,-high]
         |                    |
        |X|    ---->          X
                              |
                              N
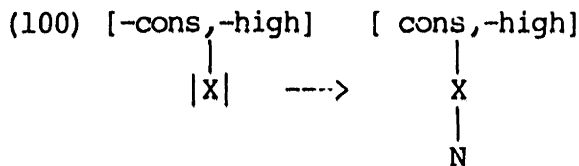
For [-cons,+high] segments, where such segments are syllabic, they are marked as N in the lexicon; elsewhere they surface as non-syllabic as a result of N''-projection:

(101) Usarufa a.    a  W  e         b. a  W  e
                    |  |  |            |  |  |
                    X  X  X            X  X  X
UR                  |  |  |            |  |  |
                       N                  |
Rule (100)          N  |  N            N  |  N
                    |  |  |            |   \ |
CSS-II              |  |  |            |    \|
                    N" N" N"           N"    N"
Surface:            [aue]              [awe]
                    'It is flesh'      'Wait'
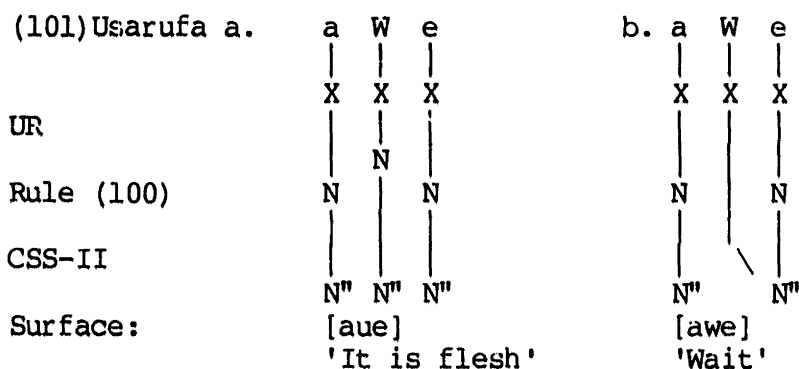
While such a system could conceivably mark a [-cons,+high] segment as N in any position, we argue that such is not the case in languages which have phonological rules of N-Placement. In languages in which glide/vowel alternations are rule-governed, lexical N-placement appears to be necessary only at the periphery of lexical items. A preliminary formulation of this

hypothesis follows:

(102)  The Metrical Peripherality Condition (MPC) (Preliminary
                                                    version)
       Lexical marking of rule-governed metrical structure is
       limited to peripheral position.


We provide support for the MPC with data from Berber, as analyzed by

Guerrsel(1984,1985).[30]


Guerssel(1984;1985) has argued convincingly that alternations between

syllabic and non-syllabic segments in Berber can be captured by rule without

use of a feature [+syllabic]. He proposes that the need to distinguish

between glides and high vowels in underlying representations, is

satisfactorily dealt with by Lexical N-Placement.[31] Such a claim is

consistent with the theory outlined thus far, where feature complexes

functioning predictably as syllable heads or non-heads are indistinguishable

in underlying representation, though X-slots may or may not be N-dominated in

the lexicon, leading to different surface realizations. This is evident in

Guerssel s concluding remarks:

> .. it has been demonstrated that an underlying distinction
> between glides and high vowels is not based on a difference in
> feature content. Rather, it is shown that the difference is
> structural. Some segments are lexically linked to rime nodes,
> and surface invariably as vocoids. Others are unassociated and
> may surface either as glides or as vowels, depending on the
> effect of rule application. As a consequence of the analysis
> proposed, the complementary distribution of glides and high
> vowels is accounted for, and the controversial feature [syllabic]
> eliminated.(p.13)

----------

30. As we seen in Chapter 3, lexical N-Placement in Klamath is consistant
with the MPC as well.

31. Guerssel uses the label R instead of N, but the two notations are clearly
equivalent.

We briefly point out in the following discussion that the underlying distinctions in syllabicity which Guerssel claims to be necessary in Berber are all in conformity with the MPC above. Lack of evidence to the contrary leads us to propose the MPC as a condition on lexical N-Placement. Before turning to the exceptional cases, we briefly review the Berber data in terms of the rules of N-placement and Projection outlined in this chapter.[32]

The data in the following examples, taken from Guerssel(1984), illustrate the predictable nature of glide vowel alternations in the Berber dialect of Ait Seghrouchen:

(103)a.  zur      'be fat'      i-zur   'he is fat'
         fa       'yawn'        i-fa    'he yawned'
         bedd     'stand up'    i-bedd  'he stood up'

     b.  ari      'write'       y-ari   'he writes'
         ass      'tie'         y-ass   'he ties'
         af       'find'        y-af    'he finds'


| (104) | Unmarked | Construct | |
|---|---|---|---|
| a. | a-mazan | u-mazan | 'messenger' |
|  | a-ghi | u-ghi | 'milk' |
|  | i-tri | i-tri | 'star' |
|  | i-zli | i-zli | 'song' |
| b. | ansa | w-ansa | 'place' |
|  | ul | w-ul | 'heart' |
|  | izi | y-izi | 'fly' |

--------

32. We discuss here the syllabicity alternations of [-cons] segments only Guerssel(1985) discusses alternations in syllabicity of [+cons] segments, which as far as we can tell never require lexical N-Placement.

```
(105)a.  x umazan           'about the messanger'
         su                 'drink'
         asi                'carry'

     b.  ansa wmazan        'the messanger's place'
         sw-ax              'Let's drink'
         asy-ax             'Let's carry'
```

The examples above illustrate the complementary distribution of glides and high vowels in Berber. Glides appear pre- and post- vocalically, while high vowels appear elsewhere. The vowel /a/ is always realized as a syllable nucleus, a fact which we formalize by rule (106) of N-Placement below:

```
(106) N-Placement-1: Berber (Redundancy Rule)
      [-high]        [-high]
         |              |
      X    - -->     X
                        |
                        N
```
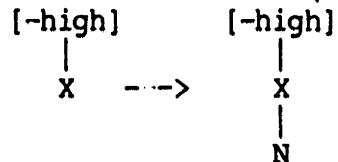
This rule feeds projection of both N" and N', accounting for the realization of [+high] segments as glides in both pre- and post- /a/ position. To account for the syllabic realization of [+hi,-cons] segments in Berber, we posit the rule below:

```
(107) N-Placement-2: Berber (Phonological rule)
      [+hi,-cons]       [+hi,-cons]
          |                 |
      X'     --->       X
                            |
                            N
```
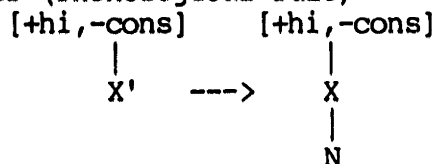
The rule above, like N-Placement-1, feeds projection of N" and N', where applicable.

In (108.a,b,c) we see derivations crucially involving Project-N"

Project-N', and N-Placement-2 respectively.

(108)      a. y a f          b. a h a  y f a        c. y f a
              | | |             | | | | | | |           | | |
              X X X             X X X X X X             X X X
              | | |             | | |  / | |            | | |
N-Plac.1      | N /             N | N / | N             | N
Projection    \N'               |  \N'  \ |             \ |
              N"                 N" N"    N"              N"

N-Plac.2                                                 N
Projection                                               N"
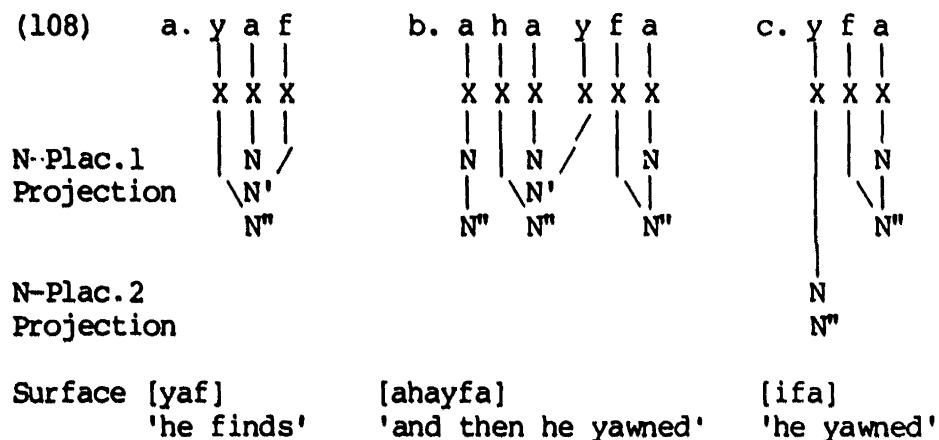
Surface  [yaf]           [ahayfa]               [ifa]
         'he finds'      'and then he yawned'   'he yawned'

The following forms illustrate that the rule N-Placement-2 is non-directional
in Berber, though whenever applied it immediately feeds N" and N'-
projection:

(109) Non-directionality
      a.  uysum / wisum        'meat(construct)'
      b.  uydi  / widi         'dog(construct)'
      c.  y-ucu / i-wcu        'he gave'
      d.  ur yudi / ur iwdi    'he did not fall'

So, for the construct form of /WYsWm/ we find alternation between vowel
initial and glide initial forms. If N-placement starts at the left, the
surface form is [uysum] whereas N-placement from right to left yeilds
[wisum].

Though the mechanisms for syllabification as well as the metrical
X'-representations motivated differ slightly from those proposed by Guerssel,
both analyses arrive at the same conclusion, namely that the syllabicity of a
segment can be derived from the position that the segment occupies in the
syllable, and nothing more.

However, examination of further data reveals certain [+hi,-cons] segments

which always surface as syllabic, despite the fact that they might be adjacent to underlying [-high,-cons] segments at some level of representation. In (110) we see examples involving the demonstrative suffix /u/.

(110) /-u/
    a. aryaz    'man'           aryaz-u    'this man'
       amazan   'messenger'     amazan-u   'this messenger'
       amawal   'dictionary'    amawal-u   'this dictionary'
       attay    'tea'           attay-u    'this tea'
       azyaw    'basket'        azyaw-u    'this basket'

    b. arba     'boy'           arba-y-u   'this boy' (*arbaw)
       afa      'fire'          afa-y-u    'this fire'(*afaw)
       ansa     'place'         ansa-y-u   'this place'(*ansaw)

In (110.a), this morpheme surfaces as a vowel, as predicted by the rule of N-Placement-2. In (110.b) however, where Project N' predicts a surface glide, this particular morpheme also surface as a vowel, preceded by an epenthetic consonant, [y]. A further example of a non-alternating [+hi,-cons] is the first person singular object clitic /i/. Examples which parallel those above follow:

(111) /-i/
    a. tessim     'she raised'    tessim-i    'she raised me'
       tejjull    'she swore'     tejjull-i   'she swore to me'
       tesseghd   she listened'   tesseghd-i  'she listened to me'

    b. tenna      'she said'      tenna-y-i   'she told me'(*tennay)
       tebgha     'she wants'     tebgha-y-i  'she wants me'(*tebghay)
       tenha      'she warned'    tenha-y-i   'she warned me'(*tenhay)

Other non-alternating segments appear verb-finally. In (112) we see several examples.

(112) Verb-final syllabic [+high] segments
    a. tessu   'she made a bed'  tessu-y ax  'she made us a bed'
    b. tettu   'she forgot'      tettu-y-ax  'she forgot us'
    c. turi    'she wrote'       turi-y-ax   'she wrote us'
    d. ini     'say'             ini-y-ax    'tell us'

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In Berber, XX sequences are not permitted  When such sequences occur as a result of morphological concatenation, an epenthetic glide appears.  Guerssel gives the following examples:

(113)   /inna-ax/ ---> inna-y-ax    'he told us'
        /a-aryaz/ ---> a-y-aryaz    'man'(vocative)


Within the present framework, the inserted segment in (113) can be accounted for by the rule of X-Insertion in (114):

(114) X-Insertion: Berber
$$\emptyset \longrightarrow X \ / \ \underset{N}{\overset{|}{X}} \ \_ \ \underset{N}{\overset{|}{X}}$$

Following Archangeli(1984),the spellout of the empty X-slot as [y] is a result of the following underspecified vowel system [33]

(115)   A. UR of Berber Vowels in UT

| | i/y | ə | a | u/w |
|------|-----|---|---|-----|
| Back | | | + | + |
| High | + | | | + |

Prediction
[ə] is the epenthetic
[-cons] segment.

B. Universal Rules (Archangeli,1984)
   a. [  ] - -> -L / [+Hi __]
   b. [  ] ---> +L / [-Hi,__]
   c. [  ]  -> -R +B / [+L,__]
   d. [-L,ᵅB] <---> [-L,ᵅR]
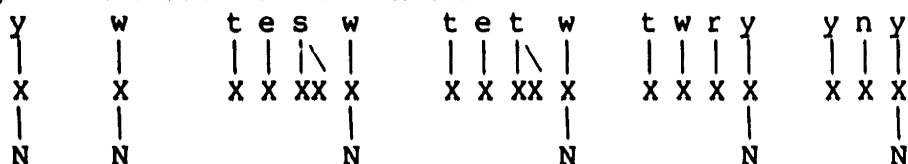
C. Complement rules (given A.)
   e.  [  ] ---> [-B]
   f   [  ] -- > [+H]


Given the rule of X Insertion in (114), it stands to reason that the

----------

33. It should be noted here that the epenthetic vowel in Berber is schwa, and not [i] as might be expected from this analysis. We assume that [-round,-cons] is uniquely realized as [ə] when N-dominated and by [y] elsewhere.
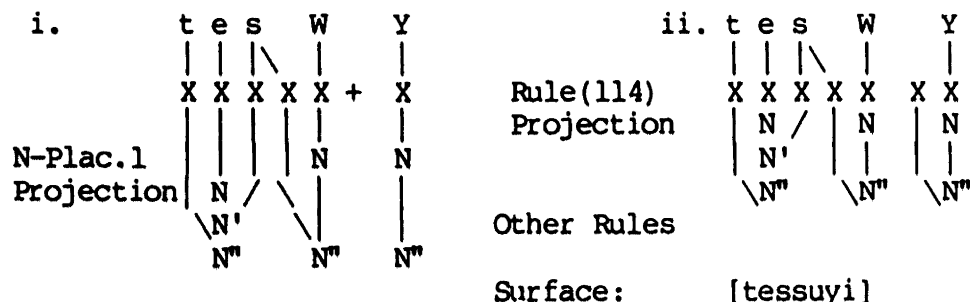
- 102 -

non-alternating segments in (111-112) are instances of lexically marked syllable heads. Following Guerssel, we posit the representations in (116) as underlying forms of the morphemes discussed above.

(116)  N-Placement in the Lexicon

```
     y        w        t e s  w      t e t  w      t w r y      y n y
     |        |        | | |\ |      | | |\ |      | | | |      | | |
     X        X        X X XX X      X X XX X      X X X X      X X X
     |        |               |             |      |            |
     N        N               N             N      N            N
```

Notice that the concatenation of one of the verbs above with a suffix-initial lexical N triggers the rule of X-Insertion, as would be expected, given its reference to adjacent Ns:

(117)    /tessW + Y/      'she made me a bed'

```
i.        t e s   W     Y                    ii.  t e s   W     Y
          | | |\  |     |                         | | |\  |     |
          X X X X X  +  X        Rule(114)         X X X X X  X X
          | | | | |     |        Projection        | N / | N  | N
N-Plac.1  | | | | N     N                          | N'  | |  | |
Projection| N / \ |     |                          \N"   \N" \N"
          \N'    \|     |        Other Rules
          N"     N"     N"
                                 Surface:      [tessuyi]
```

In light of the examples of lexical N-placement in (116), we formalize what appears to be a well motivated generalization, namely that exceptions to regular alternations in syllabicity only occur at boundaries of lexical items:[34]

(118) The Metrical Peripherality Condition (MPC)
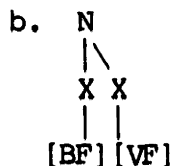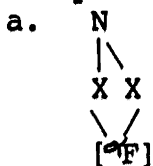      Lexical marking of rule-governed metrical structure is limited to
      peripheral positions.

---

34. At the moment, we posit this generalization for all metrical structure building rules, which include rules of stress assignment. If upheld, this generalization would instantiate medial accent in terms of an n-ary foot at the periphery, which could block regular rules of stress assignment.

The MPC is another way of saying that lexical exceptions to metrical structure building rules may occur only at the periphery of morphemes, i.e. at the origin of construction of metrical constituents. As a condition on lexical representations, it greatly limits the number of grammars available to the langauge learner, since non-peripheral morpheme-internal realizations of syllabicity or stress must be rule-governed. As stated above, it will also account for the fact that not only lexical accent, but lexical extrametricality, as well, within a metrical theory of stress, is a property limited to peripheral position. Whether or not the property "extrametricality" is also necessary within a metrical theory of syllabicity will be examined in Chapter 3.

Summarizing our discussion thus far, we have seen that the categorial status of a particular feature matrix is either marked in the lexicon (lexical N-placement) or is determined by a redundancy or phonological rule. If marked in the lexicon, in languages involving phonological rules of N-placement, such marking is limited to peripheral position by the MPC proposed above. In either case, no reference need be made to the feature [+syllabic]. In addition, we argued in Section 2 1.3.2 that, in the case of monosegmental long vowels, a rule of N-placement would result in a complex nucleus as shown in (119.a) as a result of the proposed Condition on Structure Dependent Rules.

(119) Complex Nuclei

```
     a.    N              b.   N
           |\                  |\
           X X                 X X
            \/                 | |
           [ᵛF]              [BF] [VF]
```

However, complex nuclei may also take the form of (119.b), where each of the two skeletal slots is linked to a separate matrix on the segmental tier. In the next section we examine such complex nuclei, which include diphthongs, checked vowels, and bi-segmental long vowels accounting for their existance within a rule-based version of syllabification of the type outlined thus far.


## 2.1.3.5 Complex Nuclei

As we have seen, rules of N-Placement as conditioned by the Condition on Structure Dependent Rules will generate branching and non-branching nuclei of the type shown in (120).

```
(120) a.  N              b.  N
          |                  |\
          X                  X X
          |                  \ /
          [αF]               [αF]
```
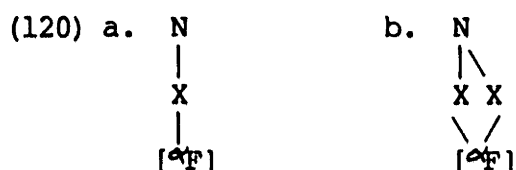
This is sufficient for a system like Niuean in which the set of nuclei consists of the short vowels /a,e,i,o,u/ and their long counterparts. In addition to the simplex and complex nuclei in (120) though, we must account for the existence of complex bi-segmental nuclei which surface in numerous languages in the form of rising and falling diphthongs, checked vowels, post-aspirated or voiceless vowels, and certain other vowel-sonorants sequences  These nuclei may be represented as shown in (121)  and are the central focus of this section.

```
(121) Bisegmental Complex Nucleus
           N
           |\
           X X
           | |
         [BF] [VF]
```
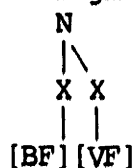
Complex nuclei have two important properties which we will attempt to derive in this section. The first is that they consist of exactly two skeletal slots, except where the CSD is concerned. The second is that they may be of either rising or falling sonority, but will never violate the SSG in and of themselves.

The first point, that complex nuclei consist maximally of two skeletal slots, is not altogether consistent with various descriptive accounts. For instance, Crawford(1963) describes Totonopec Mixe (TM) as having complex nuclei of the form: V:, V?V, V:?, V?, Vh, V:h, V?Vh. However, on closer examination of the phonetic details he provides, each of these sequences can be seen as a complex nuclei of two skeletal slots, with the features [+constricted glottis] and [+spread glottis] anchored either to nuclear slots, or to neighboring segments. When what is written as /h/ follows a short or long vowel, the following segments are pronounced with a spread glottis. This explains the voiceless sonorant in (122.a,b), and the voiceless sonorant followed by aspirated stops in (122.c).

(122)   Vh, V:h in TM
    a. /vi:hn/    [vi:N]        'eye
    b. /vi:hnk/   [vi:Nk]      'strange'
    c. /?ahntk/   [?aNt$^h$k$^h$]   'cave'

According to Crawford, the /?/ in complex nuclei V?V and V:?  is

> manifested as laryngealization of different portions of the vocoid span. The contrastive difference between these two expansion forms depends on the area of the vocoid span in which the laryngealization is concentrated. In the form V?V the greatest laryngealization occurs towards the central part of the duration of the vocoid, whereas in V:? it occurs towards the end of that span.(p.45)

Given such descriptions, it appears that there is a single basic complex
nucleus type in TM, pictured in (123.a), to which the features [+constricted
GL] (?)  or [+spread GL] (h) may associate as shown in (123.b-f):

(123) Complex Nuclei in TM

```
     a.  [^F]    b.  [^F]    c.  [^F] ?   d.  [^F] h   e.  [^F] h
         / \         /?\         / \/         / \/         /?\ /
        /   \       //  \       /   \/       /   \/       //  \/
       X     X     X     X     X     X      X     X      X     X
       |    /      |    /      |    /       |    /       |    /
       |   /       |   /       |   /        |   /        |   /
       | /         | /         | /          | /          | /
       |/          |/          |/           |/           |/
       N           N           N            N            N
       V:          V?V         V:?          V.h          V?Vh
```
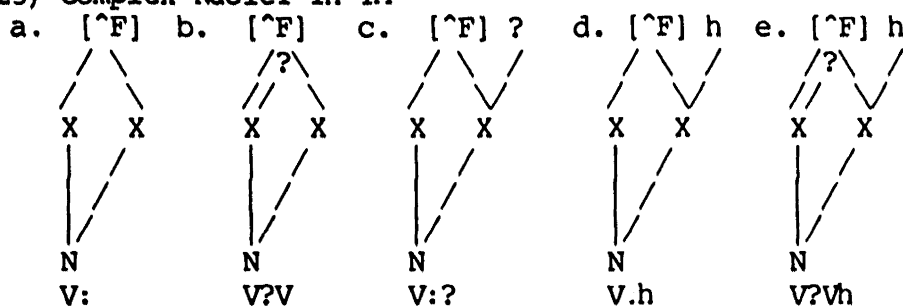
As remarked earlier, the lack of supralaryngeal specifications for /h/ and
/?/ allow them to appear on the same plane as vowels without resulting in
crossing association lines as in (123.b). The devoicing of the final nasal
in (122.a) [vi:N] then, can be treated as the result of spreading of the
feature [+spread glottis] within the N' projection:

(124)

```
        v    i  h n
        |    |\/ \|
      [ X[ [X X] X]]
        N"  N'  N
```
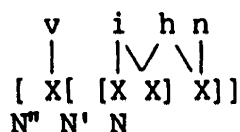
How is this account superior to one in which the sequence V?Vh is mapped onto
four consecutive skeletal slots as shown in (125)?

(125)

```
           V
          /?\   h
         / | \  |
        X  X  X X
        | / / /
        |/ / /
        |/ / /
        |
        N
```

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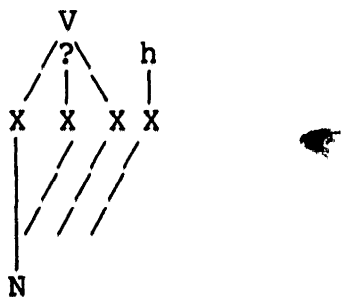
If $N^0$ is multiply branching as shown in (125), we are unable to explain the absence of extra-long and extra-extra long vowels: V::, V:::. In addition, there is no obvious way of limiting the final X-slot in the nucleus to the features [+constricted GL], [+spread GL]. Lastly, a nucleus which involves complex $N^0$s as in (125) allows for clusters of the form $V_1?V_2h$ where $V_1$ and $V_2$ are distinct segments. However, no such nuclear sequences occur. Treating V? and Vh as complex segments allows us to account for all N-Placement in TM by the simple N-Placement rule in (126), with complex nuclei resulting from the CSD:

(126)

```
       [-cons]      [-cons]
          |            |
(X')   X  --->   X     X
                  \     |
                   \    N
                    \   |
                     \  |
                      N"
```

While the simple distributional facts in Totonopec Mixe seem to point to complex nuclei limited to two skeletal slots, other phonological properties such as mora count of a syllable also show a dual limit on complex syllable h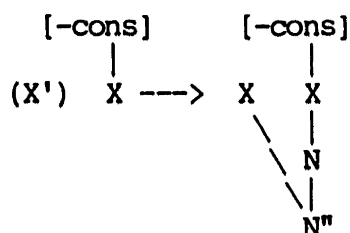eads. For instance, mora count in Cahuilla (Seiler,1977), a native language of Southern California counts up to two [ cons] segments in the syllable, but no more. In this language, long high vowels /i:/ u:/ are distinct from the sequences /iy/, /uw/, though phonetically these sequences are sometimes identical. Vowel-glide sequences are differentiated from long vowels mainly by increased stricture before (velar) consonants and in word-final position. Within a metrical theory of syllabicity, the sequences /i:/:/iy/ and /u:/:/uw/ are structurally distinct. The long vowels are represented as

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monosegmental geminates, while the glide vowel sequences are like other

diphthongs in the language in that they are bisegmental.

Based on the fact that only elements within $N^o$ count as moras for the rules

of secondary stress assignment in Cahuilla, we choose to represent these

complex nuclei, as shown below.

(127)  Structural Syllabicity Distinctions in Cahuilla

```
     a. /i:/          b. /iy/
          i               i  i
         / \              |  |
         X X              X  X
         |/               |/
         N                N
```
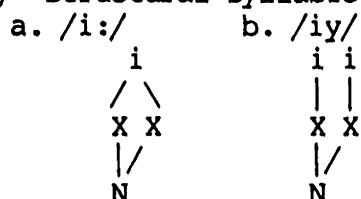
The stress facts are the following. Primary stress generally falls on the

first syllable of the root, though there are lexical exceptions. Secondary

stress, however, is predictable from the placement of primary stress.

Secondaries alternate bidirectionally from the main stress on alternate

moras, where both long vowels and vowel glide sequences (including V?)

constitute bi-moraic sequences.[35] Examples of secondary stress assignment

are given below. Of interest is the fact that a cluster of vowels or vowels

plus glide cannot count as more than two moraS. This is illustrated by

-----------

35. See Levin(1982) for a metrical account of stress assignment in Cahuilla.
While /?/ counts as a mora in all cases, it cannot be stressed. Glides and
sonorants are counted as moras only if they are not stressed, i.e. if they
constitute weak branches within the foot.

example (128.e)

(128) Mora count in Cahuilla

```
                / \
V=  1  a.  [takalicem]          'one eyed ones'
                / \
VV= 2  b.  [qa:nkicem]          'palo verde',plur.
                / \
GV= 2  c.  [cexya?am]           'name of stars "3 sisters"
                / \
VG= 2  d.  [hemhiwnaspi]        'that they would stay'
                / \                                  / \
VVG=2  e   [pente:wqal]         'I see him'  (*[pente:wqal])
```

These facts are handled straightforwardly by treating each skeletal slot

immediately dominated by $N^o$ as a single mora.  Because complex nuclei consist

of maximally two skeletal slots, the post nuclear glide in (128.e) will be

syllabified by N'-Projection, and will not have mora value   The proposed

structure for the complex nuclei in (128.b-e) are given below:

(129) Complex Nuclei in Cahuilla
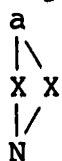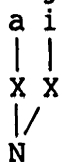
```
    b. monosegmental long vowel        c. rising diphthong
              a                                 i a
             |\                                 | |
             X X                                X X
             |/                                 \|
             N                                   N
    d. falling diphthong               e. long vowel plus glide
             a i                                e   u
             | |                                |\  |
             X X                                X X X
             |/                                 |/ /
             N                                  N /
                                                |/
                                                N'
```
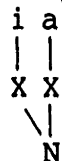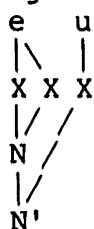
Mora count of each structure above is two, the maximal number of skeletal

slots within a single nucleus.  Though /u/ has mora value when it is within

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the nucleus, in (129.e) it does not, as it must be syllabified into N'.[36]

Complex nuclei of the type shown in (129) are generated parallel to simplex nuclei: they may be the result of a redundancy rule, a phonological rule, or prespecification in the lexicon. As we saw earlier, a simple redundancy rule like that in (130.a) will result in a complex nuclei if the matrix is a monosegmental geminate. In Cahuilla, other complex nuclei, including the rising and falling diphthongs seen above, may be seen to be the result of the phonological rule of coalescence stated in (130.b) below:

(130) N-Placement in Cahuilla
```
  a.  [ cons]     [-cons]
         |           |
       |X| - ->     X
                     |
                     N
  b.
       X  X   - ->      X X
       |  |              |/
       N  N              N
```

Recall that complex nuclei in Mokilese resulted only from CSD for long vowels. In Cahuilla, the same process, N-Placement as conditioned by the CSD, and the additional rule of vowel coalescence as shown in (130.b), are responsible for the generation of complex nuclei.

The final rule responsible for the creation of complex nuclei is the rule

--------

36. As far as we know, the maximal number of tone bearing units within the nucleus in tone languages is also limited to two.

of reanalysis. This rule can be generically stated as follows:

(131) Reanalysis

```
     X  X  ---->  X X
     |  /          |/
     N /           N
     |/
     N'
```
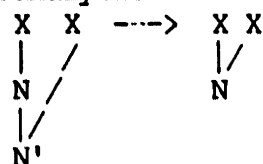
Various instances of this rule will be motivated in Chapter 3 in our discussion of Ancient Greek diphthongs and in our reanalysis of Klamath glide vowel alternations. At the moment, we suggest that the generation of complex nuclei is limited to the three processes above: N-Placement as conditioned by the CSD, coalescence, and reanalysis. Because coalescence and reanalysis have as targets a maximum of two skeletal slots, their output is limited to complex nuclei or complex syllable heads of at most two timing units.[37]

Given the categorial status of $N^o$, it is not possible to incorporate or adjoin elements to this node. Within this rule system, then, we predict that the only way to generate a complex nucleus incorporating more than two skeletal slots is via the Condition on Structure Dependent Rules, just in case a segmental matrix is linked to two or more skeletal slots We turn our attention now to a case like this in Greenlandic Eskimo.

In Modern West Greenlandic Eskimo(Rischel 1974) bi-segmental complex nuclei are the result of a rule of coalescence which applies after N-Placement. In West Greenlandic (WG) well-formed surface nuclei may consist of one of the

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37. Complex head formation in this sense is paralelled in morphology and syntax by the processes of compounding and restructuring which also appear to apply only to two $X^o$ elements at a time. These rules, unlike complex N formation may be iterative as in [[lion-eater][eater]].

short vowels /a,i,u/, one of the long vowels /a:,i:,u:/, or the tautosyllabic

sequence /ai/.[38] We can account for the short and long vowels by the

following redundancy rule:

(132) N-Placement: West Greenlandic

```
[-cons]    [ cons]
   |          |
   X  --->    X
              |
              N
```
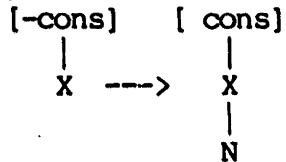
N-Placement for monosegmental (morpheme internal) long vowels will be

conditioned by the CSD, and will result in complex nuclei of the type shown

in (133.b). Simplex and complex instantiations of N-Placement are given

below:

(133)
```
        a. /aataq/  'grandfather'    b. /aataaq/  'saddleback'
            a  t a q                     a  t a  q
            |\ | | |                     |\ | |\ |
            X X X X X                    X X X X X X
N-Plac.     |/    |                      |/    |/
            N     N                      N     N
```
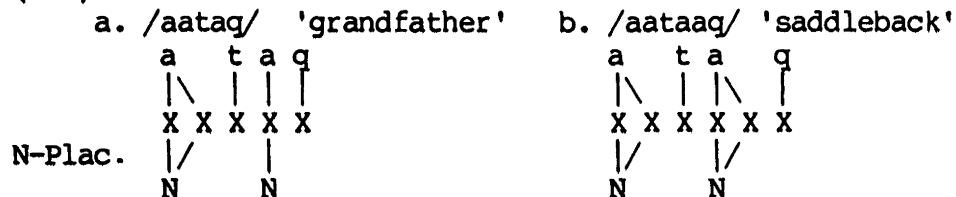
As noted above, the single diphthong [ai] only surfaces in word final

position.[39] In other environments, sequences of a + V --> a:, where both

vowels are short. Examples of this process are given in (134.a) and a

--------

38. The diphthong /ai/, which surfaces in word-final position only, is
realized as a lengthened /a/ with a palatal off glide.

39. Rischel notes that "it is at present an open question to what extent the
assimilation of /ai,au/ to /aa/ in non-final position is complete in the
northernmost dialects of WG. ..I have not noticed any evidence for
preservation of underlying diphthongs in the varieties of WG with which I
have been concerned..(p 161). Sources which describe diphthongs [ai] and
[au] in non-final position for modern WG include Lynge(1955), and
Lorentzen(1945) See Rischel(160ff.) for discussion.

preliminary statement of the rule is given in (134.b).

(134)
```
     a. /sava    +  innaq    / - -> sava:nnaq
        'sheep'     'merely'
        /nuna  + uvuq/        ---> nuna vuq
        'land'   'is'
        /nuna +  a  /         - ---> nuna:
        'land'   'his'
     b.  a [^F]        a
         | |          |\
         X X  --->    X X / ___|X|
         | |          |/
         N N          N
```

In absolute word final position, rule (134.b) does not apply. Instead, bi-segmental diphthongs surface, as shown below.[40]

(135)
```
        /ila +       i     /        ---> ilai  'his companions
        'companion' 'his,pl.'

   vs. /ila  + i + nik  /           ---> ila:nik 'with his
               'with'                             companions'
```

To account for the realization of the sequence /ai/ as a diphthong rather than as a disyllabic sequence, we propose the general rule of coalescence shown in (136):

(136) Coalescence in WG
```
     N N        N
     | |        |\
     X X  --->  X X
     | |        | |
     a[^F]      a[^F]
```
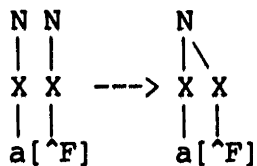
Recall that, in Niuean, the generation of complex nuclei is purely a consequence of the CSD, and so, a specific statement of complex-N formation

_ _ . _____

40. The absence of word-final [au] in modern WG is a consequence of the fact that /au/ has been replaced historically by /auq/, a sequence which via rule (134.b) will surface as [aaq]. See Rischel(pp.75-77) for discussion.

need not appear within the grammar. In WG however the existence of a single diphthong, albeit in a restricted environment, necessitates mention of a rule of Complex-N formation in the grammar: coalescence. With coalescence as stated in (136), we can reformulate the rule of post-/a/ assimilation in (134.b) as follows:

(137) N-internal Feature Spread

$$
\begin{array}{c}
a[\alpha F] \\
| \backslash \quad | \\
| \quad \backslash | \\
x \quad x \quad |x| \\
| \quad / \\
| / \\
N
\end{array}
$$
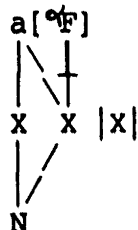
The rule of Feature Spread in (137) is posited as an innovation of the modern language. In Old West Greenlandic, as well as in certain Northern dialects of WG, the presence of coalescence as formulated in (136), as well as the absence of rule (137), led to surface diphthongs /ai,au/ in all positions.[41] A comparison of lexical items from dialects with and without rule (137) is given below:

(138)  Possible Diphthongs in Dialects of WG

| Dialect A: [-Rule (137)] | Dialect B: [+ rule (137)] |
|---|---|
| qainiarit | qaani$^j$arit |
| aulavoq | aalavuq |
| na$^i$ppoq | naappuq |
| a$^u$pput | aapput |

----------

41. With respect to the existance or non-existance of surface diphthongs in WG, Rischel states that " it is probably no overstatement that this is a major question in WG dialectology."(p.162) Some sources positing diphthongs are: Thalbitzer(1904) for northern WG of about 1900(pp.148-152); Lynge(1955) for the modern Upernavik dialect; and Schultz-Lorentzen(1945) for "normative" WG.

As in Cahuilla, the analysis of long vowels and diphthongs as
complex-nuclei in WG makes mora-count a trivial process of projecting $N^O$. As
analysed by Rischel  a HLH tone melody is assigned to the last three moras of
the word:

(139)
```
   a. /akivat/ 'you answered him'  [akivat]
         a k i v a t           H  L  H
         | | | | | |            / / /
         X X X X X X           X  X  X
         |   |   |             |  |  |
         N   N   N             N  N  N
   b. /akivaa/  he answered him'  [akiva:]
         a k i v a             H  L  H
         | | | | |\            / / /
         X X X X X X         X   X  X X
         |   |  |/           |   |  |/
         N   N  N            N   N  N
   c. /akivaacit/  he answered you' [akiva:cit]
         a k i v a c i t           H L  H
         | | | |  |\ | | |          // /
         X X X X XX X X X        X  X XX  X
         |   |  |/  |           |  |  |/ |
         N   N  N   N           N  N  N  N
```
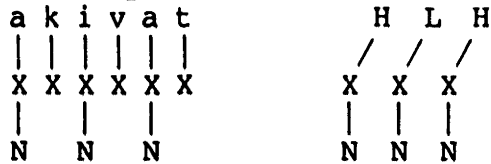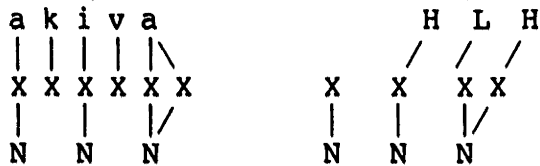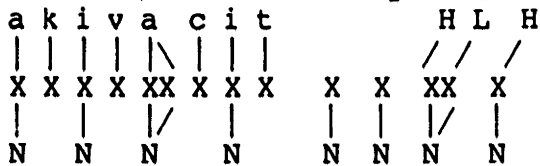
Recall that within the system we are proposing complex-N formation is
limited to instances conditioned by the CSD, and to rules of coalescence or
restructuring. While coalescence and restructuring limit output to nuclei
consisting maximally of two skeletal slots, the same is not true of
N-Placement as conditioned by the CSD. Our interpretation of N-Placement
predicts that if a ternary linked feature matrix existed (either derived or
underlying) and was subject to N-placement, the CSD would generate a
complex-N consisting of three skeletal slots.

This prediction appears to be born out as evidenced by West Greenlandic
yes/no question-formation. In yes/no questions, the first mora of the
phrase-final syllable is lengthened, creating, in some cases  ternary

branching nuclei. That such length is phonologically significant is apparent

from the tone pattern HLH, which shifts accordingly:

(140)

```
        HL H                    H LH
        || |                    | ||
a. tɾku aːna            taku aːnaː
   'he saw me'          'did he see me?'


        H LH                    HLH
        | ||                    |||
b. cigu aː              cigu a :
   'he takes that'      'does he take it?'


        H LH                    HLH
        | ||                    |||
c. apirai               apiraːi
   'he asked them'      'did he ask them?'
```

The lengthening rule, then, as formulated in (141), will create a ternary

branching segmental matrix in (140.b), and a binary branching matrix in

(140.c) both of which, subject to N-Placement under the CSD will result in

ternary branching nuclei. Derivations of these forms are given in (142).

(141) WG Interrogative Lengthening
```
       [αF]      [αF]
        |         /\
       X  ──>  X X /   . . [   [ [__ . .] ] ] ]
                          Nᵐ    N̄         S'[+yes/no]
```
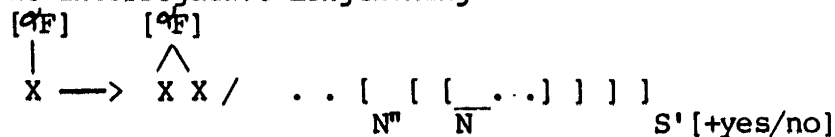
(142)
```
a. [cigu aːː]
   c i g u a              c i g u  a               c i g u  a
   | | | | |\   (141)     | | | | /|\  N-Plac.     | | | | /|\
   X X X X X X   ──>      X X X X XXX   ─ ──>       X X X X XXX
   |   | |/               |   | |/     CSD          |   | \|/
   N   N N                N   N N                    N   N N


b. [apiraːi]
   a p i r a i            a p i r  a i             a p i r  a i
   | | | | | | |  (141)   | | | |  /| |  N-Plac.   | | | |  /| |
   X X X X X X  ──>       X X X X X X X   ───>      X X X X X X X
   |   | |/               |   | |/       CSD        |   |   \|/
   N   N N                N   N N                    N   N   N
```

So we see that the CSD, under circumstances like those illustrated above,

will create n-ary branching structures.

We summarize the limited set of rules generating both simplex and complex
nuclei below:

(143)
```
  A.  N-Placement              [αF]      [αF]
                                |         |
                               X -- ·>   X
                                         |
                                         N


  B.  Coalescence             X X --->   X X
                              | |        |/
                              N N        N


  C.  Restructuring           X  X --->  X X
                              |  /        |/
                              N /         N
                              |/
                              N'
```
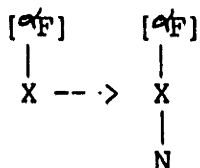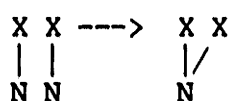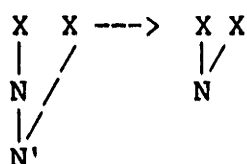
We have illustrated that the system of N-Placement rules shown above can be
stated without use of the feature [+syllabic], and that such rules appear to
exhaust the types of syllable heads found in phonological systems. It should
be clear, however, that the status of the rules in (143) as the only rules of
head placement is independent of the representation of syllabicity as a
metrical property. Having established the rules in (143), we now turn to the
question of what kind of segmental matrices they manipulate. The question we
attempt to answer is whether or not the class of feature matrices designated
as syllable heads is predictable either universally or within a given
phonological system.

## 2.1.3.6 N-Placement and Universals

Having established a limited set of rules which assign nuclear status to skeletal slots, we examine whether or not such rules are limited to slots associated with specific segmental matrices. Within certain feature systems, for instance that utilized by Kaye and Lowenstamm(1984), non-alternating syllabic segments are distinguished from segments alternating in syllabicity on the segmental plane in terms of the features [+high] and [+vocalic]. The feature system proposed by Kaye and Lowenstamm(1984) is given below

(144) Major Class Features (Kaye and Lowenstamm,1984)

| Feature | obstruents | liquids | nasals | glides/high Vs | V s |
|---|---|---|---|---|---|
| vocalic | - | + | + | + | + |
| consonantal | + | + | + | + | - |
| nasal | - | - | + | - | . |
| high | - | - | - | + | . |

The authors remark that:

> ...si les liquides, les nasales  les semi-voyelles reçoivent la
> même specification pour les traits de classes majeures, ils se
> distinguent toujours les uns des autres par la hauteur
> (normalement les semi-voyelles sont hautes)...ou [vocalique] et
> [consonantique] sont les traits de classes majeures, il n'est pas
> possible de représenter les voyelles comme un classes naturelle.
> Cette observation est correcte mais sans grande portée  En
> effet, des notion comme 'voyelle' ou 'consonne' ne sont pas
> definies et n'ont, en fait, pas de statut théorique.(p.132)

Within such a system [+vocalic] matrices are those that appear within the nucleus  while only [+consonantal] matrices may appear outside of the nucleus.[1] Such a system relies on the supposition that [-cons,-high]

--------

1. We examine this feature system in order to determine whether it is universally appropriate for language specific rules of N-Placement and

segments, which are redundantly [+vocalic], are universally obligatory

syllabic nuclei  as well as on the supposition that obstruents can never

function as syllable heads.  These claims, as well as many other universal

statements concerning the categorial status of segments are easily refuted.

Although there appear to be few langagues in which [-cons,+low] segments

are not redundantly specified as syllable heads, Pekingese as analysed by

Pulleyblank(1983), and Axininca Campa, as analyzed by Yip(1983) both provide

examples of identical feature matrices which may surface as either a syllabic

[a], or as a non-syllabic glide [G].[2]  In Pulleyblank's study, syllabicity

distinctions are, for the most part, underlying, while in Yip's analysis, low

glides are derived via a feature-spread rule.

In Pulleyblank's investigation of syllabicity distinctions in Pekingese ,

the vowel /a/ is shown to be the syllabic equivalent of a non-syllabic fully

voiced laryngeal glide /H/ in syllable initial and syllable final position.

For instance, Pulleyblank's representation of an 'peace', which,for most

speakers contains an initial low glide, involves linking a [-high,+low,+back]

---

further rules of syllabification  However, it should be noted that problems
associated with Kahnian syllabification algorithms do not arise for Kaye and
Lowenstamm(1984) since they take the position that syllable structure is
present in the lexicon:"Puisque notre position est précisement que la
structure syllabique est présente des le lexique, nous allons montrer que le
trait [syllabique] peut être éliminé de ce niveau de
représentation...(p.130)." This approach of course makes the elimination of
the feature [+syllabic] a trivial matter, since nucleus placement is always
present in underlying representations.  The example of the Mokilese prefix
[XXX-] examined in Chapter 1, is evidence enough that syllable structure is
not exhaustively present in the lexicon, a hypothesis which has much support
in the literature.  See for example Kiparsky(1984);Steriade(1981,1982);
Harris(1983); Walli(1984)  Dell and Elmedlaoui(1985).

2. See Pulleyblank(1983;pp.3-6) for a general discussion of the laryngeal
voiced glide /H/.

matrix to a C slot as shown in (145.a). In (145.b) we see the low back glide

in final position where its association to the preceding V slot as well

accounts for the surface realization of the vowel as a low back rounded [ɔ]:

(145) Pekingese Low Glides
```
     I. Pulleyblank(1983)    II. X-Skeleton        Surface
  a.     a n                    a   n
        /| |                   / \  |
        C V C                  X  X X              [ an]
        \|/                    \  | /              'peace'
         o-                     \ N/
                                 \N'
                                  N"

  b.  pw a                    p u  a
      |/\/|                   |/\/  \
      C V C                   X  X X             [p ɔ]
      \|/                     \  | /             'wave, breaker'
       o-                      \ N/
                                \N'
                                 N"
```
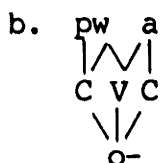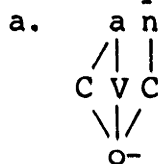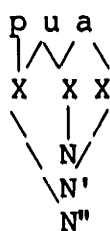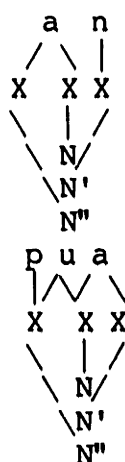
Within a metrical theory of syllabicity, the realization of the

[-high,+low,+back] matrix as syllabic or nonsyllabic is dependent on whether

or not the X-slot to which it is linked is dominated by N.

In Axininca Campa(Yip,1983), [+low,+back] glides are derived via

association of underlying /a/ to an empty skeletal slot. Whether or not the

glide in Axininca Campa itself is actually [+low] is debatable, but it is

clearly [-high], refuting the claim that glides are universally [+high].

Payne(1981) refers to this segment as a "velar glide", and gives it the

feature specifications [-low,+high,+back], though his description of this

segment is that "its articulation involves very little tongue movement from

the neutral /a/(p.71)." Yip suggests that it is more likely pharyngeal,

having the feature specification [+low,+back], like [a]. In any case, the

point to be made here is that the underlying feature matrix for /a/, a

[-high] segment may function either as a syllable head, or as an onset in

Axininca Campa (AC).

This glide [G] has a very restricted surface distribution, occuring only between two low back vowels, one of which is in a vowel cluster, or in the environment a__a##. Vowel clusters in AC consist of any vowel /a,i o/ followed by /i/, or any long vowel. The environments then in which [G] surfaces are listed below:

(146) a__a##   a__a:     a:__a
              a__ai     ai__a

The environment a__a## can be collapsed with a__a:, given the rule of final shortening (Payne's geminate reduction), given below:

(147) AC Final Shortening

$$
\begin{array}{ccc}
[\text{\^{}F}] & & [\text{\^{}F}] \\
\wedge & & | \\
\text{X X} \quad \longrightarrow & \text{X} & / \quad \text{X...}\underline{\quad}\text{\#\#} \\
\vee & | & | \\
\text{N} & \text{N} & \text{N}
\end{array}
$$

Yip proposes that the underlying forms of stems with final velar glides are as in (148), where Rs have been changed to Ns and Cs and Vs to Xs for the sake of consistancy.

(148)  a. /taG-/  'burn'        b. /oyaaG-/  'insert'

```
       t  a                    o  i  a
       |  |                    |  |  |\
       X  X  X -               X  X  X X  X -
          |                    |     |/
          N                    N     N
```

The spread rule below fills the empty X-slot under affixation, resulting in derivations like those shown in (150).[3]

––––– –––––

3  Note that the structure created by rule (149) in (150.a) is ternary branching.  Unlike yes/no question formation in West Greenlandic examined

(149) AC: Feature-Spread

```
                 Ⓧ  X
                  \  |
                   \ |
              [-round,-cons]
```

(150)

A.
```
t  a     a N c  i
|  |   / |\ | |  |
X  X  X+ X XX X  X
 \ |  \  |// \ |
  \N   \N/    \N
   \|   \N'    \|
   N"    N"     N"
```

B.
```
p i N t  a   i r o
| | | |  |  / | | |
X X X+ X  X X+ X X  X
 \ |   \  |  \ | \ |
  \N    \ N   \N  \N
   \|    \|    \|  \|
   N"     N"   N"   N"
```

C.
```
n o t a  a k i r o
| | | | /| | | | |
X X+X X X+X X X X X
 \ |  \ |  \ |  \ |  \ |
  \N   \N   \N   \N   \N
   \|   \|   \|   \|   \|
   N"   N"   N"   N"   N"
```

[taGaaNc i]              [piNtayiro]              [notaakiro]
'to burn'                'you will burn'          'I have burned'
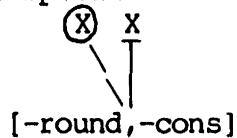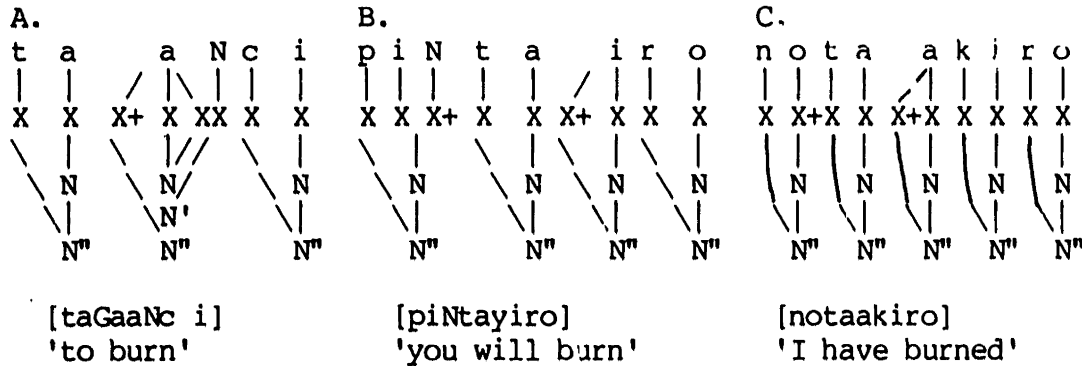
If [G] is treated as an underlying segment rather than as an empty X-slot,
the fact that its distribution is limited to environments like that in
(150.A) is not explained. In addition, a form like (150.B) must involve
delinking of the preassociated /G/ and spreading. Finally, an analysis with
underlying /G/ is unable to explain the peculiar fact that /G/ does not
surface if proper syllabification can procede without it as in (150.C).
Payne posits a rule of Velar glide deletion to account for cases like C.
above where the velar glide does not surface:

(151) Velar Deletion

$$[\text{-cons,+high,+back}] \longrightarrow \emptyset / \begin{Bmatrix} <CV> \\ \{C,V\}V(N)CV \end{Bmatrix} \underline{\quad} V \begin{Bmatrix} <C> \\ \#\# \end{Bmatrix}$$

Yip accounts for this fact by positing the following rules of syllabification

---

earlier, here the skeletal slot is presyllabified as onset of the following
syllable, and thus N-placement and invocation of the CSD are inapplicable.

for AC:

(152) Syllabification in AC (Yip,1983)
    I. Syllabify all associated skeletal elements as far as
       possible.
   II. If associated material is left unsyllabified, use
       available unassociated skeletal slots for syllabification.


The maximal syllable in AC is shown below:


(153)
```
            N"
           / |
          /  N'
         /   N\
        /   |\\
       X    X XX
               |
            [+nas]
```
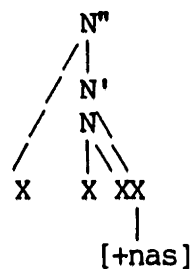

Instead of singling out /G/ as a segment which can only be syllabified at a

later stage, or as one which must be deleted in the environment V__V when the

two vowels can be tautosyllabic, Yip's rules of syllabification make a

crucial distinction between skeletal slots unassociated to segmental material

and those linked to segmental material.  Derivations employing the rules in

(152) are given below for the same stem /taG-/ 'burn':

(154)a.
```
        o-              o-          b.   o-   o-        o-    o-
       /|              /|               /|   /|        /|   /|
I.    X X X+ X X X X X               X X+ X X X+ X X X X X
      | |   |/ | | |                 | |  | |   |/ | | | |
      t a    a N c i                 n o  t a    a k i r o
```

```
      *   o-                              o-
         /|\                             /|\
        X X X X X                       X X X
        | | |/ |                        | | |
        t a a  N                        t a a
```

II.
```
        o-  o-      o-
       /|  / |\\   /|
      X X X+ X X X X X                 --------
      | |   |/ | | |
      t a    a N c i
```

        [taGaaNc i]                    [notaakiro]


Yip's analysis, which does not involve deletion of the empty X-slot, is

problematic on examination of further data. Payne cites the form below as

evidence that his rule of velar glide deletion feeds rule (149) above:

(155)  /ir + owamaG + a /        ---> [howama] 'he killed himself'
       3pm   kill     refl/nonfut.

The deletion of /G/ creates a sequence of identical vowels which is later

subject to degemination.

We can preserve the explanatory power of both Payne and Yip's analyses by

adopting the underlying representations in (148), and by stating the rule of

/G/-deletion as one of X deletion:[4]

———————— ·

4. The fact that X does not delete in the final syllable of a bisyllabic
word, or must be preceded by at least two syllables in order to delete is not
an isolated phenomena. Morphology of genitive noun forms is also sensitive
to such a syllable count. Noun stems with two vowels take the suffix /-ni/,
while those with more than two vowels productively take the alternation

(156) X-Deletion

```
      X  ---> 0 /<o->... X ___ X<##>
                         |     |      (where N is non-branching)
                         N     N
```

Our analysis of AC then requires first a rule of the following form:

(157) N-Placement in AC

```
          [-cons]              [-cons]
             |                    |
             X'    --->           X
                                  |
                                  N
```

This rule is followed by projection of N'' and N'. After syllabification, rule

(156) applies, followed by the feature-spread rule (149). The realization of

the derived segment [G] as a non-head is predicted then, since the

phonological rule of N-placement above applies to underlying representations

in which segments like the final element in /taG-/ are represented as

skeletal slots with no associated features. In summary, /a/ in Axininca

Campa is not redundantly specified as a syllable head. It may surface either

as a syllable head via rule (157), or as a non-syllabic segment through the

application of rule (149). We conclude from the discussion of Pekingese and

AC that all [-cons] segments may surface as syllabic or non-syllabic. A

feature like [+high] or [-lo] then cannot be used to distinguish

non-alternating syllabic segments from segments which alternate in

syllabicity.

At the other extreme, the feature system in (144) disallows [-vocalic]

(equivalent to [-sonorant] in standard terms) segments from ever acting as

---

/-ti/. This could be related to metrical structure, though data is
unavailable.

syllabic nuclei. Though syllabicity is limited for the most part to

[+sonorant] segments, such a constraint does not appear to hold

universally.[5] One of the most striking and well-documented cases of syllabic

obstruents is that found in the Berber dialect of Imdlawn Tashlhiyt (ITB) as

analyzed by Dell and Elmedlaoui(1985), D&E from hereon. In ITB, consonantal

sonorants, as well as fricatives and stops may be realized as syllabic

nuclei, depending on their position and relative sonority in the string. The

data in (158) show syllabicity alternations of verb-initial consonants, where

verbs are given in the perfective aspect.

(158) Syllabicity Alternations of Sonorants and Obstruents in
      Indlawn Tashlhiyt Berber (D&E;p.2)

| 3. masc. sg. | 3 fem. sg. | Gloss |
|---|---|---|
| ildi | tldi | 'pull' |
| irba | trba | 'carry on one's back' |
| inda | tnda | 'shake(milk)' |
| imda | tmda | 'be worn out' |
| izdi | tzdi | 'put together' |
| izla | tzla | 'get lost' |
| ivza | tvza | 'dig' |
| ihda | thda | 'give(gift)' |
| isti | tsti | 'select' |
| ifsi | tfsi | 'untie' |
| ixsi | txsi | 'go out(fire)' |
| ihba | thba | 'cover' |

It is clear from the data in (158) that obstruents in ITB may function as

syllabic nuclei, a fact which leads Dell and Elmedlaoui to construct a

syllabification algorithm which includes [-sonorant] segments as possible

--------

5. See Hockett(1955) and Bell(1978) for cross-linguistic surveys of syllabic
consonants. See also Hoard(1978) for discussion of syllabic obstruents in
languages of the Pacific Northwest, and Dell(1981) on syllabic obstruents in
the Bai language of Southern China.

syllable heads.[6] The syllabification algorithm presented by D&E is given in (159), and is intimately tied to the sonority scale of ITB, a partial version of which is given in (160):

(159) Core Syllabification: (D&E;p.10)
associate a core syllable with any sequence (Y)Z, where
Y can be any segment and Z is any segment of type T.
(where T is a variable to be replaced by a certain set
of feature specifications, which successively takes on
all the feature values in the sonority scale given in
(160).)

(160) Imdlawn Tashlhiyt Berber Sonority Scale (D&E;p.10)
a
i,u
l
n,m
.
.
.

It should be pointed out that while N-Placement rules in ITB appear to follow the sonority scale above, within a given language, it is not the case that elements which may function as syllable heads are more sonorous in absolute terms than those which may not. In Sanskrit (Steriade,1985), /r/ is specified underlyingly as [-syllabic] while /w/ is specified as [0 syllabic] subject to regular alternations in syllabicity determined by a rule of N-placement identical to that in Mokilese. However, contrary to what one might predict, the sonority scale relevent to consonant clusters specifies /r/ as more sonorous than /w/. A similar situation is found in Gonja(Painter,1970), a dialect of North Guang spoken in the Northern Region

_____

6. The model of syllabification and syllable structure presented by D&E is similar to that presented here, though syllables are viewed more as autosegments than as trees generated by a primitive version of X bar theory. Core syllables for D&E are syllable heads with single member onsets, or left sisters.

of Ghana. Here the discrepancy between the sonority heirarchy and rules of
N-placement is even more pronounced, since all sonorants except /l/,
including the nasals /m,n,n/, can occur in what Painter calls
"syllable-centre position." So we find words like [lr] 'to go out', [tr] 'to
plaster', [kr] 'to tie',[mful] 'salt', [ndung] 'there' and [nmeya] 'kick'.
In native words, /l/ appears in pre- or post-vocalic position: [lo] 'weave',
[efol] 'rope' kulti 'walk around. An epenthetic [u] splits up
unsyllabifiable clusters in loan words, where we find [Xsukul]  school' and
[Xtebul] 'table'. Such facts seem to indicate that [l] is unable to act as a
syllable head in Gonja. Given that /l/ is more sonorous than the nasal
sonorants and less sonorous than /y/ and /w/, it is impossible to devise a
sonority-based rule of N-placement for this language. Rather, it appears
that rules of N-placement must be stated as applying to the natural class of
[+sonorant,-lateral].

What does appear to be the case is that, should a grammar contain both
N-placement by redundancy rule and phonological rule, the feature matrices
specified by the redundancy rule will always be more sonorous than those
specified by the phonological rule. Furthermore, if a language contains more
than one phonological rule of N-Placement, these rules will be ordered with
respect to the relative sonority of the target segments. Finally, as a
result of structure preservation, N-Placement in the lexicon is limited to
elements which are possible syllable heads in derived lexical
representations.[7] Given the three instances of N-placement repeated in below

--------

7. A preliminary experiment has been carried out supporting this final
claim. In English, where all [+sonorant] segments may function as syllable

we observe the apparent universal relations stated in II. below:

(161)
```
    I.  A. Redundancy Rule        B. Phonological Rule        C. Lexical
          [^F]        [^F]            [^G]        [^G]            [^H] (in UR)
           |   --->    | / Y__Z        |   --->    | / Y __Z        |
           X           X               X'          X               X
                       |                           |               |
                       N                           N               N
```
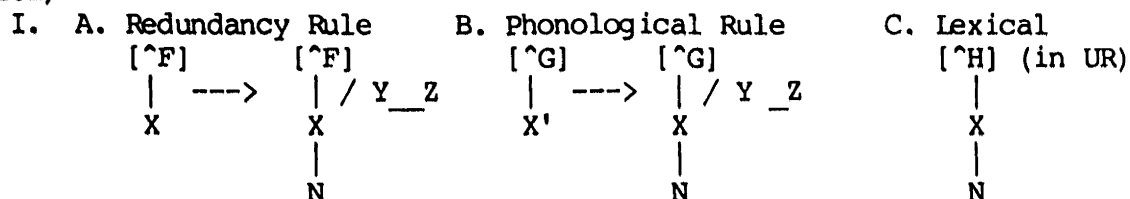
II. Proposed Universals
   a.  [^F] is more sonorous than [^G]
   b.  Given two Rules B1 and B2 with targets [^G1] and
       [^G2] respectively, if [^G1] is more sonorous
       than [^G2], then B1 applies prior to B2.
   c.  [^H] is a proper subset of [^G]


By establishing N-placement in terms of the rules listed above, we merely

eliminate an intermediate step in the derivation, namely that of marking

certain segments as [+syllabic], [-syllabic] or [0syllabic] in underlying

representation. Furthermore, the rules in (161 I) are constrained by the

revised Redundancy Rule Ordering Constraint and the Condition on Structure

Dependent rules, allowing us to dispense with extrinsic ordering and a

--------

heads, the following nonsense words which contain syllabic obstruents were
perceived as either monosyllabic or illformed by native speakers, while those
with syllabic sonorants were uniformly perceived as bisyllabic regardless of
whether or not they were well-formed words in English:

Perception of Syllabic Obstruents by Native Speakers of English

|    |          | English? | # of σ-'s | Repetition |
|----|----------|----------|-----------|------------|
| a. | [stap]   | Yes      | 1         | [stap]     |
| b. | [sbIl]   | Yes      | 1         | [spIl]     |
| c. | [skuwl]  | Yes      | 1         | [skuwl]    |
| d. | [aks]    | Yes      | 1         | [aks:]     |
| e. | [maetz]  | No       | 2         | [maetz^]   |
| f. | [maesz]  | No       | 2         | [maesz^]   |
| g. | [meyzs]  | No       | 2         | [meyzs^]   |
| h. | [maets]  | Yes      | 1         | [maets:]   |
| a. | [mpowz]  | No       | 2         | [^mpowz]   |
| b. | [ntap]   | No       | 2         | [^mtap]    |
| c. | [lguwl]  | No       | 2         | [lguwl]    |
| d. | [maeDl]  | Yes      | 2         | [maeDl]    |
| e. | [maesr]  | Yes      | 2         | [maesr]    |

proliferation of constraints on geminate structures. We have also proposed that, in addition to the rules in I. above, complex nuclei may result from coalescence, reanalysis, or from a combination of these rules and the CSD. Having determined the means by which a segmental matrix may acquire syllabic status, and having shown how such syllabic status may be minimally represented as a categorial label $N^o$ on the syllable plane, we now turn to the phonological projections defined by $N^o$ and the rule systems proper to such projections.

## 2.1.4 Projections of N

Within most current versions of phonological theory the fact that every syllable contains a Nucleus (or syllabic peak) and the fact that every Nucleus is dominated by the Rime-projection are disjoint and non-derivative. That is to say, there is nothing within the theory which requires that the Rime immediately dominate the Nucleus. Rather, metrical theory aside, one could just as well define the Rime constituent linearly as the set of all tautosyllabic elements following and including the syllablic peak.

The proposal put forth here relates the endocentric relationship between the nucleus and the so-called rime to a particular property of X'-bar theory. This is accomplished by adopting the following universal X'-bar schema, where X may equal N, the syllable head:

(162)      $X^n ---> ...X^{n-1}...$

The particular rules determined by this system are given below:

(163)  i.  N″ ---> (Spec) N'
       ii.  N' ---> ...N...

Such rules generate syllables of the following sort:

(164)

```
                N″
               /|
              / N'
             / |\
            /  N \
           /  |\  \
          /   | \  \
         /    |  \  \
        /     |   \  \
     (X )     X  (X )(X )
        o        o     o
```
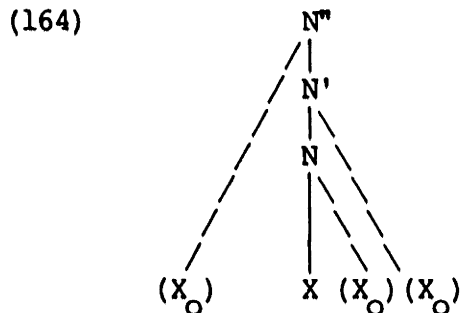
Obviously, syllables can be more or less complex than the basic structure
above.  In this section we investigate the rule systems governing the
constituency of N, N', and N″ as well as additional rules of adjunction to
N″. We argue on empirical grounds that rules of projection derivative from
the X-bar schema in (162) are formally distinct from rules of incorporation,
which are constrained by sonority scales and may be either iterative or
non-iterative.  Only with this distinction can we account for distributional
restrictions of elements preceding and following the nucleus.


## 2.1.4.1 Project-N″

We have already established the set of rules which determine head status of
particular skeletal slots.  Once a head has been established, X'-theory
requires the interpretation of a maximal projection.  This universal aspect
of the theory of syllabification, which has been termed Onset-formation or
the CV-rule, is simply the result of the rule schema in (163).  Viewed as a
syllable-building algorithm, we will call this Project-N″ and state it as

follows:

(165) Project-N" (Universal)

```
                              N"
                             /|
             N              / N
             |             /  |
    (X('))   X   --->   (X)  X
```
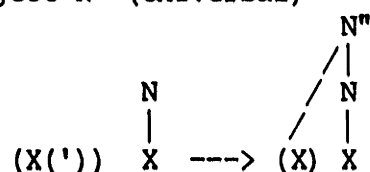
If there is no skeletal slot preceding the nucleus, a non-branching N" will

result. A simple example of N-Placement followed by Project-N" is given

below from Niuean:

```
(166)  h a k u           h a k u            h  a k  u
  UR   | | | |   N-Plac.  | | | |   Proj.-N" |  | |  |
       X X X X            X X X X            X  X X  X
                             |   |            \ | \  |
                             N   N             \ N \ N
                                                \|   \|
                                                N"    N"
```
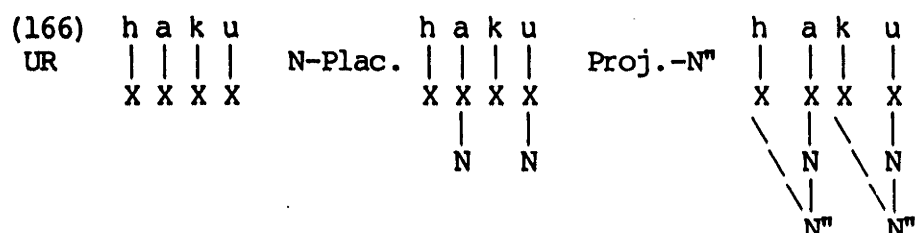
As stated in (165) Project-N" will universally effect elements which are

unassociated to the syllable-tier, and will have the option of applying in a

structure changing fashion as well, as indicated by the parentheses

notation.[8] In language specific cases projection of N" will be extended to
elements which have been syllabified at a previous stage in the derivation.

--------- --

8. The slot to be syllabified via Project-N" is purposely notated as X, and
not |X|. Project-N" is not powerful enough to effect a structure like X X. A
case of devocalization like Sanskrit [iti asti]---> [ityasti] is seen as a
two-step process. The first takes XX (ia) to X'X, and the next involves
Project-N". For motivation of devocalization as a two step process, see 4.2.
Furthermore, though on the surface it is clear that certain elements do not
occur as onsets in some languages, it is not clear whether this is ever a
result of restrictions on the rule in (166). In English, for example, the
absence of [n] in the onset can be seen as the absence of /nG/ in the onset,
a fact related to incorporation rules (see next section). In other languages
where /?,h/ are prohibited from onset position, this can be seen as a
restriction on the anchoring of glottal features.

We see this clearly in Klamath, where initial creation of CVC syllables

feeds the rule of epenthesis, which must be seen then in certain cases to

bleed a rule of closed syllable reduction. The rules of epenthesis and

closed syllable reduction are given in (167), and derivations involving a

structure-changing application of Project-N‴ are given in (168).

(167)  a.  Epenthesis:                 $0 \longrightarrow X / \underline{\quad} X']$
       b.  Closed syllable reduction:  $a \longrightarrow {}^{\wedge} / \underline{\quad} \ldots]_{N'}$

(168)  Resyllabification via Project-N‴ in Klamath
       /gawm/ 'spring' /-'a:k/ diminutive suffix

```
                      g  a  w  m          g  a  w m 'a  k
N-Plac.               |  |  |  |          |  |  | |  |\ |
Project-N‴            X  X  X X X         X  X  X X  X XX
Project-N'            \  | /  | |         \  | /  \  |//
(see next              \ N/   | |          \ N/    \ N/
Section)                \N'   | |           \N'     \N'
Epenthesis              N‴    | |            N‴      N‴
Project-N‴                 | N/
Project-N'                  \N'
                            N‴

Syllabified
output:               ga.wam              gaw.ma:k
Closed-syllable         ^                    ^
reduction
Surface:              [gaw^m]             [g^w.ma:k]
```
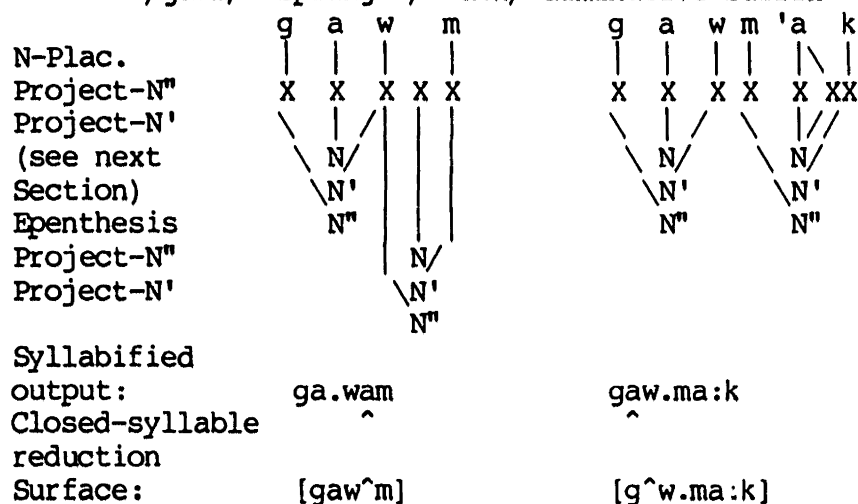
That Project-N‴ applies after epenthesis in a structure changing fashion is

clear from the output of [gaw^m], where the first vowel is not reduced, a

sign that it is in an open syllable. The rule is structure changing since

Project-N' must precede epenthesis as evidenced by forms like /bam/ 'drum'

---> [b^m] or /som/ 'mouth' ---> [som] where epenthesis does not apply, and

the close syllable generated by Project-N' feeds vowel reduction, where

applicable. For justification of the formulation of epenthesis in (167.a),

as rule which refers necessarily to X in its structural description, see

Chapter 4, Section 2.

Another illustration of Project-N″ as structure-changing, also with

relation to epenthesis, can be found in Yokuts(Archangeli,1984). Archangeli

posits the creation of CV syllables (projection of N″), followed by Rime

formation which is collapsed with a rule of closed syllable shortening.

After Rime formation (or N'-Projection, cf. following discussion) epenthesis

takes place. The output of epenthesis is an open syllable, which in turn

feeds a structure changing application of N″-projection and allows the long

vowel to surface. In (169.a) we see the shortening rule posited by

Archangeli, and in (169.b) the rule of epenthesis:

(169) Yokuts Syllabification
    a. Rime Formation/Shortening    b. Epenthesis
      N'                           N
      |\\                            |
      X(X) X'            0 ---> X / __ X'
      |/
      [ ]
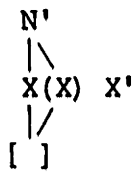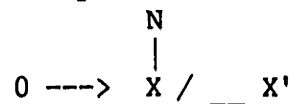
Now we examine a derivation where the environments for shortening and

epenthesis are both met:

(170) /soonl  + mi/     ---> [soo.nil.mi] 'having back-packed'
      back-pack gerund

```
s o  n l m i                    s o  n l m i
|  |\ | | | |   Core syllab.     |  |\ | | | |   Epenthesis
X XX X X X X   ------------->    X XX X X X X   -------->
  |/      |                       \ | /    \ |
  N       N                        \N'      \|
                                    N"       N"


s o  n  l m i                   s o  n  l m i
|  |\ |  | | |   Core syllab.    |  |\ |  | | |
X XX X X X X X   ------------->   X XX X X X X X
  \ | /  |   \ |                   \ |/ \ |/  \ |
   \N'   N    \|                    \N   \N'   \|
    N"         N"                    N"   N"    N"
```
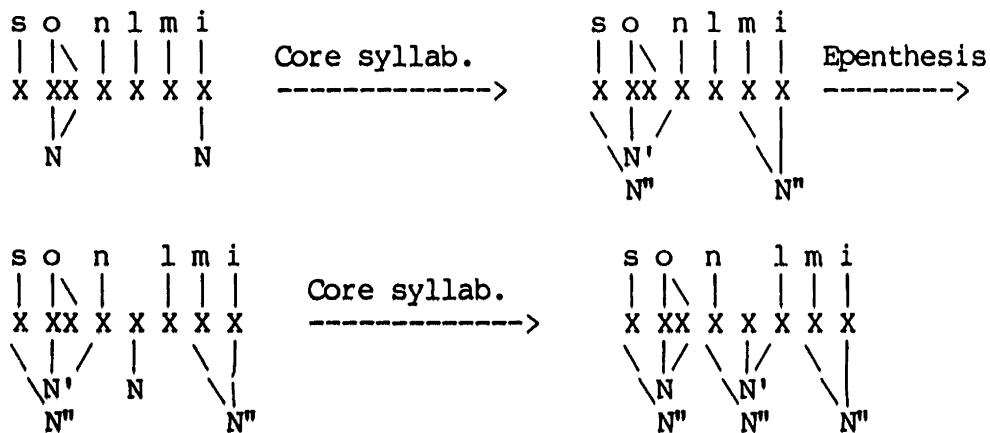
As in Klamath, syllabification must take place before epenthesis, since it is

only after CVC syllables are formed that the targets for epenthesis,

unsyllabified X-slots, are properly distinguished from other X-slots. The insertion of an epenthetic vowel opens up the initial syllable and allows the long vowel to surface.[9] Here is another case, then, where N"-projection may be structure changing.

The question now arises as to whether there are any languages which do not allow structure changing applications of Project-N". Because, on the surface, sequences of [XXX] are generally perceived as being syllabified [X.XX], we can only ask whether there are languages which clearly require intermediate phonological representations of the form [XX.X], and for which there is no phonological evidence for the syllabification [X.XX]. If we find such a case, we can hypothesize that, given no phonological evidence to the contrary, within the phonological component, Project-N" does not apply in a structure-chainging fashion.

Intuitively, this appears to be the case in English, for the /-Ing/ suffix which appears to have no effect on the syllabification of preceding segments, even for very late rules. In (171), for instance, note that the late rules of intervocalic gemination of glides, r-coloration of tautosyllabic vowels, tensing of [ae] in syllables closed by nasals, and syllable initial aspiration of stops (in non-flapping dialects) as indicators of late stages of syllabification, all indicate that the /-Ing/ suffix leaves the preceding

--------

9. For evidence supporting this particular statement of shortening and epenthesis, see Archangeli(1984,Chapter 3).

syllable closed:[10]

(171)

| | | I. | II. |
|---|---|---|---|
| Gemination: G ---> GG/ X.__ X | | 'layer' | 'eyeing' |
| | | le.yer | ey.In |
| | | ley.yer | ey.In |

R-color: [ ]r
     |/|
    [X X...]
    N'

| | I. | II. |
|---|---|---|
| | 'currant' | 'purring' |
| | k^.r^nt | p^r.In |
| | k^.r^nt | prr.In |

[ae]-Tensing: ae ---> ae/ __[+nas]
              T |
            X X...]
              N'

| | 'Hannah' | 'tanning' |
|---|---|---|
| | hae.n^ | taen.In |
| | hae.n^ | taen.In |

Aspiration:
[-son] ---> [+spread GL]/ [__
               N"

| | 'slipper | 'hopping' |
|---|---|---|
| | sli.p^r | hop.In |
| | sli.p'^r | hop.In |

In Mohawk, there is strong phonological evidence for intermediate phonological representations which are syllabified as [XX.X] and no phonological evidence that such sequences are resyllabified. In Mohawk as analyzed by Michelson(1985), stress rules, epenthesis rules, and a rule of tonic lengthening interact in quite interesting ways to produce what appears to be a rule ordering paradox.[11] Stress, in words containing no epenthetic vowels, falls consistently on the penultimate syllable. If the stressed syllable is open the vowel in this syllable will lengthen. This rule of

----------

10. These late rules are all optional, but still appear to offer distinctions between the forms in columns I and II. The rule of [ae]-tensing is only apparent in dialects of the Greater New York metropolitan area, where [ae] and [ae] are distinctive, as evidenced by certain minimal pairs like [tIn kaen] 'tin can' but [ay kaen] 'I can'.

11. Much thanks to Karin Michelson and Alicja Gorecka for discussion of the Mohawk facts.

tonic lengthening is shown in (172):

(172) Mohawk Tonic Lengthening

```
      N        N
      |        |\            where o denotes DTE of a foot.
      X ---> X X /  ___ ]            |
                     ‾o  N"          |
                      |
```

Forms illustrating the lengthening of a stressed open syllable follow:
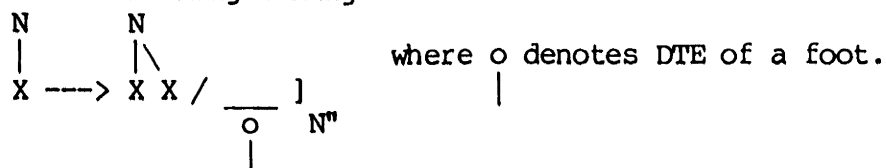
```
                       /
(173) k-awak-s    ---> kawaks ---> ka:waks       'I shake,fan it'
                              /
      wal-awak-u ---> wakawaku ---> wakawa:ku 'I have shaken it'
but:                        /
   te-k-hriht-ha? ---> tekhrihta?  (n.a.)       'I smash,break'
```

A curious fact is that two different types of epenthetic vowels act

differently with respect to whether or not they may be stressed, and whether

or not they trigger lengthening of the preceding syllable. A summary of the

behaviour of the two types of epenthetic vowels is given in (174):

(174) Mohawk: Properties of epenthetic vowels (Michelson,1985;12)

| in syllable type | "joiner" [a] closed | open | epenthetic [e] closed | open |
|---|---|---|---|---|
| Stressable | yes | no | yes | no |
| Blocks length | — | no | — | yes |

The rules of epenthesis motivated by Michelson are given in (175):

(175) A.  Joiner Insertion: 0 ---> a/ C+___+C]
                                      ‾‾‾‾‾Verb base
      B.  Epenthesis          0 ---> e/ C ___ {C',R}
      (C' = extrasyllabic consonant,R = n̄,r̄,w)

In cases where epenthesis has applied, stress is assigned to the penultimate

syllable, provided that the penult is not in an open syllable derived via

either of the two rules in (175).[12]

Given that epenthetic vowels in closed syllables can be stressed, syllabification of such epenthetic vowels must occur before the rule of stress assignment, as stress relies on syllable count. However, if this is so, it appears that Joiner-Insertion takes the immediately preceding consonant in as an onset, while Epenthesis does not. If N"-Projection is formulated to be structure building alone, or both structure building and structure changing, how are we to account for the Mohawk facts?

The answer lies in the statement of the rule of joiner insertion. This morphologically conditionned rule of [a]-insertion need not refer to the syllabified or unsyllabified nature of a skeletal slot. We therefore are free to formulate the rule as in (176), and to allow it to apply before any rules of syllabification have taken place:

(176) Joiner Insertion

$$0 \longrightarrow \underline{X} \; / \; X+ \underline{\quad} +X...]$$
Verb base

In this way, Joiner-Insertion feeds a non-structure-changing application of Project-N", taking in the preceding X-slot as an onset, and in some cases creating preceding open syllables which will be lengthened if stressed. After syllabification, the rule of epenthesis applies. We state this rule as

--------

12. See Michelson(1985) and Gorecka(1985) for analyses of the interaction of stress and epenthesis. The formulation of the rule given by Michelson is as follows:

Vowel Lengthening: $/ \quad /$
$$V \longrightarrow V: \; / \; \underline{\quad} C \; V$$

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shown in (177):

(177)  Epenthesis                              [+son]
                                                 |
            0 ---> X̲ / X ___ {X',X}

The fact that Epenthesis does not feed Tonic Lengthening leads us to

hypothesize that Project-N‴ is not structure-changing in Mohawk.

The only remaining question concerns the spellout of the two inserted

vowels, and the fact that they only count for rules of stress assignment in

closed syllables.  First, we invoke a morphologically conditioned spellout

rule which can be stated as in (178).

(178) Morphologically conditioned spellout
            X̲ ---> X̲ / + ___ +...]
               |                 Verb base
               a

Within the theory of underspecification we are adopting, treating [e] as the

unmarked vowel in underlying representations accounts for the fact that the

epenthetic vowel, in the unmarked case, will surface as [e] as a result of

the redundancy rules of the language.  As to why skeletal slots marked as

syllable heads but unassociated to segmental material are not available to

stress rules, we refer the reader to the theory of accent presented in

Chapter 4.  There, we propose that, though information on the segmental plane

is not available to stress rules, the absence or presence of an association

line from a skeletal slot to the segmental plane is accessible to rules of

stress assignment.  Rules of accent are stated in terms of branching nodes,

where the following may count as branching or non-branching:

(179) Branching within N"
     a. N"    b. N'    c. N    d. X   (where lines in d.
       $\wedge$       $\wedge$      $\wedge$     $\wedge$   indicate association to
                                         different planes.)

This allows us to state the rule of stress assignment in Mohawk as follows:

(180) Mohawk Stress
     Build left-dominant foot on right edge of word.
     (where DTE or head of foot = accent)
     Accent head of N" iff branching.

The lack of branching of Xs onto two distinct planes disallows such segments

as acting as heads of feet, as described above.

In summary, it appears that Project-N" applies universally as a

structure-building rule.  In some languages it may reapply in a

structure-changing fashion, and in others, it must not apply in this fashion,

at least not before the application of phonological rules.

2.1.4.2 Project-N'

Whether or not post-nuclear elements occur within the syllable is clearly a

language specific property.  We designate this parameter in terms of the

existence or non-existence of an intermediate projection N' provided by X-bar

theory, and generated within syllables as shown in (181):

(181) Project-N' (Language-Specific)
```
        N"              N"
        |               |
        |               N'
        |               |\
        |               | \
        N               N  \
        |               |   \
        X  X' --->      X    X
```
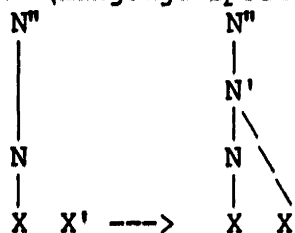
The fact that this rule is language specific is inherent in the X-bar system where only an $X^0$ and an $X^{max}$ are universally required. Niuean, like many other Polynesian languages, does not project N'. Syllabification is limited, as shown above, to rules of N-Placement, and N‴ projection. Yokuts (Newman,1944) differs minimally from Niuean in terms of rules of syllabification in having the Project-N' option. Any consonant in Yokuts may be syllabified as a post-nuclear element, allowing us to state Project-N' as in (181) without alteration.

Archangeli(1984) collapses Project-N' (Rime-formation) with the rule of closed syllable shortening as shown in (182.A) below, where we would represent shortening as in (182.B):

```
(182)A. Yokuts: Rime Formation/   B. N'-Shortening
                Shortening            N'           N'
       |\                             |\           |\
       | \                            N \          N \
       X(X)  X'                       |\ \         |  \
       |/                             X X X ---> X X X
       [ ]
```
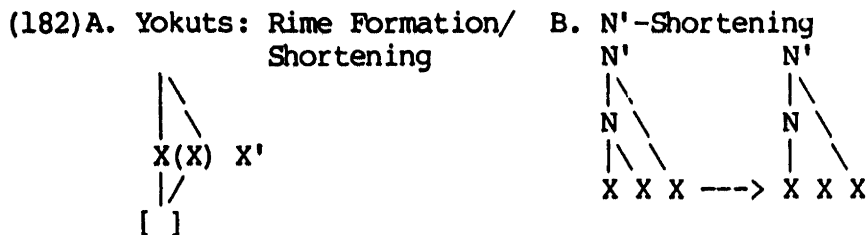
The collapse of two processes in A. is motivated by a particular analysis of certain lexical exceptions to shortening, in particular, the causative repetitive, /-(i)(l)saa/ which selects a XXXXXX template in which the final syllable does not shorten as predicted by A. above. We choose to characterize N'-projection as a single immutable process, and so propose an independent rule of shortening, that given in B. above. The exceptional nature of the causative-repetitive can be captured in terms similar to that proposed by Archangeli, by proposing a rule of N‴-adjunction in these forms.

Below we give Archangeli's exceptional rule in C. and our reformulation in D.

(183) C. (i)(1)saa Rime Incorporation

```
       N'''
       | \
       |  \
       X  X  X']
            root
```

in the caus.-rep.

D.

```
    N'''
    |\
    N \
    |  \
    X  X']
        root
```
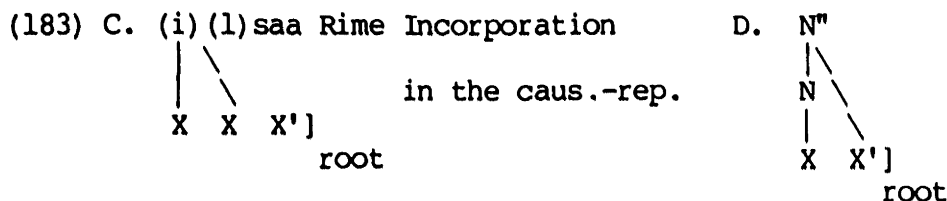
With this, we need not say anything exceptional about Project-N'' in Yokuts. It is formulated as in (181) above, and along with N-Placement, Project-N''', Rule (182.B) and the exceptional rule in (183.D) above, gives rise to all the well-formed syllables in the language.

In Umpila, an Australian language of the Cape York Peninsula, Project-N' applies only to unsyllabified sonorants. Project-N', then, may be subject to language specific feature restrictions:

(184) Project-N':Umpila

```
    N'''              N'''
    |                 |
    |                 N'
    |                 |\
    N                 N \
    |                 |  \
    X   X'   --->     X   X
        |                 |
     [+son]            [+son]
```
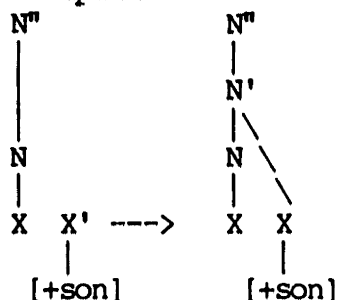
From the example above, it might appear that Project-N' is in conformity with the sonority scale of a given language in the sense that elements which can be sisters of N are more sonorous than those which cannot. However, this could not be the case given languages like Axininca Campa (AC), where

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Project-N' is limited to [+nas] segments:

(185) Project-N':Axininca Campa

```
        N"              N"
        |               |
        |               N'
        |               |\
        N               N \
        |               |  \
        X  X' --->      X   X
           |                |
        [+nas]           [+nas]
```
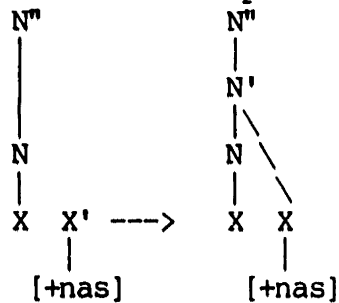
AC also contains segments /G/ and /w/ which are [+son,-cons,-cont], as well as /r/ which is [+son,+cons,+cont]. All of these segments are more sonorous than [+son,+cons,-cont,+nas] segments in terms of the sonority hierarchy. A relative sonority scale, in which all sonorants were equivalent with respect to sonority, but distinct from obstruents, would be possible, but it would not explain the restriction of rule (185) to nasals.

So, within the subset of languages which project N´, the set of possible post-nuclear elements may be restricted to certain segments. Furthermore, restrictions of this sort are not conditioned by sonority, making them unlike incorporation rules (see next section) which do appear to conform to relative sonority scales. As with Project-N", instances of Project N' may be structure changing. An example is the resyllabification accompanying stress in many languages, including English( cf. Stampe(1972); Hoard(1976) Selkirk(1983) and Borowsky(1984)), where resyllabification appears to occur within the metrical foot: or.che.stra but or.ches.tral; li.tur.gi.cal but liD.ur.gy; ma.ni.a.cal but man.i.ac, etc.[13] In each case, the first

---

13. See Borowsky(1984) for arguments that such rules are syllable-, rather than, purely foot-based within a metrical approach to syllabicity such as the

syllabification is that generated by structure-building rules alone, while in

the second, a syllable with primary stress followed by one with no stress, is

input to a structure-changing application of Project-N', which resyllabifies

an already-syllabified segment out of the following syllable, and into the

preceding syllable:

(186) Structure Changing instance of Project N': English
```
     a. X.XX   - -> XX.X
        ‾o‾/‾      ‾o‾/‾
         |/         |/


     m  e  n  i  ae k         m  e  n  i  ae k
     |  |  |  |  |  |         |  |  |  |  |  |
     X  XX X  XX X  X --->    X  XX X  XX X  X
      \ |/\ |/ |/              \ |//  |/ | /
       \ N \ N N/               \ N/  N  N/
        \|  \| N'                \N'  |  N'
         N"   N" N"               N"  N" N"
```
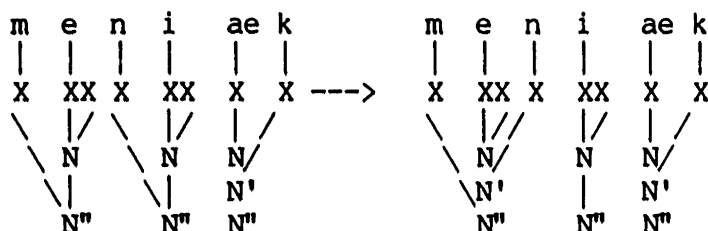
Simple projections of N, where N is a result of N-placement or a rule of

complex-N formation, as characterized by Project N" and Project-N', generate

maximal core syllables of the following type:[14]

```
(187)        N"
            /|
           / N'
          /  |\
         /   N \
        /    |\ \
       X    X X X
```
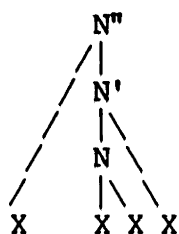
Still, this rule schema is not sufficient to account for the wealth of

syllable types observed in natural language. Take, for instance, the English

word [sprInts], which clearly necessitates something in addition to N" and N'

--------------

one proposed herein.

14. As noted earlier in relation to West-Greenlandic, $N^0$ will be n-ary
branching where required by the CSD. Elswhere it will be maximally
binary-branching.

projection. What this something is will be the focus of the next two
sections.

## 2.1.5 Incorporation

We turn now to supplemental rules of syllabification which essentially fall
into two types. The first type, rules of incorporation, incorporate
additional X-slots into N' or N", creating, as a result, possible n-ary
branching nodes out of the binary branching nodes present in (187). The
second type of rule, adjunction, adjoins elements at the N" level, creating
additional projections of N". While incorporation rules are those that obey
relative sonority scales(Steriade,1982), rules of adjunction are distinct in
allowing sonority violations. Rules of incorporation and adjunction may be
specified as iterative or non-iterative. Furthermore, rules of adjunction
are limited for the most part to peripheral position, while rules of
incorporation are not. A prediction of this system then is that languages
may exhibit binary, ternary or n-ary branching at the N' and N" level.
Evidence in support of this prediction will be provided in the following
sections. In Chapter 3 we will look at further evidence which supports a
theory in which projection of N' and N" be separated from other rules of
syllabification.

The term incorporation will be used to describe the processes illustrated
below:

(188)   A. Incorporation into N"   B. Incorporation into N'
            N"                          N'
           /|                          |\
          / |                          | \
         X' X                          X  X'
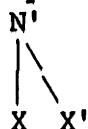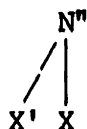
Rules of incorporation have two important properties, which will be illustrated below. First, they apply iteratively or non-iteratively. Second, the structures they create are subject to sonority restrictions. As discussed above, we adopt the relative version of sonority scales proposed by Steriade(1982). Within this system tautosyllabic sequences of consonants are defined by determining the relevant language particular sonority scale and by then designating a value for the minimal distance in sonority on that scale between the members of an onset or coda cluster. Instead of onset or coda clusters, we rephrase minimal sonority distance as a condition on the rules of incorporation shown above. For each rule, a distinct Minimal Sonority Distance will be specified. As we will see, the iterative/non-iterative parameter on incorporation rules interacts with minimal sonority distance to produce the well-formed consonant clusters within a given language.

Steriade(1982), does not distinguish between projection and incorporation rules. Thus, for her, N'-projection in a language like Axininca Campa, where no coda clusters occur, is an instance of non iterative Coda formation. In our model, such a language has no rule of incorporation into N'. In studies of onset clusters in Ancient Greek, Latin, and Sanskrit, Steriade has provided evidence for sonority scales which also produce maximal clusters of two consonants within each language (again, adjunction rules aside). She argues quite convincingly that, though in these cases the onset rule is iterative, one need not mention this aspect of the rule in the grammar, since the eventual number of segments allowed in complex onsets falls out from the

proper statement of the sonority scale and MSD value.[15] Within a model in which the first element in the onset is generated by projection, and successive elements are syllabified by a rule of incorporation, we may ask whether or not it is still necessary to specify iterative or non iterative application of an incorporation rule.

As a first step in our argument for the need of iterative versus non-iterative instantiations of incorporation, we present an example of non-iterative incorporation into N‴. We can show that the rule must be specified as non-iterative if the sonority scale and MSD required to account for possible biconsonantal clusters predicts longer clusters which do not exist.

In Chukchee as described by Bogoras(1922), biconsonantal clusters of obstruent-sonorant and sonorant-sonorant are found in word-initial position.[16] In (189) we see a chart of attested initial clusters:

(189) Initial Clusters in Chukchee
```
nl  nr  mn mn  km
ml  mr  tn tn
pl  tr  pn pn
kl  pr     qn
ql  kr
    gr
    qr
```

---

15. Such scales must also be supplemented with appropritate filters on homorganic clusters such as *bw,pw etc.

16. The cluster [pc] as in pcegtuwarkIn 'thou takest off the boots' is not taken into account here. Bogoras notes that "the combination pc seems exceptional in this series," and outside of this one lexical item, we have been unable to find additional examples of this cluster in Chukchee, nor in Koryak, which has parallel initial clusters.

Such clusters are distinguishable from unacceptable initial clusters where an epenthetic vowel is inserted. So, for instance, the verb stem /pkir-/ 'come' has surface forms [puki'rgat] 'they came but [ge pkiLin] 'he came'(p.663). The clusters in (189) may be generated by positing the sonority scale in (190) with a MSD of 1 as a condition on incorporation into N".

(190) Chukchee Sonority Scale
l,r     [+son,-nas]
n,n     [+son,+nas,+cor]     MSD = 1
m       [+son,+nas,-cor]
p,k,t,q [-son]

Note first that this scale also requires mention of [coronal] in one sub-branch of the scale, but not in the other. This is in accordance with the view of the sonority hierarchy as a binary branching tree, where the branching on one side is independent of branching on the other. The tree for Chukchee will look as follows:

(191) Chuckchee Sonority Hierarchy (subtree)
                / \
          [+son] [-son]
            / \
      [+nas] [-nas]
        / \
  [+cor] [-cor]
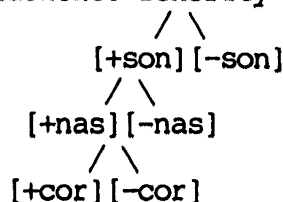
We conclude from this that Steriade's initial proposal to represent a feature on both sides of the tree is too strong. As long as every subtree is in accordance with the sonority heirarchy, a sonority scale is well-formed.

Secondly, note that if incorporation is not specified as non-iterative, we expect clusters like tmn, kmn, mnl, or mnr. Such clusters, if they occur, appear, however, to be unsyllabifiable, as they are split by epenthesis: /tm-/ 'kill' surfaces as [tImne'n] (*[tmne'n]) 'he killed him' but

[na'nmuaˆn] 'they killed him' (where t ---> n by a morphological rule of

consonant gradation). So, it appears that this is a case where incorporation

into N‴, a rule distinct from N‴ projection, as conditioned by a relative

sonority scale, must be specified as non-iterative.

Examples of iterative incorporation into N‴ are much harder to find, since,

in most cases, sonority restrictions limit such clusters to two elements.

This is argued to be the case in Latin, Sanskrit, and Ancient Greek

(cf.Steriade,1982) and could be said of English as well. In English,

incorporation into N‴ appears to be non-iterative, as maximal clusters under

N‴ consist in two consonants (not including initial [s], which, as we will

see in a moment, is the result of adjunction). The restriction of

syllable-initial clusters to two segments, is accounted for by positing a

non-iterative or iterative application of (188.A), subject to a minimal

sonority distance of 3 on the scale in (192).

(192) English Sonority Scale[17]
```
     y,w      [-cons,+son]
     r        [+cons,+son,,-nas,-lat]    N‴:MSD = 3
     1        [+cons,+son,-nas,+lat]
     m,n      [+cons,+son,+nas]
     s,z      [+cons,-son,+cont]
     P,T,K    [+cons,-son,-cont]
```

Such languages provide no positive evidence for distinguishing between

iterative and non-iterative applications of incorporation into N‴, since a

maximal of two segments is always a result of the MSD. However, there are

languages in which tautosyllabic sequences of more than two consonants of

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17. This scale must be supplemented with appropriate filters on homorganic
clusters:*bw,pw,tl,dl. See Clements & Keyser(1983) for precise formulations
of these filters.

equal or decreasing sonority surface before the nucleus.

One such language appears to be Kutenai as described by Garvin(1948).[18]  In
Kutenai, a native American language spoken in northern Idaho and southern
Bristish Columbia, initial clusters of up to four consonants occur.  A list

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18. Other sources for Kutenai transcriptions include Boas(1918) and
Canestrelli(1927).

of attested initial clusters appears below:

(193) Kutenai word-initial clusters

| pl | tk | kp | qk | st | l'p | xm | ct |
|----|----|----|----|----|-----|----|----|
| py | t? | kt | q? | sk | l k |    | ck |
|    |    | kk | qs | sq | l'q |    | cq |
|    |    | kq |    | sl' | l'? |   | c? |
|    |    | k? |    | sn | l'l' |  | cs |
|    |    | ks |    | sw |     |    | cl' |
|    |    | kl' |   |    |     |    | cx |
|    |    | kx |    |    |     |    | cm |
|    |    | kc |    |    |     |    |    |
|    |    | km |    |    |     |    |    |
|    |    | kn |    |    |     |    |    |
|    |    | kl |    |    |     |    |    |
|    |    | kw |    |    |     |    |    |
|    |    | ky |    |    |     |    |    |

| kk? | sqk | l'qs | ckk |
|-----|-----|------|-----|
| kq? | sq? | l'cx | ckl' |
| ksk | sl'q |     | cky |
| ksl' | sl'? |    | cqs |
| kl'q | sl'l' |   | (c?k) |
| kl'? | sl'x |    | cxm |
| kl's | sl'c |    |     |
| kl'm | sl'w |    |     |
| kcq |     |      |     |
| kc? |     |      |     |
| kcx |     |      |     |
| kcy |     |      |     |

| ksl'q | sq?m | | ckcx |
|-------|------|--|------|
| ksl'? |      |  |      |
| ksl's |      |  |      |
| kl'c? |      |  |      |
| kl'cl' |     |  |      |
| kl'cx |      |  |      |
| kl'cm |      |  |      |
| (kc?k) |     |  |      |

Apart from the two sequences in parentheses the clusters in (193) obey the

sonority scale given below:

(194) Kutenai Sonority Scale
    [+son]   (?,h,l,m,n,w,y)        $N^m$: MSD > 0
    [-son]   (p,t,k,q,s,l',x,c)

As for the clusters in parentheses, as well as other sequences of /c?/ and

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/q?/, there is little evidence that such sequences constitute clusters, as opposed to glottalized stops. Garvin states that "...q? and c? are released simultaneously in all positions (phonetically [q'],[c']),"(p.41). In the absence of evidence to the contrary, we assume then that such sequence are glottalized stops: complex segments which occupy a single timing slot, and which, as such, do not constitute clusters of the kind under discussion.[19] With this we can account for the variety of prenuclear clusters in Kutenai by N"-projection followed by incorporation into N", which is clearly iterative, and in accordance with the sonority scale in (194). Having examined clear examples of iterative and non-iterative instances of incorporation into N", we now turn to incorporation into N'.

We suggest first that English exemplifies a case of non-iterative incorporation into N'. That is, though the sonority scale and MSD predict longer well-formed post-nuclear clusters, clusters obeying the Sonority Sequencing Generalization are limited to two consonants.[20] In (195.I) below, we list well-formed word-final clusters in English which obey the relative sonority scale repeated in (196), and in II. ill-formed clusters which, given

---

19. Recall, however, that if, as hypothesized earlier, /?/ and /h/ are not included in sonority scales, such clusters are still problematic, since the first element is a result of Project-N", not incorporation.

20. In addition to incorporation into N', English also has a rule of adjunction which is discussed in the next section, accounting for post-nuclear clusters like [ksθs] in 'sixths'.

iterative rule application are predicted to exist:

(195) I.                          II.
                                  *rlm
           rl  lv                 *rlv
    lm rm  mp                     *lmp *rmp
    ln rn  nk                     *lnk *rnk
    ls rs  sk                     *lsk *rsk
    ls rs  sp                     *lsp *rsp
    ln rn  nc                     *lnc *rnc
    lm rm  mn(?)                  *lmn *rmn


(196) English Sonority Scale
    y,w      [-cons,+son]
    r        [+cons,+son,,-nas,-lat]    N':MSD = 1
    l        [+cons,+son,-nas,+lat]
    m,n      [+cons,+son,+nas]
    s,z      [+cons,-son,+cont]
    P,T,K    [+cons,-son,-cont]


We suggest that the clusters in II. are ruled out, not by the sonority
hierarchy, but by the fact that incorporation in English is non-iterative,
regulated by the sonority scale shown in (196), with a minimal sonority
distance of 1. The first elements of the clusters rm and mp will be instances
of N'-projection, and the second elements of these clusters will be
incorporated under (188.B). However, in a cluster like *rmp, the final p
cannot be incorporated. Though the sequence mp is in accordance with the MSD
for English, the rule of incorporation is non-iterative:

(197)  a. [tIm]      b. [tIrm]      c. [Imp]   d. *[tIrmp]
        t   I  m      t   I  rm      I   mp    t    I   rm p
        |   |  |      |   |  ||      |   |\    |    |   ||| |
        X   X  X      X   X  XX      X   XX    X    X   XX X
         \  | /        \   | //       |  //     \   |  //
  N-Plac\  N /          \  N //      N //        \  N //
         \ |/            \ |//       |//          \ |//
  Proj-N" \ N'            \ N'       N'            \ N'
           \|              \|        |              \|
  Proj-N'   N"              N"       N"              N"
  Incorp.-N'
  (non-iterative)


– 154 –
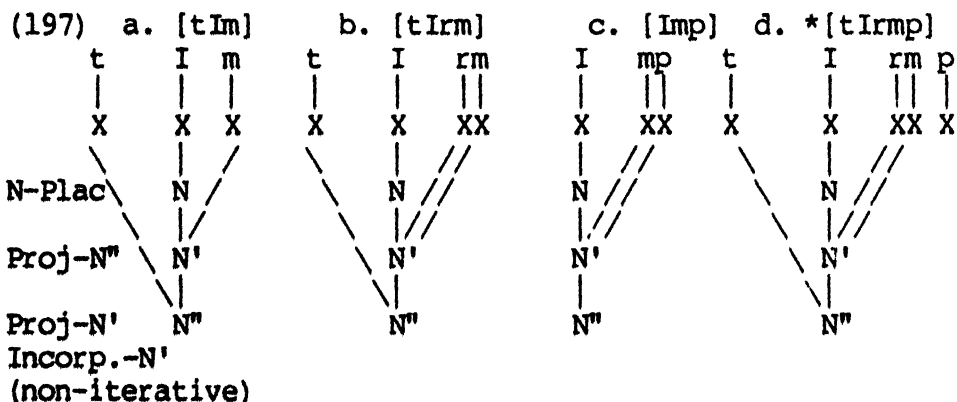
Note that while the sonority scale in (196) is identical for Incorporation into N' and N", the MSD for N" = 3, while that for N' = 1. We provide further support for Steriade's version of relative sonority scales by showing that all rules of incorporation within a given language obey a single scale, though the MSD can be distinct for different projections.

Another example of non-iterative incorporation into N' is found in Estonian(Lehiste,1960; Harms,1962), where coda clusters obeying sonority sequencing generalizations are limited to two elements, again despite the fact that the sonority scale should allow for longer clusters. Inspecting biconsonantal clusters within N', we see that sonorants proceed obstruents and, furthermore, that within the obstruent series, continuants precede stops. The attested CC coda clusters are given in (198), where clusters in parentheses are the result of a later adjunction rule:[21]

(198) CC-Clusters in Estonian

| hv | rt | lm | lm | nf | | mf | ss | ff | vs | tt | pp | kk |
|----|----|----|----|----|----|----|----|----|------|------|------|------|
| hl | rs | lt | lv | ns | ns | ms | st | ft | (ts) | (ps) | kt | |
| hr | rm | lv | ls | nt | nt | mp | sk | | | tk | pt | (ks) |
| hm | rn | lp | lp | | nk | | | | | | | |
| hn | rv | lk | lk | | | | | | | | | |
| hf | rp | | lt | | | | | | | | | |
| ht | rk | | | | | | | | | | | |
| hk | | | | | | | | | | | | |

We account for the above clusters by positing the sonority scale in (199), with a MSD > 0. This scale will clearly allow unbounded strings of consonants, unless it is stated in the grammar that the application of

_____

21. These clusters, as well as all triconsonantal clusters, are the result of an adjunction rule which, much like that in English, adjoins a stray /s,t/ to N". See next section for more on adjunction rules.

Incorporation into N' is non-iterative.

(199) Sonority Scale: Estonian
```
        y     [-cons,+high]
        h     [ cons,-high]
        r l   [+cons,+son,+cont]      MSD > 0
        n,m   [+cons,+son,-cont]
        s     [+cons,-son,+cont]
        p,t,k [+cons,-son,-cont]
```

While in English and Estonian incorporation into N' is limited to a single application, in Totonopec Mixe(Crawford,1963), incorporation into N' is clearly iterative, creating clusters of up to six consonants. Crawford notes that all clusters of four or more consonants contain the morpheme /t^k/, a derivational suffix, which may surface as [...tk...]. This might lead one to posit an underlying vowel in these clusters. However distinctive near minimal pairs exist: [myunu:?kstkp] 'he is asking for mercy' versus [myunu:?kst^k^t] 'he will ask for mercy.' A list of attested word-final clusters is given in (200):[22]

(200) Word-final Clusters in Totonopec Mixe (Crawford,1963)

| A. | yc | vt | nt | mp | sp | ks | pc | tp | cp |
|----|----|----|----|----|----|----|----|----|----|
|    | yk |    | nc | mk | st | kp | pk | tk | ck |
|    | yp |    | nk |    | sk | kt | ps |    |    |
|    | yt |    |    |    |    | kc |    |    |    |
|    |    |    |    |    |    | kk |    |    |    |

| B. |     |     | ntk  | stk  | ksk | psp |
|----|-----|-----|------|------|-----|-----|
|    | ytk | vct | nct  | stkp | ksp |     |
|    | ypc | vst | ntkp |      | kst |     |
|    |     |     |      |      | kcp |     |
|    |     |     |      |      | kstk |    |
| Incorporation |  |  |  |  | kstkp |   |
|    |     |     |      |      | kstkpc |  |

| C. Adjunction |     |     |  | sm  |     |    |    |
|---------------|-----|-----|--|-----|-----|----|----|
| (see following section) | | |  | skm | ksm | tm | cm |

--------------

22. /c/ is a complex segment /ts/, and /s/ is a voiceless retroflex alveo-palatal grooved fricative.

While the clusters in A. can all be generated by Project-N' with a single application of incorporation into N', those in B. must be the result of the iteration of incorporation. In A. and B., sonorants precede obstruents, though, among the obstruents, order appears to be free (pc,cp,ksk,psp). We can account for such a system by positing the sonority hierarchy in (201), with a MSD > 0.

(201) Totonopec Mixe Sonority Scale
    [+son]
    [-son]                MSD > 0.

The clusters in C. above are generated by a rule of /m/ adjunction which is discussed in the following section.

While the restriction of the sonority scale in TM on the iterative rule of incorporation into N' is negligable given the MSD > 0, in Klamath(Barker,1964), iterative application of incorporation interacts with a more complex sonority scale. Attested word-final clusters are given in (202):

(202) Klamath Word-final Clusters

| wc | yt | lp | nt | ms | hs | st | pt | tk | kt | qt |
|----|-----|------|-----|------|----|----|-----|-----|------|-----|
| wk | yc | lk | nc | mc |    | sk | pk | ts | ks | qs |
| ws | ys | lq | nk | ms |    |    | ps | tks | kst | qst |
| wtk | yl | ls | nq | mns |    |    | pks | tst |    |    |
| wks | ytk | Lt | ns | npks |    |    | pkst |    |    |    |
| wqs | yks | l's | ntk |    |    |    |    |    |    |    |
|    | yqs | ltk | nkt |    |    |    |    |    |    |    |
|    | ykst | lqs | nks |    |    |    |    |    |    |    |
|    |     | lst |    |    |    |    |    |    |    |    |
|    |     | lpks |    |    |    |    |    |    |    |    |
|    |     | lqst |    |    |    |    |    |    |    |    |

We propose that incorporation into N' is iterative in Klamath and adheres to

the sonority scale in (203), where, as in Mixe, MSD > 0.

(203) Sonority Scale: Klamath

| w,y | [-cons] | |
|-----|---------|---|
| l,m,n | [+cons,+son] | MSD > 0 |
| h,s | [+cons,-son,+cont] | |
| p,t | [+cons,-son,-cont,+ant] | |
| c,k,q | [+cons,-son,-cont,-ant] | |

All violations of the scale in (203) involve a final /s/ or /t/, which we claim is adjoined to N‴ in word-final position(cf.next Section). In Mixe there were no examples of multiple sonorants incorporated into N', though such clusters are predicted within this system. In Klamath, we do find examples of two incorporated sonorants. A form like [?eyw^llqpga] 'is sticking the head up' is syllabified as [?ey.w^llq.pga], given that pre-vocalic clusters in Klamath may contain at most two elements.

In the following chart, we summarize the types of incorporation rules examined in this section.

(204)

| Incorporation | Iterative | Non-Iterative |
|---------------|-----------|---------------|
| Incorporation into N‴ | Kutenai<br>MSD = 0 | Chukchee<br>  MSD = 1<br>English<br>  MSD = 3 |
| Incorporation into N' | Totonopec Mixe<br>MSD = 0<br>Klamath<br>MSD = 0 | Estonian<br>MSD = 0<br>English<br>MSD = 1 |

From this chart we extract the preliminary generalization that all non-iterative rules of incorporation are the result of a MSD greater than zero. We formalize this generalization as follows:

(205) Sonority Condition on Incorporation
        If the Minimal Sonority Distance for a particular
        Incorporation rule is greater than zero, then
        that rule is non-iterative.

The full spectrum of parametrization of incorporation rules is given in

(206):

(206) Instantiation of Incorporation Rules
         [MSD = 0]   ---> + iterative
                          -
         --------------------------
         [MSD > 0]   -- ·> - iterative

The system of syllabification rules arrived at thus far generates well-formed

syllables within a given language by the set of rules and choice of values

below, where incorporation is conditioned by language particular sonority

scales, as described above.

(207)  Syllabification Typology ( [+] = present; [-] = absent)

      N-Placement +   (Universal)
      Complex N   +
                  -
      Project-N"  +   (Universal)
      ------------------------------------------------ --------
                       Incorporation  + ---> +/- iterative
                       into N"         -

   Project-N'  + --->  Incorporation  + ---> +/- iterative
               -       into N'         -

With this, we turn our attention to the final element of syllabification

algorithms: the set of rules responsible for adjunction of segments to the

syllable in violation of language particular sonority scales, and in

violation of the Sonority Sequencing Generalization.


2.1.6 Adjunction

    As noted in the above discussion, certain syllable-internal elements which

are not themselves syllabified via Project-N" or Project-N' appear to be

adjoined to N" without regard for sonority sequencing generalizations. We

will adopt an idea of Fujimura and Lovins(1978,1979), further developed by Halle and Vergnaud(1980) and Kiparsky(1981), namely that such segments are (Chomsky)-adjoined to N'''. Rules of adjunction differ from those of incorporation in three respects. First, as already mentioned, they do not obey any version of the sonority hierarchy. Secondly, adjunction is limited to maximal projections, so that elements may only be adjoined to N''', not to N' or $N^0$. Thirdly, we will illustrate that, if an adjunction rule refers to specific features of the target segment, it may only refer to place of articulation and manner features and, furthermore, among place features, segment-specific adjunction is limited to [+anterior] segments. Rules of incorporation, as seen in the last section, have no such inherent restrictions.

The separation of rules of adjunction from those of incorporation is strengthened by the fact that, where motivated, the two rules are always in a feeding relationship. Given that adjunction is only defined onto maximal projections, N''' must be maximal before adjunction rules apply. This explains why projection and incorporation must always feed adjunction rules. Adjunction rules, like rules of incorporation may be iterative or non-iterative, and may operate from right to left, or from left to right. We refer to the right to left application of the rule as initial adjunction and the left to right application as final adjunction. A general schema for

these rules is given in (208):

(208) Adjunction to N" (iterative or non-iterative)
   a. Initial               b. Final

```
                N"                                    N"
               /|                                    |\
      N"      / N"              N"                    N"\
      |      /  |               |                     |  \
 X'   X  ---> X  X ...      ...X   X'  --->  ...  X   X
```
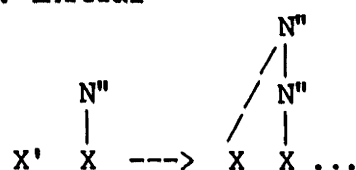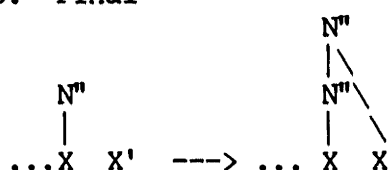
Some scholars, including Hockett(1955), Kiparsky(1981), and Steriade(1982) have proposed that adjunction be limited to peripheral position in the phonological constituent. Embedded within this restriction is an attempt to treat "extrametrical" or adjoined segments in syllabification systems on par with extrametrical constituents in stress systems, which appear to be limited to peripheral position. This system encounters a variety of problems when what appear to be "extrasyllabic" segments, are found in word-internal position. Within the theory being proposed, we expect adjunction to be applicable in any position within the phonological phrase, as long as it is restricted to maximal projections, i.e. N". As we will see, this prediction is born out by evidence from a variety of languages. The fact that, in many instances, adjunction appears to be limited to peripheral position, is considered no more than a reflex of prefixal and suffixal systems of concatenative morphology. Adjunction is more likely to take place on the periphery of words, where concatenation of morphemes creates clusters incompatible with sonority sequencing generalizations.

Instances of both initial and final adjunction as well as non-iterative and iterative instantiantions of these rules can be found in English. Our previous discussion of initial clusters in English accounted for the existence of obstruant-sonorant clusters as in [prInt] by N"-projection,

followed by a non-iterative application of incorporation into N". However, as
is well known, all well-formed CC clusters in English may be preceded by an
initial /s/. This /s/ in a word like [sprint], however, is in violation of
the sonority scale repeated below:

(209) English Sonority Scale
     y,w    [-cons,+son]
     r       [+cons,+son,-nas,-lat]
     l       [+cons,+son,-nas,-lat]
     m,n    [+cons,+son,+nas]
     s,z    [+cons,-son,+cont]
     P,T,K  [+cons,-son,-cont]

We propose that after projection and incorporation, initial adjunction in
English, as formulated below, occurs:

(210) Initial Adjunction: English

```
                                 N"
                               / |
                 N"          /  N"
                 |         /   |
         X'  X  --->  X   X ...
         |            |
 [-son,+cont,+cor,+ant] [-son,+cont,+cor,+ant]
```
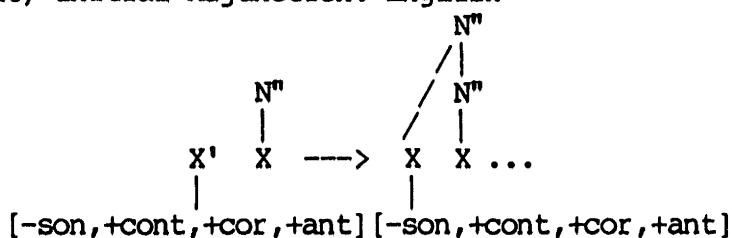
This rule appears to be non-iterative, as clusters such as *ssl, *ssp, as
well as *sssl, sssp are treated as biconsonantal by native English speakers.
However  the absence of tautosyllabic geminates in English, if stated
elsewhere in the grammar, perhaps as an output filter, would make it
unnecessary to state the iterative or non-iterative application of rule
(210). Any iterative application would lead to a geminate clusters which
would be ruled out by other means.

In addition to rule (210), English, as analyzed by Kiparsky(1981), also
allows coronal obstruents to be adjoined to syllable-final position in a
clearly iterative fashion, in violation of the sonority scale in (209).

Adjunction to N‴, leading to the generation of such final clusters as those

in [sIksθs] 'sixths' and [Estreynjdst] 'estrangedst' can be formulated as in

(211):

(211) Final Adjunction to N‴ (iterative)

```
                              N‴
                              |\
      N‴                      N‴\
      |                       |  \
   ...X   X'    --->    ...  X   X
          |                      |
      [-son,+cor,+ant]       [-son,+cor,+ant]
```

In (212) we illustrate syllabification of [siksθs]:

(212) Final Adjunction: English

```
        s    i    k    s θ s
        |    |    |    | | |
        X    X    X    X X X
         \   |   /    //_/
          \  N  /    ///
           \ |/    ////        I.    N-Placement
            \N'  ////          II.   Project N‴
             \|  ///           III.  Project N'
              N‴////           IV.   Incorporation (n.a.)
              |///             V.    Adjunction
              N‴//
              |//
              N‴/
              |/
              N‴
```

To illustrate that adjunction is not limited to peripheral position, we need

only look at a form like [Ekstra] 'extra'. Whether syllabified as [Ek.stra]

or [Eks.tra], an application of adjunction in word·internal position is

required, making restriction of adjunction to the periphery untenable.[23]

----------

23. If /s/ is not considered to be adjoined to the syllable in sTR clusters,
but rather is considered as part of the core syllable, a drastic reworking of
the sonority hierarchy is in order.  Such a reworking would appear to render
vaccuous the distinction adhered to here: that within N‴, elements obey the
sonority sequencing generalization, and that any element which does not is a

While adjunction in English is limited to coronals, and need not be
specified as non-iterative, in Klamath, any single segment may be adjoined to
the left of N". Klamath word-initial clusters, which are limited to two

---

**priori** defined as an adjunct.

(213) Klamath word-initial clusters

| tw | ty | pl | pn | tm | wh | | ps | tp | pt | kc | cg | pq |
|----|----|----|----|----|----|---|----|----|----|----|----|----|
| cw | cy | tl | kn | km | p? | | ts | kp | kt | kc | tk | tq |
| kw | ky | cl | qn | qm | k? | | ks | kp | qt | qc | sk | sq |
| qw | qy | kl | dn | gm | q? | | ms | qp | qt | qc | nk | nq |
| bw | by | ql | gn | dm | s? | | ws | qb | kt | nc | wk | wq |
| dw | dy | bl | pn | cm | l? | | | tb | kd | wc | tg | pg |
| gw | qy | dl | cn | km | w? | | | kb | qd | sj | pk | tg |
| tw | sy | jl | kn | sm | | | | wp | pt | nj | sg | sg |
| cw | wy | gl | qn | sm | | | | sb | wt | wj | ng | ng |
| kw | | tl | sn | nm | | | | mb | sd | pc | wg | lg |
| qw | | cl | sn | lm | | | | lb | nd | pc | pk | wg |
| sw | | kl | mn | lm | | | | wb | ld | sc | tk | pq |
| sw | | ql | wn | | | | | sp | wd | sc | sk | tq |
| lw | | sl | | | | | | sp | lt | nc | nk | sq |
| | | sl | | | | | | mp | st | lc | lk | nq |
| | | WL | | | | | | mp | st | wc | wk | lq |
| | | wl | | | | | | wp | nt | | | | wq |
| | | wl | | | | | | | nt | | | | |
| | | | | | | | | | lt | | | | |
| | | | | | | | | | wt | | | | |

Given the sonority scale in (214), which was posited in order to account for the possible and impossible word final clusters in Klamath in the preceding section, we see that, in (213), all the clusters below the horizontal line in each column violate the sequencing requried by the sonority scale.

(214) Klamath Sonority Scale
    [-cons]
    [+cons,+son]                    MSD > 0

----------

24. There are two exceptions to the two-member limit on initial clusters. The first is the initial CCC-cluster in /twge:wtsgews/ 'bluejay' which is most likely onomatopoeic. The second is the cluster /wcl/ in /wclosLi/ 'sweeps into' and other derivatives of the verb /c(l)o:s/ 'sweep, brush' plus the verbal prefix /w/ 'act with a long instrument'. There are two possible accounts of this aberrant CCC cluster. The first is that the underlying form of /c(l)o:s/ contains an unassociated /l/, which is only later projected onto the skeletal tier. Before this projection, wc is syllabified as a well-formed onset. This is supported by the fact that /l/ only surfaces in certain forms, witness: [koco:satdi:la] 'mops around under'. Another possibility is that the initial /w/ in this case is realized as /wu/, breaking up the CCC cluster on the surface.

[+cons,-son,+cont]
[+cons,-son,-cont,+ant]
[+cons,-son,-cont,-ant]

Even if a distinct scale with only two degrees [+son] and [-son] and a MSD
of zero was proposed for incorporation into N‴, sonorant obstruent clusters
(of which almost all appear to be well-formed) would have to be accounted for
by a separate rule of adjunction. However, this would predict three member
clusters where the innermost element was syllabified via Project-N‴, the next
via incorporation, and a final element via adjunction. Such clusters do not
exist, pointing to a single rule of adjunction which may, but need not
respect any version of the sonority hierarchy. The rule of adjunction for
Klamath is given below:[25]

(215) Klamath Initial Adjunction (non-iterative)

```
                       N‴
                      / |
        N‴           / N‴
        |           /  |
    X'  X  --->  X   X ...
```
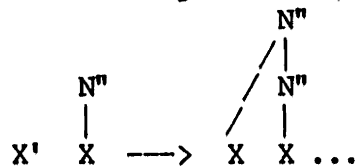
To illustrate that the rule of adjunction is truly non-iterative and not a
secondary result of non-existance prefixal morphology, we examine several
derived initial clusters. Initial clusters of three consonants, which may
arise via morphological prefixation, are reduced to biconsonantal clusters
via C-deletion. Several examples, with dashes indicating morpheme boundaries

---

25. An identical rule can be posited for Cambodian initial consonant
clusters, which, as in Klamath, are restricted to two members, with no
adherence to any version of a sonority scale. See Blevins(1985) for a
discussion of the Cambodian facts.

are given below:

(216) Reduction of Triconsonantal Clusters[26]
I. X X X --> X X          II. X X X ---> X X
   1 2 3      2 3             1 2 3      1 3

| | | | |
|---|---|---|---|
| /ksV-/ | 'to act upon a living object' | /slE-/ | 'act upon a clothlike object' |
| | | /clE-/ | 'act upon a massive shapeless object' |
| ksV-d | sd | slE-d | sd |
| ksV-bV | sb | clE-d | sd (frozen?) |

-----------------------------------------------

| | | | | |
|---|---|---|---|---|
| /kt-/ | 'hit with the fist, kick' | | | |
| kt-k | | tk (*kk) | kt-? | k? |
| kt-q | | tq (*kq) | kt-L | kl |
| | | | kt-c | kc |
| | | | kt-t | kt |
| | | | kt-d | kd |
| | | | kt-b | kb |
| | | | kt-p | kp |
| | | | kt-t' | kt' |

Ignoring for the moment the prefix /ksV-/, we can modify slightly the rule of initial adjunction to produce the clusters above. The modification involved allows the ruɫ to skip to the first X' of a sequence of X's. We restate the rule as follows:

(217) Klamath Initial Adjunction (revised)
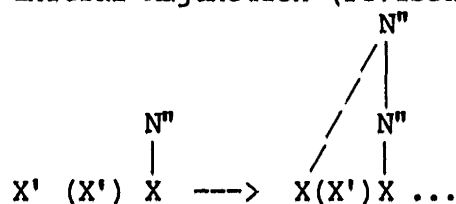


The illformedness of [kk] and [kq] onsets can be stated as an output filter which will force adjunction to apply to /t/ in the clusters /kt-k/ and

------------

26. /E/ and /V/ stand for empty skeletal slots associated with floating [e] and nothing respectively.

/kt-q/. As for /ksV-/, we posit a morphologically conditioned rule of k-deletion which precedes adjunction.

Klamath also has a rule of final adjunction which accounts for the word-final clusters in (218), which are clearly not in accordance with the sonority scale in (214):

(218) Cluster Generated via Adjunction: Klamath

| ps | ḱs |
|----|----|
| ts | qs |
| tst | kt |
| pkst | qt |
|  | kst |
|  | qst |

To account for such clusters, we posit the rule of final adjunction shown below, which allows /s,t/ to adjoin to N‴:

(219) Klamath Final Adjunction (iterative)

```
                          N‴
                          |\
      N‴                  N‴\
      |                   |  \
  ...X   X'   --->  ...  X    X
      |                   |
  [-son,+cor,+ant]   [-son,+cor,+ant]
```
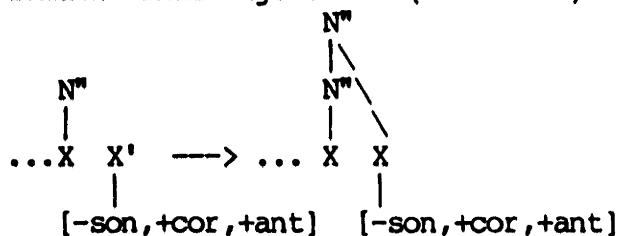
Clusters like <u>kst</u> illustrate iterative rule application. This rule is identical the rule of final adjunction in English seen earlier. Klamath also provides evidence illustrating that adjunction is not limited in application to word-initial position. The syllabification of of word medial clusters may involve initial or final adjunction. Some word-medial clusters are listed below:

(220) Some word-medial clusters: Klamath

| wtsg | ykst | lksd | nksg | pkst |
|------|------|------|------|------|
|  |  | lqpg | nqsp | tspg |
|  |  | lqsc | nktkd | kstg |
|  |  | lqsg | nkstg | qtqn |
|  |  | llqpg | nktkn |  |

All of these clusters are syllabifiable given the rules proposed above.
While a cluster such as -lksd- could be syllabified as either lks.d or lk.sd,
either syllabification requires an application of adjunction
word-internally. The cluster -tspg- has only a single possible
syllabification which illustrates application of both initial and final
adjunction word-internally:

(221)  Word-internal Adjunction: Klamath

```
            t   s   p   g
            |   |   |   |
 ... X  X   X   X   X   X   X ...
      \  | / /  / \ \ |
       \ N/ /      \ \ N
        \N' /       \ \|
        N"/          \ N"
        N"            N"
```
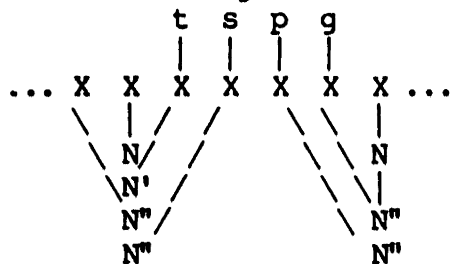
It appears then that adjunction is well-motivated in both peripheral and
non-peripheral environments.

Postnuclear triconsonantal clusters in Estonian, which were mentioned in
passing in the previous section, can all be accounted for as the result of an
adjunction rule as well. According to Harms, in word-final $C_1C_2C_3$ clusters,
$C_1$ is realized as /k/ or any sonorant with the exception of /j/. $C_2$ and $C_3$
are either a geminate obstruent, or one of the non-geminate clusters shown in
(222):

(222) Estonian: Non-geminate $C_2C_3$ in final CCC clusters

| st | ts | ps | pt |
|----|----|----|----|
|    |    | ts | kt |
|    |    | ks | st |
|    |    |    | ft |

The rule of final adjunction in Estonian then appear to require two disjoint

conditions, one for geminates, and one for /s,t/ as shown in(223):

(223) Estonian Final Adjunction (non-iterative)

```
        N‴
        |
     ...X  X'
        |
  [-son,+cor,+ant]                        N‴
                    -------->             |\
        N‴                                N‴\
        |                                 |  \
     ...X  X'                          ... X   X
        \/
      [...]
```
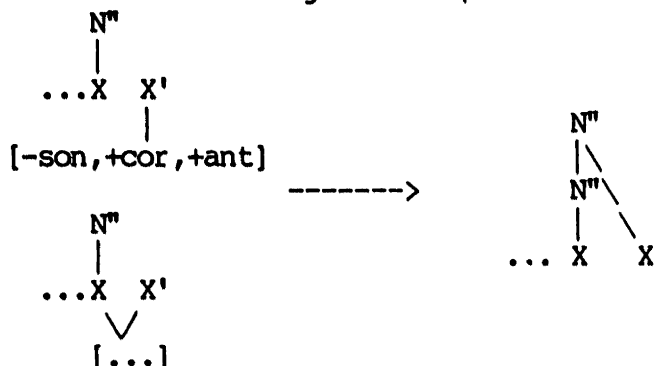
Of interest is the fact that, again, if the rule of adjunction mentions any features at all, it includes (either implicitly or explicitly) mention of [+anterior]. Only in the absence of any feature specifications whatsoever, will non-anterior segments be adjoined.[27]

In Totonopec Mixe(Crawford,1963), as shown previously, the final clusters /sm, skm, ksm, tm, cm/ are all in violation of the sonority scale. A rule of final m-adjunction is necessary to account for these forms:

(224) Final Adjunction (non-iterative): Totonopec Mixe

```
                              N‴
                              |\
        N‴                    N‴\
        |                     |  \
     ...X  X'   --->  ...  X   X
        |                     |
  [+nas,-cor,+ant]      [+nas,-cor,+ant]
```

----------
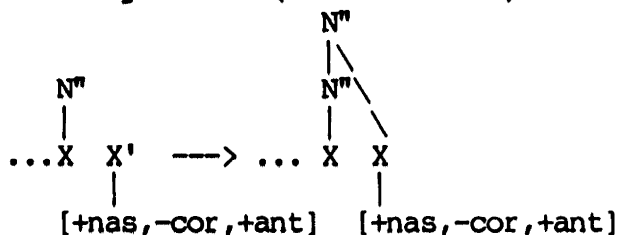
27. The one possible exception to th: [+anterior] condition is a rule of adjunction in the Attic dialect of ʋreek discussed by Steriade(1982). This rule creates clusters ks, ps, mn, nn, kt, pt which violate the sonority scale of Attic, and can be shown to apply after incorporation into N‴. Rather than state this rule as the adjunction of a [-coronal] which would violate the [+anterior] condition on specified segments, we can impose an output filter on [+cor][+cor] sequences where the first is an adjoined segment. In this way, the adjunction rule in Attic is identical to that in Klamath or Cambodian, but subject to a distinct filter.

A rule of initial adjunction in Totonopec Mixe, which appears to be a more general version of rule (224) is responsible for all initial CC-clusters. In (225) we see the list of attested clusters:

(225) Totonopec Mixe Initial Clusters

| m? | mz | mp | nn | nv | nc |
|----|----|----|----|----|----|
| mh | mv | md |    | nz | nd |
| mm |    | mc |    |    | ng |
| mn |    | mg |    |    |    |

Crawford notes that such clusters occur in "phonemic word-initial position" only (p.70).[28] This fact is clearly related to the morphology, as /m-/ and /n-/ are the second and first person possessive markers. We formulate initial adjunction as in (226):

(226) Initial Adjunction (non-iterative): Totonopec Mixe

$$
\begin{array}{ccc}
 & & N^m \\
 & & /\,| \\
N^m & & /\ N^m \\
| & & /\ \ | \\
X'\ \ X & \longrightarrow & X\ \ X\ \ldots \\
| \\
[+nas]
\end{array}
$$
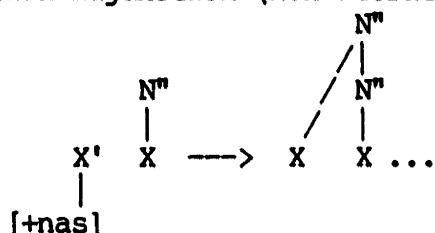
So, we have seen that adjunction rules which generate strings which violate sonority sequencing generalizations may apply in an iterative or non-iterative fashion, and furthermore, that such rules are not restricted to word-, or phrase-initial position. While much more study is clearly needed on the universal nature of adjunction rules, we propose the following

---

28. This is in contrast to a rare occurence of preconsonantal /s/, a palatal grooved fricative, which cannot occur in "phonemic phrase-initial position" (p.70). The example given is /?^c sku:?p/ 'he pricked me (as with a hypodermic needle)'. We assume that the restriction of such clusters to phrase medial position is indicative of the syllabification of /s/ into the preceding N'.

preliminary generalizations:

(227) Features of Adjunction Rules
    A. If the target of an adjunction rule is specified for
       distinctive features, it will be :
        i. [+anterior]
        ii. unspecified for [voice] (i.e. Voicing is not
           distinctive in segments adjoined to $N^{m}$.)
    B. If a language has rules of initial and final
       adjunction, the segments adjoined by
       one rule will be a proper subset of those
       adjoined by the other rule.
    C. If the grammar contains an adjunction rule,
       then the grammar contains Project-N'.

The proposed universals in (227.A) are phonetic in nature, though their

realization is often phonological. We have already pointed out the scope of

(A.i). (A.ii) refers to that fact that no rule of adjunction ever need

mention the feature [^voice]. Either the adjoined segment will receive a

default value for voicing, or a rule of assimilation will occur. An example

is the plural morpheme /-S/ in English. When this segment occurs in adjoined

position it is subject to a rule of voicing assimilation. The prediction of

such a theory is that surface minimal pairs like [spiyks] and [spiykz] or

[spiyks] and [zpiyks] could not exist in English, or any other language where

stops were lower in sonority than continuants. (227.B), a statement

consistent with all the data we have analyzed, strengthens our claim that

initial and final adjunction are one and the same process, since they appear

to be in a subset relation. Finally, (227.C) formalizes what might appear to

be an obvious generalization, namely that a tautosyllabic sequence of a

nucleus followed by a single segment is universally interpreted as an

instantiation of the N' projection. While the N' projection is designated by

X-bar theory, adjunction requires formulation of a particular phonological

rule with specification of iterativity.

While it remains to be seen whether or not such generalizations hold for all languages, it is only by distinguishing between rules of adjunction and rules of incorporation that we are able to propose the preliminary universals above.


## 2.1.7 Summary and Implications

We have outlined in this section a schema of syllabification rules which all appear to be stateable without reference to the feature [+syllabic]. In particular, it appears that N-Placement, stated as either a redundancy rule or a phonological rule, can be adequately formulated with reference to the major class features [+consonantal], [+sonorant] as well as to place and manner features. We have suggested that rules of N-placement, which affect categorial status of segments, are subject to the CSD, explaining the tautosyllabic nature of monosegmental syllabic segments. We also proposed that the formation of complex nuclei, where not a result of the CSD, is limited to nuclei consisting of two skeletal slots.

Projection of N, the head of the syllable, creates a maximal projection N", as determined by X-bar theory. This process is universal and without exception. Whether or not a language has an intermediate N'-Projection appears to be a language specific property which much be stated independently in the grammar. Immediately adjacent elements may be incorporated into N' or N" by rules which obey the Sonority Sequencing Generalization. Under this generalization, all elements within N" are of equal or rising sonority preceding the nucleus, from which point all elements are of equal or falling sonority. As argued by Steriade(1982), rules of incorporation are subject to

a minimal sonority distance on language specific sonority scales. While
sonority scales are constant for incorporation to N" and N', the two rules
may differ within a given language in values for a minimal sonority
distance. Both of these incorporation rules were seen to have iterative and
non-iterative instantiations. As a preliminary hypothesis, we proposed that,
if the Minimal sonority distance for an incorporation rule is greater than
zero, then that rule is non-iterative.

Finally, we examined a class of rules which adjoin elements to N" in
violation of sonority sequencing generalizations. Where adjunction is
restricted to maximal projections, we were able to show that initial and
final adjunction rules are motivated in word internal as well as peripheral
positions. Furthermore, we suggested that feature specification for adjoined
segments were universally limited to [+anterior] segments, and that voicing
could not be distinctive in adjoined segments.

An interesting and perhaps non-trivial consequence of the theory outlined
thus far is that it generates distinct non-branching, binary-branching,
ternary-branching and n-ary branching nodes. Given the existance of a node,
say N', as determined by a language specific instance of a possible N'
projection, a binary branching node is created. Then, iterative versus
non-iterative incorporation results in ternary versus n-ary structures as

shown below:

(228)  I.  N'-Projection

```
                    N'
                    |\
        N           N \
        |           |  \
        X X' --->   X   X
```
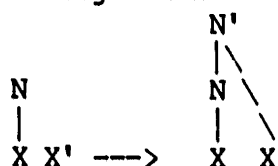
II.  Incorporation:
    a. non-iterative

```
    N'                    N'
    |\                    |\
    N \                   N \
    |  \                  |  \
    X  X X' X'... --->    X  X  X' X'
```

    b. iterative

```
    N'                    N'
    |\                    |\
    N \                   N \
    |  \                  |  \  \  \
    X  X X' X'*... --->   X  X  X  X ...
```
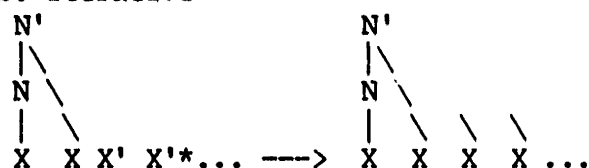
While allowing iterative versus non-iterative instances of incorporation appears to be empirically motivated, we are left to wonder whether a metrical theory of the syllable differs in this way from say, metrical structures in stress assignment algorithms, where non-branching, binary branching and n-ary branching nodes alone appear to be empirically motivated. We turn briefly then to the question of whether or not a distinction between binary, ternary and n-ary branching structures is empirically motivated outside the domain of N and the N-projection.

The class of feet in classical metrical theory (cf. Hayes(1982); Hammond(1984);Halle and Vergnaud(to appear)) has been limited to non-branching, binary branching and n-ary branching structures which include feet, cola, and word-trees. While non-branching feet are themselves considered unambiguous heads (or DTEs) of their domain, in binary feet, a

head is opposed to a non-head. The unbounded foot specifies a peripheral

head, with iterative adjunction of syllables within a domain. The three

types of feet are illustrated in (229):

(229)  Metrical Feet
　　a. Non-branching　　b. Binary　　c. Unbounded
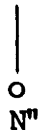
```
       |               |\              |
                        | \            |    \   \   \  ...
       o               o   \          o    \   \   \
       N"              N"  N"         N"  N"  N"  N"
```
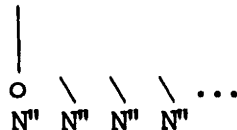
While, within the present system, binary and unbounded feet are seen as

primitives, another position is also imaginable. If the DTE is in some sense

the head of a foot, then we are able to derive a binary foot via

F-projection. That is, like Project N", the generation of binary feet can be

viewed as a simple result of X-bar theory which requires that, for every

head, there exist a maximal projection. From binary feet, unbounded feet are

derived via iterative incorporation of stray syllables (where "stray syllable

adjunction" of Hayes(1981) is already motivated as a universal convention.)

Notice, however, that within such a system, there is an intermediate step

which involves a _single_ application of stray syllable adjunction. That is,

within a rule system like the one we have proposed governing N-projections,

ternary branching structures are predicted to arise, since incorporation, or

stray adjunction, may apply within a given rule system, in a non-iterative

fashion. Ternary branching feet, while quite rare, appear to exist in

several languages.

One of these languages is Cayuvava, a native language of Bolivia. Cayuvava

as described by Key(1961) appears to necessitate the construction of

left-dominant ternary feet built from the right edge of the word.[29] Key

states:

> The tri-syllable stress group patterning marks strong stress from the final syllable of multi-syllable utterances. Strong stress occurs on the antepenultimate syllable and every third syllable preceding it.(p.149)

Examples exhibiting this ternary pattern follow:

(230) Cayuvava Stress

|    |   |   |
|----|---|---|
| a. | /<br>kíta | 'the water' |
| b. | /<br>úhia | 'you(sg.) go' |
| c. | /<br>uhíai | 'I go' |
| d. | /<br>ariúuca | 'he came already' |
| e. | \  /<br>Badácaoai | 'my younger brother' |
| f. | \   /<br>maráhahaeiki | 'their blankets' |
| g. | \    /<br>ikíta-parérepeha | 'the-water-is ·clean' |

Stress in this language cannot be accounted for using final syllable

extrametricality with binary foot or perfect grid construction, since the

ternary count continues beyond the final three syllables. That is, the

(230.d-g) forms pose serious problems to metrical theories which have no

recourse to ternary branching structures. Furthermore, (230.d) would require

a foot-deletion rule which is not in the environment of a clash.[30] All but

ternary feet are deleted unless they are dominated by the word tree as in

--------

29. For another example of ternary branching feet, see the analysis of Piraha stress in Chapter 4.

30. See Prince(1983) and Hammond(1984) for metrical transformations in terms of class avoidance.

(230.a,b). The rules we propose are the following:

(231) Cayuvava Stress Assignment
    A. Construct right-dominant ternary feet from right to
       left.
    B. Build right-dominant word tree.
    C. Prune degenerate feet where degenerate = ternary.

While restriction of incorporation rules to non-iterative application appears

to be the marked case in a metrical theory of the syllable as well as in that

of stress, evidence clearly points to the existence of such rules, and points

to a coherent and cohesive approach to the generation of metrical

constituents, whether in the domain of stress or in the domain of

syllabicity.


## 2.2 The Form of Templates


The formulation of syllabification algorithms without use of the feature

[+syllabic] is possible by making reference to other features linked to the

skeleton, as we saw above. The question which now remains is for a metrical

theory of syllabicity, is how syllabicity is to be represented on skeletal

templates, when the skeletons involved, as argued in Chapter 1, are

featureless.

McCarthy's original encoding of the CV-tier with the features

[+consonantal] and [+syllabic] was necessary to ensure the proper linking of

vocalic and consonantal melodies. We now turn to the problem of accounting

for proper associations between melodic elements and skeletal slots, where

syllabicity is unspecified in the skeleton. If [+syllabic] is a distinctive

feature, then there are two possible representations for the Arabic

CV-template seen earlier, though the Mokilese reduplicative prefix, which

must be specified as consisting of a single syllable, can only be marked as

such on the syllable plane itself:

(232) Possible Underlying Representations Morphological Templates
    A. 9th Binyan (CCVCVC)                [+syll] [+syll]
                                             |      |
    i. X  X  X  X  X  X      ii. X  X  X  X  X  X
             |     |
             N     N

    B. Mokilese Reduplicative Prefix

        [ X   X   X]
                  N� 

As we saw earlier, it is necessary to specify that the Mokilese prefix

consists in a single syllable.  The position of the nucleus is left

unspecified, as it could occupy the first skeletal slot [andandip] or the

second [pˆdpˆdok].  As we saw earlier, marking any slot as [+syllabic] will

create unnecessary complications for the association convention.

For the case of Semitic morphological templates, there are also reasons to

prefer the representation in (232.A.i) over that in (A.ii).  Here we refer to

the apparent generalization first noted by Marantz(1982) that prespecified

features on skeletal slots appear to override features of elements which link

to them.[31]

One example of this is found in reduplication in Akan as analyzed by

--------

31. I believe the observation that representations like 232.A.ii are
problematic for this reason is originally due to Bruce Hayes, though it was
brought to my attention by Donca Steriade (p.c.).

Marantz(1982).[32]  In Akan, the reduplicate form of monosyllabic verb stems,

which indicates intensive, repeated, or habitual action is formed by

prefixation of a copy of the first CV-sequence of the stem with one

adjustment: the prefixal vowel is always realized as [+high,-lo], regardless

of the quality of the stem vowel.  Some examples from Akuapem Twi as

described in Schacter and Fromkin(1968), are given in (233):

(233)Reduplication in Akuapem Twi
       Verb-Stem                      Reduplicate
       /si?/    'to stand'            /sisi?/
       /fI?/    'to vomit'            /fIfI?/
       /se?/    'to say'              /sise?/
       /sE?/    'to resemble'         /sIsE?/
       /sa?/    'to cure'             /sIsa?/
       /tw^?/   'to cut'              /twitw^?/
       /bu?/    'to bend'             /bubu?/
       /sU?/    'carry on the head'   /sUsU?/
       /so?/    'seize'               /suso?/
       /sO?/    'light'               /sUsO?/

As should be clear from the forms above, the features[+round], [+ATR] in the

reduplicated vowel are the same as those of the stem vowel.  While the value

of ATR in the reduplicate prefix can be accounted for by a general

word-internal vowel harmony rule(cf.  Berry,1957; Welmers,1966;

Stewart,1967), harmony will not account for the value of round in the

reduplicate prefix.  Thus, Marantz proposes the model shown in (234) where a

preattached [+high] is part of the reduplicative prefix:

(234) a. s e ?    s e ?        b.  s O ?   s O ?
         | |      | | |             | |     | | |
         C V  +   C V C             C V  + C V C
         |                          |
       [+high]                    [+high]

Surface: [sise?]                 [sUsO?]

_____

32. For another convincing case see Yip(1982) on Chinese.

- 180 -

Notated as an X-skeleton, the reduplicative prefix in Akan will look as follows:

(235)      [+high]
              |
        X    X  -
              |
              N
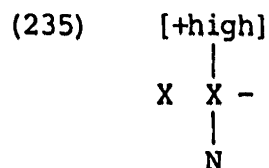

Association of melodic segments to the skeleton is overridden by the existence of preattached features:"the preattached [+high] feature...takes precedence over any [+high] specification of the phoneme associated with the V slot of the reduplicating prefix."(Marantz,1982;p.449)[33]

This proposal has received further support from work on consonant mutation by Sproat(1982), Massam(1982) and Lieber(1983), on Welsh, Irish and Fula respectively. In these all of these analyses, if a feature matrix ^F is linked to a slot which is prespecified as -^F, -^F overrides ^F. Such analyses must also allow a prelinked feature to override linking of some other feature just in case the output is non-structure preserving.[34] So, for instance, in her account of Irish mutation, Massam(1982), accounts for the

------------

33. The fact that linking of /a/, a [+low] vowel, to a slot pre-specified as [+high] results in a [+high] vowel, illustrates that the prelinked [+high] not only overrides a [-high], but any features which are redundantly determined by [+high], i.e. in this case [-low].

34. Note that this version of structure preservation is intimately tied to UT in that well-formed feature matrices are those generated in the lexicon by the combination of redundancy and phonological rules.

inalterability of certain segments by the Linking Constraint given in (236):

(236) Link..ng Constraint   (Massam,1982)
    A feature matrix Y can be linked to a skeletal slot X if and
    only if no contradiction exists, either among the feature values
    of Y or betwヲen the feature values of any matrix which is already
    linked to X, where <u>contradiction</u> is defined as follows:

    If [^F] implies [-BG, as indicated by a Redundancy Rule,
    then:
    [^F] [-BG]      [-BG] [^F]      [^F,-BG]
      \ /             \ /             |
       X               X               X
    are contradictions.

The linking constraint then is yet another instance of prelinked features

overriding features linked via the association convention.[35]   It appears then

that the association convention which links autosegments to segment-bearing

ur:its is properly forr lated as follows:

(237) Universal Association Convention
    Associate autosegments to segment-bearing-units
    one-to-one from left to right or right to left
    where i. association lines may not cross, and
          ii. prelinked features override associated features.

The generalization of this phenomenon to all prespecified features, as stated

in (237.ii), has as a result that a representation like (232.A.ii) will be of

no use in terms of the linking conventions: any segment may link to any

skeletal slot, with the pre-specified [+syllabic] overriding a prespecified

[-syllabic].  For most segments in Semitic, no problem arises, as they are

redundantly [-syllabic] and thus ι 11 be filtered out by (237.ii).  However,

---------

35. McCarthy(1983), in his analysis of Chaṅa verbal morphologӯ, also points
out that association, in this case, is conditioned by a filter which requires
output of the linkirg rule to be structure-preserving in the sense that no
new segment types may be created.  This appears to be an alternative
statement of Massam's linking convention.

a "consonantal" root in Classical Arabic which contains a glide is
potentially problematic, given that glides and vowels are distinguished
solely by the feature [+syllabic]. That is to say, even if a glide is
underlyingly specified as [-syllabic], nothing within the present theory
prevents it from associating with a slot prespecified as [+syllabic],
eventually surfacing as a vowel. To illustrate this, we look as the root
/sw(y)/ 'to be equivalent,equal,similar'. If prelinked features may override
those of associated features, we have no way of ruling out the following
association:

(238)

```
s     w     y
|    /|    /\
X X   X   X X X        III binyan (CVVCVC)
 | /    /|
[+syll] / [+syll]
       a              Perfective Active

*su:yay
[sa:way]              'to be equivalent, be equal'
```
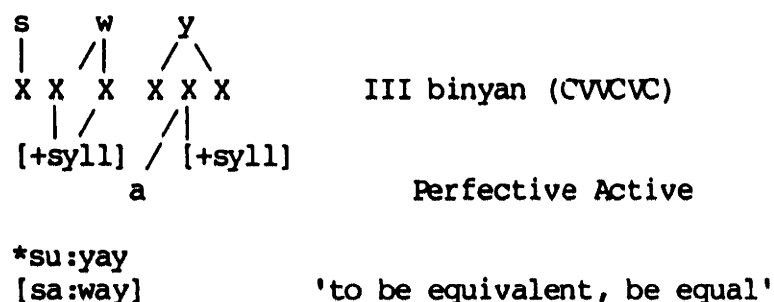
The /w/ of the root can link to a slot specified as [+syll], and this feature
will override its [-syllabic] specification, allowing an [u] to surface.
This possibility will also allow associations leading to *sa:wiy and
*su:way.

By choosing (237.A.i), where minimal syllable structure is marked in
underlying representation, we can define "vocalic" and "consonantal" planes
in terms of the categorial features syllable head and syllable non-head
respectively. Association conventions will require that segments on the
syllable-head, or N-plane associate to slots dominated by N on the skeleton.
While this association convention, stated as such, might appear arbitrary, it
can be seen to follow from a particular interpretation of rules of

N-Placement.

If we specify the "vocalic" tier specifically as [-consonantal], the rule

of N-placement in (239), which is independently required in Arabic, will

entail that elements on the "vocalic" plane on linking to the skeleton, must

be dominated by N. That is, N-placement can be seen as an output condition on

all associations of segments to templates. If N-placement as stated in (239)

must be satisfied by association, all elements on the [-consonantal] plane

must link to slots dominated by N. The elements on the "consonantal" plane,

which can be viewed as unspecified in terms of distinctive features, will

then link to the remaining available slots in a one-to-one, left-to-right

fashion.

(239) N-Placement in Arabic

```
     [-cons]    [-cons]
        |          |
   X'   X  --->  X  X        where X = [-cons,-hi]
   1    2         \  |
                   \ N
                    \|
                     N"
```

(240)

```
   s     w   y non-heads
   |     |   |
   X X X X X X              I. Associate elements on [-cons] tier
     |/   /|   heads           with N-Placement as an output condition.
     N \ / N  ([-cons])   II. Associate elements on "consonantal"
        a                     tier.
```
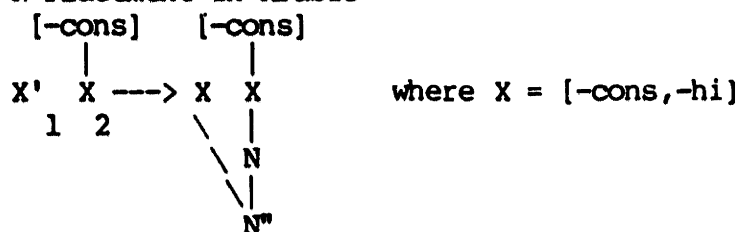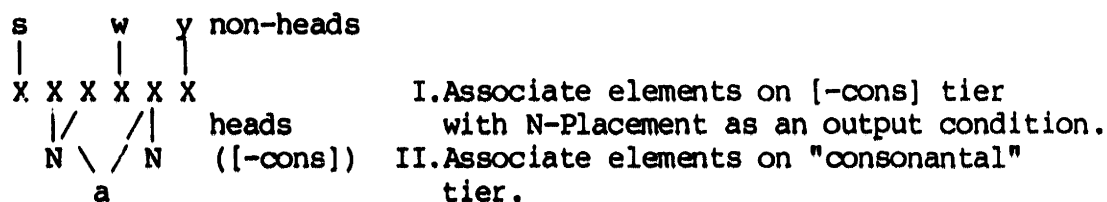
The morphologically and phonologically distinct properties of the vocalic

and consonantal tiers requires that linking of one melodic tier be a distinct

phonological process from linking of the other. Forms like *suːyay are ruled

out in intermediate representation, since the output of the association rule,

a phonological rule, does not satisfy the output condition of rule (239):

(241)  *  s    w   y

```
     X X X X X X
     |    /|
     N   / N
         a
```
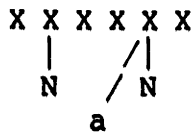
Given the added condition on association in (237.ii), and the obvious choice
of i. for Mokilese, we will adopt representations such as that in (232.A.i)
for Semitic templates.

The translation of CV-templates in Semitic to X-skeletons is
straightforward. As illustrated in (242), wherever a single V occurs, we
have a non-branching N, and wherever a VV sequence occurs, we have a single
branching N:

(242) From Vs to Xs

```
          V = X̄          VV = XX
          |               |/
          N               N
```

Linking begins with the vocalic melody as conditionned by rules of
N-placement. Remaining X-slots are filled by elements on the non-head tier
in a one-to-one, left-to-right fashion, as originally argued by
McCarthy(1979).

Such a move leads to the observation that syllabicity in the lexicon is
marked either on the N-tier (morphological templates) or is dete;mined by the
segmental tier (common lexical entries in English, Mokilese, etc.)  via rules
of N-placement. Rules of N-placement then are seen to play a role in both

association and syllabification:

(243) N-Placement in Action

I. Rule of N-Placement:

```
            a          a
            |          |
            X  --->  X
                       |
                       N
```

II.

a. Association                    b. Syllabification

```
                a                  p a        p a
              / \                 | |        | |
  X X X X X --> X X X X X          X X  --->  X X
    | |          | |                           |
    N N          N N                           N
```

Up to this point, then, we have managed to account for syllabification as determined by phonological strings, and morphological templates without use of the feature [+syllabic].

In the next chapter we focus on residual analyses which appear to require reference to [+syllabic] on either the skeletal or segmental tier. We first attempt to illustrate that such analyses are either notationally equivalent to one using the label N, or that where differences arise, the structural theory of syllabicity finds empirical support. Showing that phonological rules referring to a feature [+syllabic] are unnecessary given the category N, we are able to eliminate [+syllabic] from the inventory of distinctive features. We are left with a theory in which N, the structural property 'head of a syllable' is the sole determinant of syllabicity.

# Chapter 3

## Reviewing the Case for [+syllabic]

> A sound which can form a syllable by itself is called
> syllabic...(Sweet,1888)

## 3.1 On the Skeleton

There are a number of phonological analyses which rely on the difference

between C and V on the skeletal tier. Such analyses are given as support for

a theory in which at least certain skeletal slots are specified with

intrinsic features in underlying and derived phonological representations.

Two arguments are presented in Clements and Keyser(1983) (henceforth CK), one

involving the representation of long vowels in Turkish, and the other

involving glide/vowel alternations in Klamath.[1]

---

1. It should be noted here that, unlike other interpretations of the
CV-skeleton, within the CK framework,"any segment dominated by V is
interpreted as a syllable peak, and any segment dominated only by C is
interpreted as a non-peak...Given this account of syllabicity, the old
feature [+syllabic] can be dispensed with(pp.8-9)." We agree entirely with
CK that the feature [+syllabic] can be dispensed with. The point of
contention is whether or not any feature, including the categorial feature
which distinguishes a V from a C, need be encoded in the skeleton itself. If
every V is dominated by the nucleus, where "the nucleus is not a
subconstituent of the syllable, but forms in independent unit on a separate
plane of representation(CK;17)," then we must ask how V is distinct from the

We will look first at the Turkish example, showing that the CV analysis may be translated straightforwardly into an X-tier analysis with the same empirical coverage. Such is also the case for CV-based analyses of certain long vowels in Hungarian(Vago,1984), and Ancient Greek(Steriade,1982).[2] We will then turn to a detailed discussion of glide vowel alternations in Klamath, showing that an analysis with X-slots is empirically motivated, where a CV analysis is not.

## 3.1.1 Turkish

The paradigm below is taken from CK(p.67), and illustrates the different forms of the dative and possesive suffixes when affixed to consonant- versus vowel-final stems.

| (244) | | Nom. | Nom pl. | Dat | Poss.3.sg | Poss.2.pl. |
|---|---|---|---|---|---|---|
| a. | 'room' | oda | odalar | odaya | odasi | odaniz |
| | 'river' | dere | dereler | dereye | deresi | dereniz |
| | 'bee' | ari | arilar | ariya | arisi | ariniz |
| | | | | | | |
| b. | cap' | kep | kepler | kepe | kepi | kepiniz |
| | 'stalk' | sap | saplar | sapa | sapi | sapiniz |
| | 'Ahmed' | ahmet | ahmetler | ahmede | ahmedi | ahmediniz |

The initial consonants of the suffixes / yE/ and /-sI/ are deleted when immediately preceded by a consonant, whereas the inital vowel of the

_____

nucleus.

2. Michelson(1984) presents an analysis of Seneca in which certain long vowels are represented as VV and others as VC on the skeletal tier. Evidence for such an analysis relies on a particular statement of the rules of stress assignment in Seneca. We will postpone discussion of Michelson's analysis to the following chapter where a detailed reanalysis of Seneca stress assignment appears, one which relies on internal structure of the syllable, and need not refer to [+syllabic] on the skeletal or segmental tier.

possesive second person plural suffix /-InIz/ does not surface when immediately preceded by a vowel.[3] The fact that such deletion rules do not affect all suffixes leads CK to posit morphologically conditioned segmental deletion rules. As they point out, however, a distinction can be made between two types of long vowels in Turkish with respect to this process. The data is given below:

```
(245)a. 'la(mus. note)  la:     la:lar    la:ya    la:si    la niz
        'spelling'       imla:   imla:lar  imla:ya  imla:si  imla:niz
        'building'       bina:   bina:lar  bina:ya  bina:si  bina:niz

     b. 'mountain'       da:     da:lar    daa      dai      dainiz
        'avalanche       ci:     ci:lar    cia      cii      ciiniz
        'dew'            ci:     ci:lar    cie      cii      ciiniz
```

The forms in (245.a) act like the vowel final stems in with respect to the allomorphic variation illustrated in (244) while the (245.b) forms act like consonant final forms. CK attribute these facts to the folowing different underlying representations:

(246) Underlying "long" vowels in Turkish (CK,p.70)

```
        o-                          o-
       /|\                         /|\
      / | \                       / | \
     C  V  C                     C  V  V
     |  |                        |  \/
     d  a                        l   a
     'mountain'                  'la(musical note)'
```
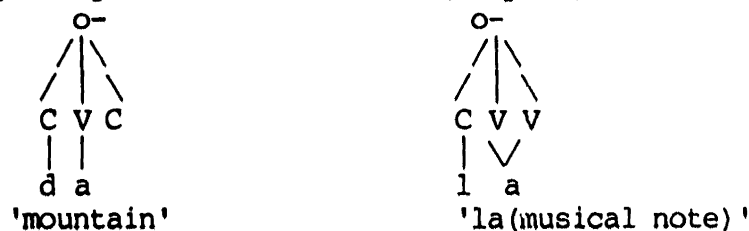
Then they state that "the application of the rules of suffix allomorphy will be sensitive to whether the stem ends in a C or a V(p.70)". As pointed out by Archangeli(1984), the Turkish facts are consistent with both a CV analysis and an X-slot analysis. Within the system we are proposing, the four types

---

3. The segments E and I represent [-high] and [+high] segments which harmonize in rounding and backness.

of stems given in (244) and (245) above will appear in underlying representation as shown below:

(247) a. o d a   l a        b. k e p   d a
      | | |   | |\              | | |   | |
      X X X   X X X            X X X   X X X

A redundancy rule of N-placement for [-hi,-cons] segments will then result in the intermediate, partially syllabified representations below:

(248) a. o d a   l a        b. k e p   d a
      | | |   | |\              | | |   | |
      X X X   X X X            X X X   X X X
      |   |     |/             |         |
      N   N     N              N         N

The a. forms above are both **X** final, while those in b. are both X' final, allowing us to state the suffixal allomorphy rules as follows:

(249) a. **X** deletion              b. X deletion

      X ---> 0 / X]__...]          X ---> 0 / X']__...]
      |          |   A                            B
      N          N
      where A = {poss2pl.,...}      where B = {dat.,poss3sg.,...}

Rule (249.b) above must apply before the Turkish rule of Project-N' which is given below, since it is sensitive to the unsyllabified status of the post-nuclear segments:

(250)  Project N'  Turkish

      X X' ---> X  X
      |         |  /
      N         N /
                |/
                N'
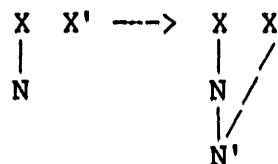
Projection of N' is seen to feed a rule which links a [-cons] matrix to a tautosyllabic rime-internal skeletal slot (CK's rule is given as well for

comparison):

(251)  a. Feature Spread            b. From CK(p.71)

```
        [   ]                          [   ]
        |\                             |\
        | \                            | \
        X  X                           V  C'
        |  /                            \/
        N /                             o-
        |/
        N'
```
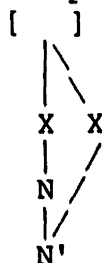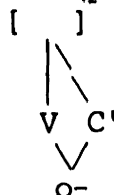
Evidence in support of the allomorphy rule (249.b) above applying before the syllabification of post-nuclear slots is apparent on further examination of the vowel initial suffixes of class A in (249).[4] The two suffixes in question are the possessive first and second person markers, /~(I)m/ and /-(I)n/. Rather than positing a rule of vowel deletion such as that in (249.a), such forms could also be derived via a morphologically conditioned epenthesis rule which applies before projection of N'. A restatement of rule (249.a) in terms of a rule of epenthesis will look as shown in (252.a) below:

(252)      a.  X-Insertion               b.  X-Deletion
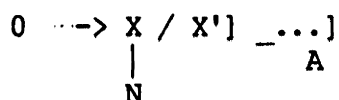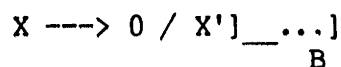
```
        0 --> X / X'] _...]            X ---> 0 / X'] __...]
              |         A                             B
              N
        where A = {poss2pl.,...}       where B = {dat. poss3sg., ..}
```

Such an analysis is unified, as shown by the identical environments above. That is, when a consonant initial suffix is attached to an X'-final stem, nothing may happen, though particular morphemes will trigger the insertion or

---

4. We restrict our attention to the inflectional suffixes. Derivational suffixes which are X-initial after X-final stems and X-initial after X-final stems include: /-(A)k/, a substantive, denotative relation; /~(A)lak/ a nominal adjectival suffix, and /-(I)nci/, an ordinal number suffix.

deletion of an X-slot.

Under such an analysis it is not coincidental that the initial vowel in the suffixes /-Im/, /-In/ is a [+high] vowel which undergoes backing and rounding harmony. An independently motivated phonologically conditioned rule of epenthesis in Turkish inserts a vowel which is realized as [+high] on the surface and acquires rounding and backness features through V-harmony. In (253) we see nominative forms in which epenthesis has applied, and accusative forms where it has not:

(253)  Nom.        Acc.        Gloss
       burun       burnu       'nose'
       sehir       sehri       'city'
       akil        akli        'intelligence'
       bahis       bahsi       'bet'

Such forms motivate a rule of the following form:[5]

(254) Turkish Epenthesis

$$0 \longrightarrow \underline{X} / \_\_ X']$$

Clusters which are broken up by this rule include sonorant-sonorant, obstruent-sonorant, stop-stop, and stop-fricative. These are all impermissible final clusters in Turkish. We conclude from this fact that epenthesis applies after N' projection and incorporation into N'. Elements syllabified by these two rules will never feed the rule in (254). Incorporation into N' in Turkish, as in English, is non-iterative and employs a sonority scale which mentions [+son] and [-son], and within [-son], [+cont] and [-cont] with a MSD > 0. In the following example we see nominative and

_ _____ ___ __

accusative forms of nouns with well-formed final clusters, where epenthesis

is bled by the syllabification rules of N' projection and incorporation into

N':

(255)  Nom.        Acc.        Gloss

| Nom. | Acc. | Gloss |
|------|------|-------|
| renk | renki | 'color' |
| kurk | kurku | 'fur' |
| kalp | kalpi | 'heart |
| ask | aski | 'love' |

Where Clements and Keyser refer to rules conditioned by C, we may refer to

rules conditioned by X, or in this case X'. Note that one cannot argue

against use of X' as opposed to C on grounds of simplicity, since the

CV-theory must also make reference to unsyllabified slots in formulating

phonological rules. The rules below which both refer crucially to

unsyllabified skeletal slots are taken from CK:

(256) Reference to X' within a CV-Theory
i. Klamath General Epenthesis     ii. French Minor rule(CK 107)
   (CK:125)                   (in non-liason contexts)

```
                σ                           σ─
                |        |                  |\
                |        |                  | \
   0 --->   V / C'  __  C' +                V  C'
```
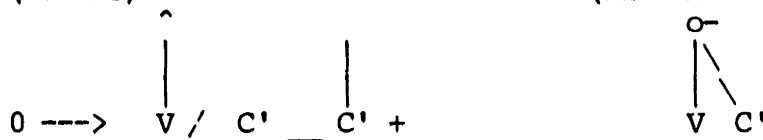
Elimination of intrinsic features in the skeleton, then, may require that

reference be made to X', an independently motivated feature of timing slots,

that of being unassociated to the syllable plane.

The analysis we have proposed, in which an empty X-slot is syllabified as a

sister of N prior to feature spreading, leads us to predict that the forms

[la:] and [da·] will have the distinct surface syllabifications shown below:

(257) a.  l    a              b.    d    a
          |   |\                    |   |\
          X   X X                   X   X X
           \  |/                     \  | /
            \ N                       \ N/
             \|                        \N'
             N"                        N"
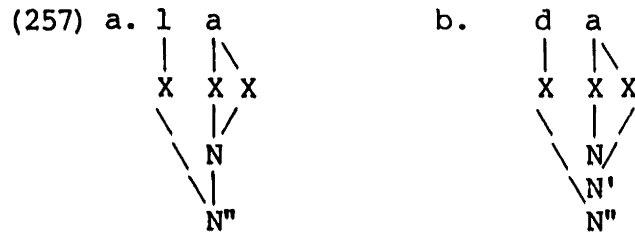
Note here that instead of referring to X' in distinguishing between the two

long vowels, we also have the option of referring to branching $N^o$ versus

branching N' after syllabification has taken place. This was essentially the

proposal of Archangeli(1984), and would be the only solution available if one

were to argue for a model of instantaneous syllabification.

A rule of vowel-shortening appears to support a distinction between the two

structures   in   (257)   above,   if   vowel   shortening   is   viewed   as   a

syllable-sensitive process.[6]  According to Swift(1962), forms which end in

long vowels of the type shown in (257.a) are often shortened when a suffix is

added.  So we find **bina:** 'building' but **binada** 'in the building',**binasi** 'his

building'; **fena:** 'bad' and **fenaya** 'to the bad' and **fenasi** 'the bad of it'.

However, forms which have long vowels of the type shown in (257.b) do not

undergo shortening.  So we find **sa:** 'right' and **sa:a** 'to the right', **sa:i**

'its right'; **da:** 'mountain' and **da:a** 'to the mountain', **da:i** 'the

mountain(acc.)'.  In (258.A) below we state the rule of shortening which

distinguishes   between   the   representations   in   (257)   in   terms   of   syllable

--------

6. We suggest that the eager reader turn to Chapter 4 for an exposition of
arguments to the effect that context sensitive rules which may be minimally
specified as inserting or deleting skeletal slots are syllable-sensitive by
definition.

structure alone. In (258.B.i) a formulation of the rule is given in the CV-theory assuming access to syllable structure is not necessary. In (258.B.ii) we give a syllable-sensitive formulation of the rule.[7]:

(258) Vowel Shortening in Turkish (optional)

```
A.              N          B.              [^F]
                |\                          /\
     X ---> 0 /  X __]X...  i.  V ---> 0 /  V __]X...
                                          N
                                          |\
                            ii.  V ---> 0 / X __]X...
```

Though any of these rules will correctly predict the length alternations observed, several comments are in order. First, Rule A. is not a segmental rule, that is, it need not mention any information on the segmental plane. This contrasts with rule B.i which specifies a limited amount of information on the segmental plane. Secondly, as a syllable sensitive rule, Rule A does not rely on the fact that the only complex nuclei in Turkish are monosegmental long vowels. Contrast this to both of the rules in B., where the deleted skeletal slot must be specified as a V to distinguish it from a C in post-vocalic position, both, within the CK theory determining a branching N constituent on a separate tier. Given that V and C define syllabic peaks and non-peaks respectively, the necessary distinction between V and C in the B. rules is enough to classify them as syllable sensitive rules. But then, if such a shortening rule is syllable sensitive, mention of V as well as information on the segmental tier becomes redundant, and leads us to posit rule A. as the simplest syllable sensitive version of the rule.

---

7. Recall that within the CK version of CV-phonology, there is no distinction between branching rime and branching nucleus, so that VV and VC sequences both determine the same structure on the N tier.

Of course, it might well be the case that vowel shortening in Turkish requires access to segmental information, but in the absence of evidence to this effect, we opt for the rule in (258.A) and, in turn, view this rule as theory-internal evidence for the distinctive syllabifications of underlying versus long vowels proposed in (257).[8]

Returning to the question of whether or not one need distinguish between C and V in the skeleton, we have shown most importantly, that where CK refer to rules conditioned by C as distinct from V, or to V as distinct from C we may refer to rules conditioned by unsyllabified X-slots (X'), or slots designated as syllable nuclei (X). Because reference to unsyllabified skeletal slots as well as information on the syllablle plane is required independently within phonological theory, we are left without independent motivation of an inherent distinction between Cs and Vs in Turkish.

## 3.1.2 Hungarian V:t Sequences

A similar case can be made with respect to Hungarian as analyzed by Vago(1984). Vago argues that the morphologically conditioned palatalization rule as given below, is sensitive to a distinction between V and C on the skeleton:

(259) Before the imperative suffix  j:

t ---> s / V __
t ---> c / C __

---

8. If vowel shortening in general, is a syllable sensitive rule, as we analyzed it to be in Yawelmani in Chapter 2, and as we hypothesize further in Chapter 4,then formulation of the rule in Turkish is limited to (258.A) or its CV-equivalent (258.B.ii).

When /t/ is preceded by a long vowel in the imperative, it surfaces as [c], a

fact which leads Vago to conclude that at least the long vowels in Hungarian

which are followed by /t/ are to be represented as VC as opposed to VV on the

skeletal tier. However,there are a number of alternatives to such a

solution. One alternative, is to follow the Turkish example and to treat

long vowels in stems like /fu:t/ 'heat' as underlying short vowels followed

by empty X-slots:

```
(260)    f u   t
         | |   |
         X X X X
```
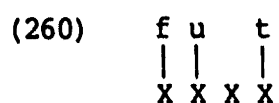
Given such a representation, N-placement followed by N'-projection will

result in the following structures for both VCC- and V:t-final stems:

```
(261) a. f u   t            b.  k o  l t
         | |   |                | |  | |
         X X  X X              X X  X X
           |  /                   |  /
           N /                    N /
           |/                     |/
           N'                     N'
```
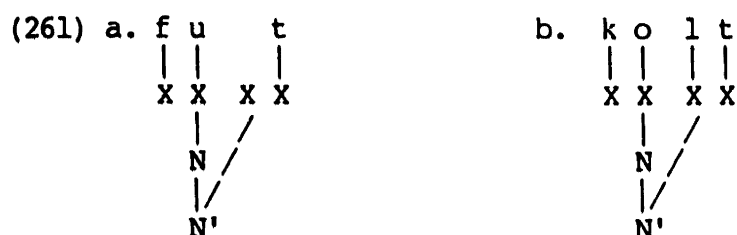
The palatalization rules in (259) can then be restated as follows:

```
(262) a.  t ---> c / __] j]
                      IMP
      b.  c ---> s  /     ___
                        T
                  X  X  ]
                  |  /    IMP
                  N /
                  |/
                  N'
```
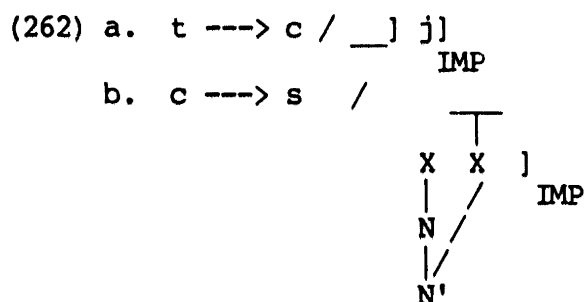
The spirantization rule in (262.b) requires adjacency between the target and

the nucleus, treating stems like the /si:t-/ 'stir up' and /kolt-/ 'spend' as

a natural class in as much as the /t/ in both cases is not immediately

preceded by the nucleus.

Vago provides further evidence that long vowels preceding /t/ in Hungarian are VC on the skletal tier, all of which is consistent with our analysis above. The evidence is provided by two morphologically conditioned epenthesis rules. The rules, as stated by Vago, are given below:

(263)
```
                  A
                  |
A.    0 ---->     V  /  C C ]  __ C
                        Verb Stem
```

```
                  O         t      t
                  |      /  |      |\
B.    0 --->      V  /  {C,V} C] __ C C
                        Verb stem
```

Rule A. inserts a low vowel between CC-final verb stems and C-initial suffixes, while Rule B. inserts a round vowel after after verb stems ending in stressed Vt, Ct or V:t before the past tense suffix. Vowel final stems and single consonant final stems do not condition the rules above, while verb stems ending in V:t and VCC do. Derivations involving rule A. are given below:

(264)

| 3sg /0/ | 3pl /nAk/ | Inf. /ni/ | Gloss |
|---------|-----------|-----------|-------|
| no:     | no:nek    | no:ni     | 'grow' |
| kap     | kapnak    | kapni     | 'receive' |
| mond    | mondanak  | mondani   | 'say' |
| fu:t    | fu:tenek  | fu:teni   | 'to heat' |

These facts are consistent with our proposal above; namely that, as in Turkish, certain surface long vowels are underlyingly vowels followed oy empty X-slots:

(265)  Underlying representation of Hungarian V:t stems
```
         f  u     t
         |  |     |
         X  X  X  X
```

The morphologically conditioned rules of epenthesis in (263) can then be
restated as follows, provided they apply after N'-projection:

```
(266)                   A
                        |
   A.    0 --->   X  /  X' ]  ___  [N"
                       Verb Stem
                    O       t        t
                    |       |       |\
   B.    0 --->   X  /      X'] ___ C C
                       /  Verb stem
                       X
```

Derivations involving rule A. are provided below:

```
(267)a. n   o   n   a  k         b.  k   a  p  n   a  k
        |  |\  |  | |              |  | |  |  | |
        X  XX  X  X X              X  X X  X  X X
N-Plac. \  |/ \  | /                \  |/ \  | /
Proj-N"  \ N  \ N/                   \ N/  \ N/
Proj-N'   \|   \N'                    \N'   \N'
          N"    N"                    N"    N"
Rule(266.A)  n.a                         n.a
```

```
  c.   m  o  n  d   n  a  k    d.  f  u   t   n  a  k
       |  |  |  |   |  | |        |  |   |   |  | |
       X  X  X  X   X  X  X       X  X  X  X  X  X X
N-Plac. \  | /     |  \  | /        \  | /    |   \  | /
Proj ·N"  \ N/      |   \ N/          \ N/      |   \ N/
Proj-N'   \N'      |   \N'            \N'      |   \N'
          N"       |    N"            N"       |    N"
Rule(266.A)       N                           N
```

A later association rule, like that required in Turkish will spread a feature

matrix to an unassociated slot to its right:

```
(268)  Feature-Spread
                [   ]
                |\
                | \
                |  \
                X   X
                |  /
                N /
                |./
                N'
```

It appears then that given a structural distinction between N and N', as well as one between X' and $\underline{X}$, the feature syllabic is rendered obsolete in this analysis.

The analyses presented for Turkish and Hungarian both argue for a distinction between long vowels syllabified as branching nuclei and those syllabified as N's. While independent phonological evidence for such distinctions is scarce in both examples, such phonological evidence is present in a similar analysis of tense versus lax vowels in Ancient Greek which follows.

## 3.1.3 Tense/Lax Distinctions in Ancient Greek

Another case where a distinction between V and C on the skeletal tier is claimed to play a role in the phonology is Steriade's(1982) analysis of lax (/O:,E:/) versus tense (/o:,e:/) long mid vowels in the Attic dialect of ancient Greek. Long mid vowels may be underlyingly either lax or tense: $^h$O:n 'whose-pl-masc.' and $^h$E:n 'whom-sg-fem.' versus o:n 'therefore' and e: 'if'. Derived tense vowels arise by a process of compensatory lengthening: $^h$e:s from $^h$Ens 'one', $^h$o:s from $^h$Ons 'whom-pl-masc'. Derived lax vowels arise through the morphophonological processes of augment and perfect reduplication: O:p$^h$e:lO: 'I owe', o:p$^h$e:lE:ka 'perf. owe', est$^h$io: 'eat-pres.' and E:st$^h$ion 'eat-impf-lst-sg.'. Long vowels which result from compensatory lengthening are represented as VC, while prefixation of a CV or V in the perfect and augment forms with subsequent melody spread, results in a VV long vowel. The process of compensatory lengthening is one of

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association as shown below:

(269) Compensatory Lengthening (Steriade;1982)
     An empty C slot in the rime is associated with the segment
     in nuclear position.  Formally:

```
      [^F]                    [^F]
       |                      / \
       |                     /   \
       V   C       --->     V     C
        \ /                  \   /
         \/                   \ /
         R                    R
```
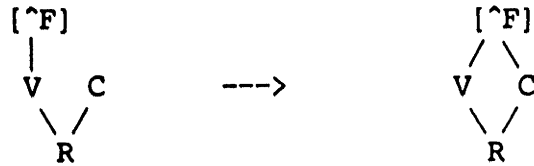
Examples of compensatory lengthening and perfect reduplication are given

below:

(270) A.  Perfect of o:pe:lo:      B.  Compensatory Lengthening
```
          o p e l e   k a             h e n s
         /| | | | |\  | |             | |\| |
        C V-V C V C V V -C V          C V C C
```
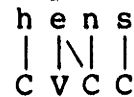
Steriade suggests that tenseness of mid vowels is simply the phonetic

interpretation of the VC linking, while a VV linking is interpreted

phonetically as lax:

(271) Long mid tense/lax distinction in Attic
      A.  Lax                      B. Tense
```
          [ hi,-lo]                   [-hi,-lo]
            /\                          /\
           /  \                        /  \
          V   V                       V    C
```
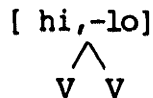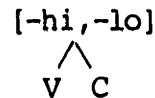
While it must be stipulated that the phonetic distinction in (271) is only

available for mid-vowels, by distinguishing tense/lax without use of an

additional distinctive feature, Steriade is able to account for the absence

of a tense/lax distinction in surface short vowels.

However, given Steriade's statement of compensatory lengthening above, we

see that the representations in (271) A. and B. are distinct in terms of

syllable structure as well, allowing us to rewrite (271) A. and B. as

follows:

(272) Long mid tense/lax distinction in Attic
    A.  Lax                            B.  Tense

```
        [-hi,-lo]                    [-hi -lo]
          |\                           | \
          X X                          X   X
          |/                           |  /
          N                            N /
                                       |/
                                       N'
```
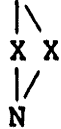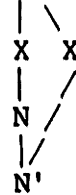
Rather than argue that the structures in (272) are interpreted as either tense or lax by the phonetic component. we propose them as intermediate structures which feed the two following rules:

(273)a.  [-hi,-lo] ---> [-tense] /

```
                                  ‾|‾
                                   X X
                                   |/
                                   N
```

      b.  [-hi,-lo] ---> [+tense] /

```
                                  T‾
                                  X (X)
                                  |  /
                                  N /
                                  |/
                                  N'
```
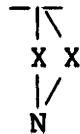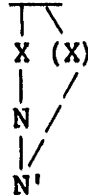
After the feature fill-in rules above apply, the branching N' structure is reinterpreted as a branching N via a rule of restructuring. Recall from Chapter 2 that restructuring was one of three ways in which complex nuclei could be derived. The restructuring rule proposed is illustrated below:

(274)    [-hi,-lo]                                [-hi,-lo]

```
          | \          Restructuring         |\
          X  X         -------->             X X
          |  /                               |/
          N /                                N
          |/
          N'
```
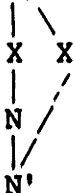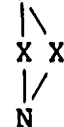
Evidence for this restructuring is provided by the accentual system of ancient Greek which requires a rule of extrametricality distinguishing between long vowels and VC sequences. Both tense and lax long mid vowels are treated as VV sequences for this rule. In particular, Steriade(1981) observes that Recessive Accent in ancient Greek is sensitive to the structure of final syllables as shown below:

(275)Ancient Greek Recessive Accent(from Steriade,1981;p.6)
```
     final rimes allowing
     antepenult accent:         V   VC   oi   ai
     ------------------------------------------------------
     final rimes inducing
     penult recesive accent:   VV   VCC   oiC   aiC
     (where VV stands for any bimoraic sequence
     vowels other than oi, ai.)
```

Steriade suggests that by treating the last non-syllabic segment of every Greek word as extrametrical, the dichotomy in (275) can be stated in terms of syllable weight. On the assumption that i in oi and ai is non-syllabic, the final rimes in (275) are given the metrical values in (276):

(276)   light rimes              V    V    o    a
```
     ------------------------------------------------------
```
        heavy rimes             VV   VC   oi   ai

The fact that final long vowels, whether lax or tense, always induce penult recessive accent argues for the restructuring rule in (274). After restructuring, the extrametricality rule, as stated below, applies:

(277)   EM in Ancient Greek

$$X \longrightarrow [X]_{EM} \ / \ \underline{\quad} \#$$

with N' dominating the final slot.

The rule above makes a final X slot extrametrical if it is immediately dominated by N'. Short and long vowels are both immediately dominated by N at

this stage in the derivation, resulting in the light/heavy distinction shown in (276).

The output forms of augment and perfect reduplication are always realized as lax vowels since there is no intermediate representation in which the second vowel is dominated by N'. Rather, as illustrated below, such morphological processes result in monosegmental long vowels whose syllabification is not structure preserving. The spreading of the vocalic matrix in (278) invokes a rule of vowel coalescence which results in a reinterpretation of the monosegmental long vowel as a single tautosyllabic segment:

```
(278)  A.  Perfect reduplication  Prefix  XX-
                o p e l e    k a
               /| | | | |\   | |   Coalescence
              X X-X X X X X -X X   ------->
              | |   | |/      |
              N N   N N       N
                o p e l e    k a
               /| | | | |\   | |
              X X-X X X X X -X X
              |/    |  |/     |
              N     N  N      N
```

Evidence from rules of vocalic contraction in Attic support this analysis. These rules have as their output both long mid tense and lax vowels. The rules, which are all optional, are shown below

```
(279)  a. Lax V:    i.   e + a ---> e:
                    ii.  o + a ---> o:

       b. Tense V:  i.   e + e ---> e:
                         e + i ---> e:

                    ii.  o + o ---> o:
                         o + e ---> o:
                         o + u ---> o:

                         o + i --> oi
```

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If the second vowel is high or mid, the resulting long vowel is tense. To account for these facts, we posit a structure-changing instance of Project-N' for sequences of the form XX where the first element is of equal or greater sonority than the second. The rule can be stated as follows:[9]

(280) Devocalization: Attic

```
X       X    --->    X   X      where X₁ of greater or
|1      |2           |1 /2      equal sonority than X₂
N       N            N /        and X₂ is [-low].
                     |/
                     N'
```

where $X_1$ of greater or equal sonority than $X_2$ and $X_2$ is [-low].
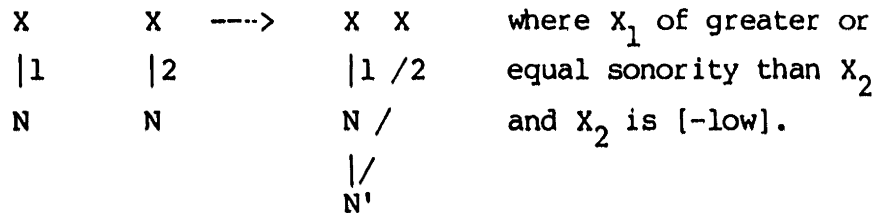
Devocalization is followed by the optional rounding/lowering rule shown below, where, internal to N', [ei]--->[e:] and [ou]--->[o:], and [oe]--->[o:].

(281) N'-Internal Spread: Attic

```
[-H][+H]      [+R][-R]
 |  \|         |  \|
[^R][^R]      [^H][^H]
[-L][-L]      [-L][-L]
 |   |         |   |
 X   X         X   X
 |  /          |  /
 N /           N /
 |/            |/
 N'            N'
```
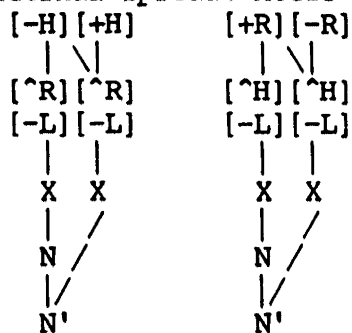
The derived representations above, like those derived via compensatory lengthening receive the feature value [+tense], as they represent branching N's. Because they are monosegmental geminates however, they are subsequently reinterpreted as branching nuclei by the rule of restructuring given in (274).

---

9. Note that the same rule was motivated for Mokilese in Chapter 2, cf. example (98).

In the case where rule (280) does not apply, that is, where the second vowel is low, a branching N' is never created:

```
(282)   [-hi,-lo] a    [-hi,-lo]a              [-hi,-lo]
         |    |          |  |                     |\
         X    X   --->   X  X   -------->          X  X
         |    |           |/                       |/
         N    N           N                        N
```
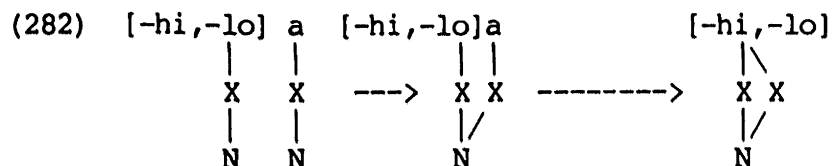
The resulting long vowels surface as [-tense] as expected.

Given a structural analysis of the tense/lax distinction as a distinction between branching N' versus branching N, we also capture the fact that such a distinction exists only for long vowels. For underlying tense/lax distinctions, instead of positing VV versus VC long vowels, we posit the following distinct representations:

```
(283)  a. ʰO:n 'whose-pl-masc.'     b. ɔ:n 'therefore'
          h o  n                        o   n
          | |\ |                        |   |
          X X X X                       X X X
```
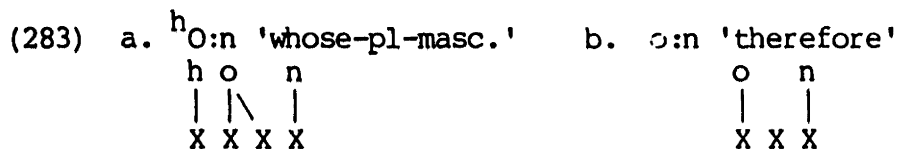
Rules of N-placement will create a branching N over the long vowel in (283.a), while the empty post-nuclear X-slot in (283.b) will be syllabfied as a coda, feeding the rule of compensatory lengthening in (269) and resulting in a structure like the one shown in (273.b) above, which is interpreted as tense. In summary then, given a structural distinction between N and N' in Attic, we are able to state both the rule of tensing as well as the rule of final segment extrametricality in a succinct fashion, without use of the feature [+syllabic].

## 3.1.4 Klamath Glide Vowel Alternations

### 3.1.4.1 The Rule of Vowel Shortening

Just as the analyses above lend themselves straightforwardly to rewriting in terms of structural distinctions between N and N' or the primitives $\underline{X}$ and X', so does the analysis of Klamath glide vowel alternations proposed by CK.[10] This is to be expected, given that the interpretation of the Cs and Vs in the skeleton is identical to that of the categories X and $\underline{X}$ proposed here. As is made explicit by the authors':

> ...there are no feature specifications on the CV-tier. By this we mean that CV-elements are not defined in terms of such distinctive feature categories as <u>syllabic</u> or <u>consonantal</u>, but are primitives of the theoretical vocabulary. These elements, as noted earlier, are interpreted as distinguishing the functional category <u>syllable</u> <u>peak</u> from <u>syllable</u> <u>margin</u>...(p.136)

The single difference between the two versions of the skeleton, appears to be that in the CK framework, V (or C) are primitives in that their properties are not reducible to any others in the theory. In a metrical theory of syllabicity, where skeletal slots are intrinsically featureless, V is a concatenation of two primitives: a single timing slot in the skeleton, and a label, or categorial feature $N^0$ on the syllable plane. As we have seen, categorial status as a syllable head may be assigned by rule. Furthermore, N is subject to X-bar theory and projects in the phonology, while an X-slot

--------

10. I am indebted to Morris Halle, Donca Steriade, Jay Keyser, Mike Hammond and countless others for enlightening discussions about the Klamath facts and their significance for a metrical theory of syllabicity.

alone does not.

A further difference between the two theories, though not intrinsic to the CV-theory, is that CK posit flat syllable structure. As we saw in the analysis of Turkish long vowels, VV and VC can not be distinguished in terms of syllable structure since they are each immediately dominated by o- on the syllable plane and by N on the "nucleus" projection:

(284)   Heavy Syllables in CV Phonology (CK;13)
        nucleus        nucleus
         /\             /\
        V  V           V  C
         \/             \/
         o-             o-
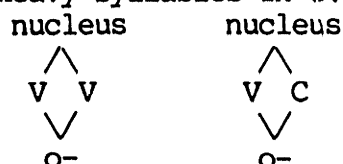

While these two differences between the theories appear slight, they are magnified by a particular rule of vowel shortening proposed by CK in their analysis of Klamath glide vowel alternations. Before turning to the facts, we briefly examine the rule proposed by CK, shown below:

(285)   Klamath Vowel Shortening (CK,p.171)
           C ---> 0 / V___
                   \/
            [ ]        in the following environments:

                       a. V:C$_{o}$___
                       b. CC___CC
                       c. CC___C$_{o}$#


The rule above deletes a C-slot when it is part of a doubly linked feature matrix preceded by a V-slot in the environments given.[11] Rather than referring to any property of syllable structure, or to unsyllabified versus

------------

11. A slight modification and simplification of these environments is suggested in the following discussion.

syllabified skeletal slots, "this solution exploits the formal possibility of distinguishing between two types of long vowels which are phonetically equivalent: those dominated by VV and those dominated by VC (CK;171)."

Given a rule based system of syllabification like that described in Chapter 2, underlying long vowels subject to N-placement governed by the CSD will result in branching nuclei, while what CK designate as VC sequences will be the result of N'-projection. The CK analysis posits syllabification of CVC syllables before the rules of pre-glide epenthesis and lengthening. As a consequence, rule (285) can be written with reference to syllable structure as shown below:

(286)  Vowel Shortening: N vs. N'
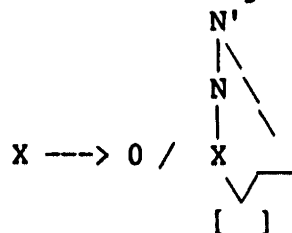
$$ X \longrightarrow 0 \ / \ \begin{array}{c} N' \\ | \backslash \\ N \ \backslash \\ | \ \backslash \\ X \ \underline{\phantom{xx}} \\ \backslash\!/ \\ [ \ \ ] \end{array} \quad \text{in the following environments:} $$

a.  $\underline{XXX}_0\underline{\phantom{x}}$
b.  $X'\underline{\phantom{x}}X'$
c.  $X'\underline{\phantom{x}}X'_0\#$

The statement of shortening above will not shorten underlying long vowels which, as a result of N-Placment and the CSD, are syllabified as branching nuclei.

While a reformulation of the VC versus VV distinction in terms of branching N' versus branching $N^0$ shown above is unremarkable, there is reason to believe that the Rule of Vowel Shortening itself is empirically inadequate. In an attmept to come to a deeper understanding of the nature of glide/vowel

alternations in Klamath and their relationship to rules of syllabification, we point out in the following discussion some of the problems with the rule of Vowel Shortening, and propose an alternative analysis in which short vowels derived from underlying glides are the result of a rule of stray glide vocalization, which, in the environments a.,b.,c., above, is seen to bleed the later rule of pre-glide epenthesis.

This alternative solution is compatible with the syllabification algorithms set out in the previous chapter, and does not require a distinction between C and V on the skeletal tier. It does make use of syllable-internal structure, and thus is not possible within the specific proposal of Clements and Keyser which incorporates flat syllable structure. It also argues for a view of syllabification as an ordered set of rules which apply at different stages of the derivation, rather than a one step process at any level.

### 3.1.4.2 Excursus on Klamath: Assessment of the Facts

We turn now to an extensive reassessment of the facts. In (287) we see regular alternations between glides, short vowels and long vowels.[12]

(287)
|       |            |                                       |          |
|-------|------------|---------------------------------------|----------|
| a.    | /dewy-/    | 'shoot a bow and arrow, gun once'     | (D,113)  |
| i.    | dewyi:ya   | 'shoots once for someone'             | (D,113)  |
| ii.   | dedwi      | 'dist. shoot once'                    | (D,113)  |
| iii.  | dewi:      | 'fires a gun once, shoots one arrow'  | (D,113)  |
|       |            |                                       |          |
| b.    | /mbody-/   | 'wrinkle from exposure to water'      | (D,236)  |
| i.    | mbotya     | 'wrinkles'                            | (D,236)  |
| ii.   | mbompditk  | 'dist. wrinkled up'                   | (D,237)  |
| iii.  | mbodi:tk   | 'wrinkled up'                         | (D,236)  |

----------

12. Page references for Klamath forms are given next to each entry where D = Barker(1963a), T = Barker(1963b), and G = Barker(1964).

| | | | |
|---|---|---|---|
| c. | /nidw-/ | 'guess, figure out, solve' | (D,264) |
| i. | nidwalla | 'guesses someone's plot' | (D,264) |
| ii. | sindo | 'guess each other' | (D,264) |
| iii. | nido: | 'guesses' | (D,264) |
| | | | |
| d. | /smoqy/ | 'have a mouthful' | (D,379) |
| i. | smoqya | 'has a mouthful' | (D,379) |
| ii. | smosmqitk | 'dist. having a mouthful' | (D,379) |
| iii. | smoqi:tk | 'having a mouthful' | (D,379) |
| | | | |
| e. | /taby-/ | 'back, behind, younger, last' | (D,401) |
| i. | tapyap | 'younger sibling of same sex' | (D,401) |
| ii. | tatbisap | 'younger siblings of same sex' | (D,401) |
| iii. | tabi: | 'last, finally' | (D,401) |
| | | | |
| f. | /tawy-/ | 'curse, bewitch, lay a spell on' | (D,402) |
| i. | tawyi:ya | 'lays a spell on a person for s.o.' | (D,402) |
| ii. | tatwi | 'dist. curse someone' | (D,402) |
| iii. | tawi: | 'curses someone' | (D,402) |
| | | | |
| g. | /-aky-/ | 'closing,shutting; on the buttocks' | (D,45) |
| i. | lakya | 'closes with a round object, inserts a cork' | (D,204) |
| ii. | salkica | 'just plugged up a hole w/ oneself' | (D,204) |
| iii. | laki:ca | 'just plugged up' | (D,204) |
| | | | |
| h. | /-akw-/ | 'across' | (D,45) |
| i. | cinkwa | 'crosses w/ the back showing' | (D,45) |
| ii. | cinkos | 'Going-Across with-the-Fin- showing' (place name) | (D,45) (D,45) |
| iii. | gako:kis | 'ford' | (D,134) |

The noun formant /-y-/ also alternates with long and short vowels like the stem-final glides above. Some examples follow.

(288)  /-y-/  'noun formant' (D,462)    /-s/  'noun formant' (D,340)

| | | | | |
|---|---|---|---|---|
| i. a. | lmeys | 'thunder' | (cf. lmena | 'thunders' D,219) |
| b. | pnays | 'the burying' | (cf. pnana | 'buries' D,309) |
| c. | qtays | 'sleep' | (cf. qtana | 'sleeps' D,324) |
| d. | slays | 'tule mat' | (cf. slana | 'spreads out a mat' D,372) |
| e. | keys | 'snow' | (cf. kena | 'snows' D,185) |
| f. | kceys | 'thorn' | (cf. kcena | 'pricks' D,183) |

ii. a. hosltis       'feeling'        (cf. hoslta 'feels' D,171)
    b. kaystis       'door'           (cf. kaysta 'closes a door' D,199)
    c. loldatgis     'interpreter'    (cf. lodatga 'interprets' D,220)
    d. papsis        'stupidity'      (cf. papsa 'is stupid' D,297)
    e. sloslo:lwis   'flute-player'   (cf. slo:lwa 'plays a flute'D,378)
    f. stintantis    'a Don Juan'     (cf. stinta 'loves' D,394)


iii.a. hoqi:s        'breath, life'   (cf. hoqa 'breathes,lives' D,171)
    b. leci:s        'the weaving'    (cf. leca 'weaves,knits' D,214)
    c. meyi:s        'the digging'    (cf. meya 'digs roots' D,238)
    d. Wali:s        'cliff,precipice'(cf. Wal- 'cliff' D,457)
    e. wayi:s        'ladder'         (cf. waq- 'ladder' D,433)
    f. yebi:s        'the digging'    (cf. yeba 'digs' D,468)


As is clear from the i. forms in (287) and (288), what is represented as an
underlying glide surfaces as a glide if it is immediately preceded or
immediately followed by a vowel. The iii. forms in (287) and (288)
illustrate that the same segments surface as a long vowels when they are
immediately preceded by a vowel-consonant sequence. In all other
environments, i.e. in ii. of (287) and (288), an underlying [+high,-cons]
segment surfaces as a short vowel.[13] In Kisseberth(1973a), the alternations
above were captured by lengthening all vocalized glides, and subsequently

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13. The fact that a vocalized /w/ does not surface as [u] can be accounted
for by a late rule of lowering, one of a number of laxing and lowering rules
suggested by the phonetic descriptions provided by Barker (G,32-33). The
rules we propose are the following:

A.  [+H,+R] ---> [-H]    / [-anterior]
B.  [+H,+R] ---> [+lax]
C.  [-H,+R] ---> [+lax] / __|X|]$_{N'}$

where Rule C. can most likely be generalized to all [-H] vowels.

shortening them by means of the following rule:

(289) Vowel Shortening in Klamath (Kisseberth,1973a)
V ---> [-long] / V C __
                  [+long] o __         Condition: "the vowel
                     C __ C #     undergoing the rule must
                     2 __ o      be underlyingly a glide."
                       C       (p.25)
                       2

While the discussion in Kisseberth focused on the apparent necessity of the

global condition needed for the rule above, CK claim to offer a solution

which does away with the need for a global condition by making use of the

CV-representation.[14]

Their analysis first relies on representing all underlyingly long vowels as

VV sequences. Underlying "glides" in Klamath are analyzed as being linked to

C-slots in underlying representation. As such, they are subject to the rule

of pre-glide epenthesis given below.[15]

(290) Pre-Glide Epenthesis (CK,p.134)
0 ---> V/ __ C'
              |
         [-cons]

----------

14. See also Clements and Keyser(1980) and Ter Mors(1981) for similar analyses.

15. CK also propose a rule of post-glide epenthesis(p.134) which inserts an epenthetic vowel after an initial unsyllabified [-consonantal] segment. We proposed in the previous chapter that initial clusters of two segments were syllabified via first Project-N''' and a later non-iterative rule of adjunction to N'''. Thus, a word like /wqas/ 'quartz' is syllabified as a disyllable in the CK analysis [w$^{u}$.qas], but as a monosyllable [w$^{u}$qas] within this system. The monosegmental monosyllabic interpretation of the initial offglide in this sequence is in accordance with Barker's description(G,28) of /w/ in the environment #__C: "A voiced bilabial segment occurs in this environment. It contrasts with a two-segment sequence [wu] or [wU], since it is of shorter duration and less fortis. It thus will be considered to be a single phone."

Pre-glide epenthesis is argued by CK to be a cyclic rule since it must both precede and follow Vowel Reduction and Vowel Deletion, which are both clearly motivated as cyclic rules. The ordering of the rule we will be examining within each cycle proposed by CK is given in (291) below:[16]

(291) Cyclic Rules in Klamath (CK;165)
    Initial Vowel Truncation
    Vowel Reduction
    Vowel Deletion
    Pre-glide epenthesis
    n-Deletion
    Glottal Lengthening


The epenthesis rule given in (290) feeds an association rule which spreads the [-cons] matrix to the preceding V-slot:[17]

(292)
$$\begin{array}{cc} & [\text{-cons}] \\ & \diagup\!\!\mid \\ \diagup & \mid \\ \text{V} & \text{C} \end{array}$$
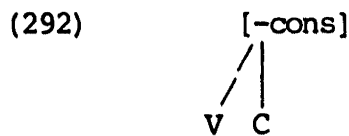
The association rule in (292) clearly must apply before the rule of Vowel shortening given earlier, since it is the only process in the language which feeds the shortening rule.

The result of these two processes, pre-glide epenthesis, and the

-----------

16. Within a model of lexical phonology and morphology, such as the one we will be adopting, Initial vowel truncation and Sonorant cluster epenthesis are both Level 1 rules, where level one consists of a stem and suffixes. Vowel Reduction and Vowel Deletion are both Level 2 rules, where Level 2 involves prefixation. n-deletion and Glottal Lengthening apply at both Level 1 and Level 2(cf. following discussion).

17. On p.135 CK state that this spreading is a result of association conventions. However a language particular rule is needed, since in other environments (i.e. compensatory lengthening after glottal deletion) spreading is from left to right. We have thus taken the liberty of interpreting "convention" as an instance of the language particular rule stated in (292).

association rule in (292), is to provide a distinction on the CV-tier between underlying and derived long vowels in Klamath, as shown below:

(293)   a. Underlying long Vowel        b. Long vowel derived via
                                            Pre-glide Epenthesis
            [^F]                            [BF]
            /\                              /\
            V  V                            V  C


Given such a distinction on the CV-tier, CK no longer need reference to a global shortening rule, rather, they need only restate Kisseberth's original rule as one which shortens the representation in (293.b), but not that in (293.a). The formulation of vowel shortening is repeated below:

(294)   Klamath Vowel Shortening (CK,p.171)
            C ---> 0 / V ___
                      \/
            [  ]        in the following environments:

                    a. $V{:}C_0$___
                    b. CC___CC
                    c. $CC$___$C_0$#


We will attempt to illustrate that within a model of Lexical Phonology and Morphology, such as that proposed by Kiparsky(1981), and further modified by Mohanan(1982) and Halle and Mohanan(1984), the rule of Vowel Shortening, as stated above, can be dispensed with. We will show that, though it appears to apply both before and after two cyclic rules, Pre-glide epenthesis is most accurately viewed as a post-lexical rule. The rule which applies before vowel deletion is not pre-glide epenthesis, but a rule of glide-vocalization. This rule of vocalization follows core syllabification at level 1 and level 2 of the phonology. Furthermore, glide vocaliztion bleeds, in some cases, the post-lexical application of pre-glide epenthesis, allowing us to account for surface distribution of underlying glides as long

or short vowels without a rule of vowel shortening.

Before illustrating the gains of an analysis which does not rely on a rule of vowel-shortening, and thus dispenses with a need for a C/V distinction on the skeletal tier, we briefly discuss several problems inherent in the CK analysis, and show how their rule of vowel shortening is translated into a syllable sensitive rule.

First, the shortening rule in (294) above will not account for the surface short vowels in the following (295.ii) forms repeated from (287) above:

(295)
|      |         |                                |         |
|------|---------|--------------------------------|---------|
| e.   | /taby-/ | 'back, behind, younger, last'  | (D,401) |
| i.   | tapyap  | 'younger sibling of same sex'  | (D,401) |
| ii.  | tatbisap| 'younger siblings of same sex' | (D,401) |
| iii. | tabi꞉   | 'last, finally'                | (D,401) |
|      |         |                                |         |
| g.   | /-aky-/ | 'closing,shutting; on the buttocks' | (D,45) |
| i.   | lakya   | 'closes with a round object, inserts a cork' | (D,204) |
| ii.  | salkica | 'just plugged up a hole w/ oneself' | (D,204) |
| iii. | laki꞉ca | 'just plugged up'              | (D,204) |

In both cases, there is a CV sequence following the shortened vowel, but according to the rule in (294) this is not an environment for shortening. If we include this environment in the rule, it appears that the right context of the rule is free and shortening can be stated as follows:

(296)   Vowel Shortening (revised)
$$C \longrightarrow 0 \ / \ VXC_1 \ V \ \underline{\quad}$$
$$\begin{matrix} \vee \\ [\ \ ] \end{matrix} \qquad \text{(Where X ranges over V,C)}$$

The only exceptions we know of to this statement of vowel shortening are forms involving the suffix /-akw/, a directional particle indicating action

across. These exceptions are listed below:

(297) Exceptions to Revised Vowel Shortening (296)
  a. wdomko:ca      /wdom-akw-ca/     'just swam across'(D,438)
  b. sponko:wapk    /spon-akw-wapk/   'will lead across'(T,66)
  c. sponko:ca      /spon-akw-ca/     'just led across'(T,66)
  d. hamko:wapk     /ham-akw-wapk/    'will call across'(T,68)

The initial vowel of /-akw/ is deleted by a general rule which deletes the
initial vowel of any vowel initial suffix when preceded by a syllable. To
account for this, CK posit the rule of Initial Vowel Truncation in (298.A)
which we rewrite as (298.B):

(298)  Initial Vowel Truncation (CK;142)
  A.    [-cons] ---> 0 / $VC_0$ + [__]$_V$

  B.    $\underline{X}$ ---> 0 / X]$_{N''}$ + __

While the rule in (298.A) specifies that the target of the rule be a short
vowel, the truncation rule in B. need not mention such information as it is
goverened by the Condition on Structure Dependent rules. Short vowels will
be deleted without exception by this rule, though long vowels, as a result of
the CSD, will be unaffected by the rule, since only the first X-slot of a
monosegmental geminate will satisfy the structural description of the rule.
After Initial Vowel Truncation, we are left with an intermediate string like
/hamkwwapk/. After core syllabification (see following discussion) the stray
glide in /ham.kw'.wapk/ undergoes pre-glide epenthesis, and should later
undergo Rule (294) of shortening since it is in the environment VCC__ . For
the moment then, we must mark these forms as exceptions to rule (294), though
elimination of rule (294) altogether will lead to a different account of
their exceptionality.

The shortening rule above appears to be a syllable sensitive rule in that it applies after all heavy syllables, those with long vowels and those with branching rimes. Note also the reference to X, an unspecified skeletal slot in the structural description. Translated entirely into X-notation, we have:

(299)  Vowel Shortening (revised)

$$
X \longrightarrow 0 \Big/ \quad
\begin{array}{c}
N'' \\
| \\
N^n \\
|\backslash \\
X\ X\ X \\
\phantom{X}1
\end{array}
\qquad
\begin{array}{c}
N' \\
|\backslash \\
N\ \backslash \\
|\ \ \backslash \\
X\quad \underline{\phantom{XX}} \\
\backslash\!\!\diagup \\
[\ \ ]
\end{array}
$$
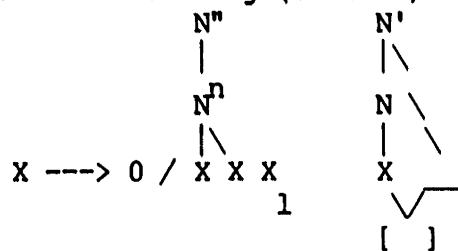
Having remedied a slight empirical inadequacy, which leaves the shortening-based account of glide/vowel alternation intact, we turn to a more serious problem which concerns an apparent circularity in the rule system proposed by CK. Given the global nature of the problem, we start at the beginning.

First, we examine three distinct processes which generate surface long vowels from underlying glides or short vowels. The first rule, pre-glide epenthesis, we have seen already. We rewrite the rule as follows, since in this case, reference to C versus V is immaterial. The crucial factor is that the glide in question is left unsyllabified after the formation of CV(X) syllables:

(300)  Pre-glide Epenthesis

$$
0 \longrightarrow \underline{X} \Big/ \underline{\phantom{XX}}\ \begin{array}{c} X' \\ | \\ [-cons] \end{array}
$$
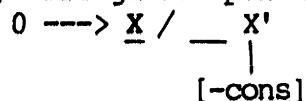
This rule clearly applies in what are traditionally considered non-derived environments. Take, for instance, the derived long vowel in [tabi:] from

/taby-/. A derivation is given below:

(301)  Pre-glide Epenthesis (& subsequent Spreading)

```
t  a b y                    t  a b   y
|  | | |                    |  | |  /|
X  X X X   ------>          X  X X X X
 \ | /                       \ | / |
  \ N/                        \ N/ N
   \N'                         \N'
    N"                          N"
```
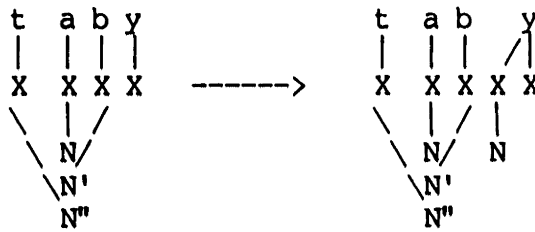
CK suggest that, given that all the rules which appear to violate strict cyclicity in Klamath are just those that refer to syllable structure, the principle of the strict cycle incorporate the following condition:

(302) Addendum to the Strict Cycle Condition (CK;168)
      Syllable structure creates a derived environment
      with respect to all rules that refer crucially
      to it.

We adopt this addendum for the moment, though we abandon in shortly, and proceed to the next rule which generates long surface vowels from underlying glides or short vowels.

Long vowels derived from underlying glides, may be the indirect result of prefixation. The set of prefixes in Klamath is extremely small. A list of these prefixes and the underlying representations we propose for them is

given below, with Barker's notation on the right:

(303) Klamath Prefixes[18]

|  | | Barker | Gloss |
|---|---|---|---|
| A. | X X X- | /re/,/rre/ | Distributive |

```
      s       h
      |       |
B.  X X-,  X X-      /se/,/he/      Reflexive/
                                    Reciprocal
```

```
      h   s
      |   |
C.  X X X-          /hes/          Causative
```

```
      s n
      | |
D.  X X X-          /sne/          Causative
```

When any of the above morphemes is prefixed to a stem, the initial stem vowel, if short, will be deleted in an open syllable. In a closed syllable, a vowel will either be reduced, or a glide-vowel/vowel glide sequence will surface as a derived long vowel.

In (304) we see distributive forms illustrating the phonological effects of

-----------

18. Though these prefixes are verbal in nature, the distributive in Klamath is used on nouns to mark plurality. The difference between the causatives in C. and D. is one of degree and kind of causative action. /sne/ implies more forceful and direct caustation than /hes/. Another prefix /s/, a verbal transitivizer quite limited in its distribution, will not take part in the phonological rules discussed as it does not constitute a syllable.

prefixation.

(304) Phonological Effects of Syllable-Prefixation

| | Stem | Distributive (+suffix) | Stem Gloss |
|---|---|---|---|
| I. a. | ba:w | baba:wsam | 'blueberrie'(D,60) |
| b. | pe:wa | pepe:wa | 'bathe'(D,301) |
| c. | ca:sis | caca:si:k | 'skunk'(D,84) |
| d. | ca:nis | caca:nis | 'not knowing'(D,84) |
| | | | |
| II. e. | conwa | coc^nwa | 'vomits'(D,79) |
| f. | sipca | sis^pca | 'puts out a fire'(D,366) |
| g. | posla | pop^sla | 'hatch an egg'(D,303) |
| h. | cipqa | cic^pqa | 'puts liquid on the face'(D,86) |
| | | | |
| III.i. | paga | papga | 'barks'(D,296) |
| j. | ciq | ciqcqa | 'shake out'(D 76) |
| k. | bok | bopka:k | 'book(Eng.)'(D,65) |
| l. | pom | popma:k | 'beaver'(D,302) |
| | | | |
| IV. m. | gayka | gagi:ka | 'is silly'(D,138) |
| n. | giwga | gago:gatk | 'stuffs'(D,155) |
| o. | heyhey | hehi:heya:k | 'silver fox'(D,165) |
| p. | meya | memi: | 'digs roots'(D,238) |
| | | | |
| V. q. | sdaynka | sdasdi:nka | 'heart'(D,354) |
| r. | pniwpca | pnipno:pca | 'blows out'(D,302) |
| s. | ksiwlga | ksikso:lga | 'dances'(D,193) |
| t. | s?oys?a | s?os?i:s?a | 'is thin,unhealthy'(D,345) |
| | | | |
| VI. u. | cwa?a:k | caco:?a:k | 'little wild potatoes'(D,80) |
| v. | lwelys | lwelo:lis | 'killer,assassin'(D,226) |
| w. | lwota | lwolo:tambli | 'dresses'(D,226) |

The forms in (I) each contain stem-initial long vowels, all of which remain unchanged. In (II), an initial short vowel in a closed syllable is reduced to [^]. In III. initial short vowels in open syllables are deleted altogether. In IV. and V., we see that tautosyllabic vowel-glide sequences surface as what appear to be derived long vowels. Note that these long vowels are clearly not subject to any version of the shortening rule discussed above, as they occur after both light(IV.) and heavy (V.) syllables. Finally in VI. we see that the realization of a tautosyllabic glide-vowel sequence may also result in a surface long vowel.

The rules proposed by CK to account for the processes of reduction, deletion, and vocalization above are given below: [19]

(305) Rules Associated with Prefixation (ordered as shown)
**Cyclic**
A. Vowel Reduction
$$[-cons] ---> \; \char"005E \; / \; V \; C_o \; [\underline{\phantom{x}}]_V$$

B. Vowel Deletion

$$\overset{\displaystyle \char"005E}{\underset{\displaystyle V}{\big|}} ---> 0 \; / \; \underline{\phantom{x}} \; \char"0020 o-$$

C. Pre-Glide Epenthesis ((300) above)

D. Association

$$\begin{array}{cc} V & C \\ \diagdown & | \\ & \\ & [-cons] \end{array}$$

------------------------------------------------------------

**Post-Cyclic**
E. Vowel Shortening ((294/296) above)

F. Pre-glide ^-Deletion

$$\char"005E ---> 0 \; / \; \underline{\phantom{x}} \begin{array}{c} o- \\ \diagup\diagdown \\ V \; \; C \\ | \; \; | \\ \; \; [-cons] \end{array}$$

D. Association

Rules A. and B. together are posited to account for the forms in (304.I,II,III), where long vowels in the stem are unaltered, and short vowels are reduced in closed syllables and deleted altogether in open syllables. The forms in (304.IV,V) are accounted for by the late rule of Pre-glide ^-deletion, which is ordered after vowel shortening, so as not to be subject

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19. Ample evidence for the cyclic application of the reduction, deletion and lengthening rules can be found in Kisseberth(1972,1977), Kean(1974), as well as in CK.

to shortening. Finally, the forms in VI. above are the result of vowel

deletion followed by pre-glide epenthesis. Derivations for forms in II, III,

V, and VI are provided below:[20]

```
(306) II.                              III.
     a. [ XXX + [posl + a]]       b. [ XXX + [pag + a]]
   1st cycle
   Syllab.        p   o   s l  a          p  a g  a
   A.  n.a        |   |   | |  |          |  | |  |
   B.  n.a        C   V   C C  V          C  V C  V
   C.  n.a         \  | / \    |           \ | \  |
   D.  n.a          \ N/    \  N             \ N \ N
                     \N'     \|              \|  \|
                      N"      N"              N"  N"

   2nd cycle
   Syllab.     p  o  p  o  s l  a       p  a  p  a g  a
   A.  x x     |  |  |  |  | |  |       |  |  |  | |  |
   B.    x     C  V  C  V  C C  V       C  V  C  V C  V
   C.  n.a      \ |   \ | / \   |        \ |   \ | \  |
   D.  n.a       \ N   \ N/    \ N        \ N   \ N \ N
                  \|    \N'     \|         \|    \|  \|
                   N"    N"      N"         N"    N"  N"

                          ^                        ^
                                                   0

   Post-cycl·
   E.,F.,D. n a
                [pop^sla]                    [papga]
```



---

20. We abbreviate the process of reduplication as shown. The ticks in the
left-hand column indicate whether or not the rule has applied in each form.

V.                                      VI.
  c. [ XX__X + [pniw + pc + a]]         d. [ XX__X + [cwa + 'a k]]
1st cycle
Syllab.        p n  i  w p c  a              c w  a ?  a  k
A. n.a         | |  |  | | |  |              |  |  |  |\  |
B. n.a         C C  V  C C C  V              C  V C  VV  C
C. n.a           \ |/   \ |                   \  | \  |//
D. n.a            \ N/    \ N                   \ N \ N/
                   \N'      \|                   \|   \N'
                    N"       N"                   N"   N"

2nd cycle
Syllab. p n  i  p n  i  w p c  a           c  a  c w  a ?  a  k
A. x x  | |  |  | |  |  | | |  |            |  |  | |  | |  |\  |
B.   x  C C  V  C C  V  C C C  V            C  V  C C  V C  VV  C
C.   x    \ |    \ |/    \ |                  \  |    \ |  \  |//
D.   x     \ N    \ N/    \ N                  \ N     \ N \ N/
            \|      \N'     \|                  \|      \|   \N'
             N"      N"      N"                  N"      N"   N"
                      ^                                   ^
                                                          0
                                                          V
                                                          o:

E. n.a
F. x               V
D. x               o:
         [pnipno:pca]                          [caco:?a:k]


In the derivation provided by CK, long vowels derived as a result of vowel

deletion, followed by epenthesis, are also seen to feed the vowel shortening

rule:

(307)  Ordering of Vowel Shortening (CK,p.151)
       /swi + swin + y + s/

       1st Cycle: swi [swin + i: + s]   Pre-glide Epenthesis
       2nd Cycle: [swi  sw^n  i:    s]  Vowel Reduction
                   swi  swn   i:    s   Vowel Deletion
                   swi  so:n  i:    s   Pre-glide Epenthesis
                   swi  so n  i     s   Vowel Shortening

To further support their argument that the long vowel in forms like

[pnipno:pca] and [swiso:nis] is the result of a late rule of Pre-glide schwa

deletion, rather than the output of Pre-glide epenthesis, CK show that the

outputs of these two rules are distinct with respect to a rule of

deglottalization and deaspiration, which is shown in (309) and which they

claim applies exclusively to the output of pre-glide epenthesis:

(308) a. ?i:Lo:n^t    /?i + ?i + eLWn + at/    'put objects onto!'(D,128)
      b. qiqo:hka    /qi + qi + Wk + a/       'd. snarl at' (D,320)


(309)  Deglottalization/ Deaspiration (CK;137)
            V  C
             \/
          [-cons] ---> [-spread GL    constr GL]


The voiceless glide in (308.a), which is subject to Pre-glide epenthesis,

undergoes deaspiration and surfaces as a long vowel. The voiceless glide in

(308.b) is preceded by a schwa which is subject to pre-glide deletion. The

output of this rule is a long vowel followed by the [+spread GL] segment

[h]. CK attribute the differences in output to the fact that deaspiration

applies after pre-glide epenthesis and before pre-glide schwa deletion.

This argument however leads us to expect the long vowel in (308.a), derived

via pre-glide epenthesis, to shorten in the appropriate environment.

However, the following form illustrates that, where the structural

description of both the original formulation of Vowel Shortening (294) and

the modified version in (296) are met, the long VC vowel does not shorten:[21]

(310)  kciLLaLLo:n?a < /Kci+r+eLWn+n'+a/  'crawls around and
                                           around on the top'(D,129)


Thus, the example used to illustrate a distinction between the rule of

Pre-glide epenthesis and a later rule of pre-glide schwa deletion is weak in

----------

21. In [?i:lo:n^t], the initial long vowel is the result of glottal deletion
followed by compensatory lengthening, so that it is a VC vowel. In this way,
the second long vowel is not in the environment for the original rule of
shortening since it is preceded by CC, but followed by CV.

that we expect the long VC vowels in (308.a) and (310) to undergo shortening, but they do not. These facts then call into question either the existence of the Vowel Shortening rule, or the distinction drawn between Pre-glide Epenthesis and Pre-Glide Schwa deletion. We review the details of this argument shortly, but first a look at the final rule creating derived long VC vowels.

The last rule we look at is that of glottal stop deletion, which results in compensatory lengthening of a preceding vowel. This rule deletes a glottal stop under N'. Forms illustrating this rule are given below:

(311) Glottal Deletion in Klamath and Compensatory Lengthening
   a. sle?a         /sle? + a/         'sees'(D,373)
   b. sle:ca        /sle? + ca + a/    'goes to see'(D,374)
   c. sle:na        /sle? + na/        'let's see!'(D,374)
   d. hesle:        /hXs + sle?/       'show!'(D,373)
   e. hesle:Wi:ya  /hXs+sle?+Wi:y+a/  'almost showed'(D,374)
   f. slesle:ca     /XXX + sle? + ca/  'd. go to see'

The rule responsible for vowel lengthening in these cases is formulated by CK as follows:

(312)  Glottal Lengthening

$$
\begin{array}{c}
\text{o-} \\
\wedge \\
\text{V} \quad \text{C} \\
\big| \diagup \big| \\
\big| \diagup \big|
\end{array}
$$

? ---> 0 /   [ ] __
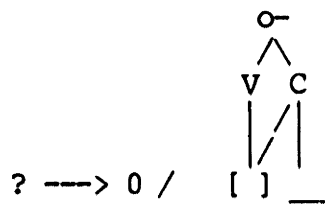
The long vowels derived via the rule of glottal lengthening are not subject to vowel reduction or deletion on the next cycle as illustrated by (311.e) above. This, then, is evidence that the rule of glottal lengthening is itself a cyclic rule.

Notice, however, that such vowels do result in surface VC long vowels, which

should undergo vowel shortening, a post-cyclic rule. However, as we see from the surface forms [hesle:], [slesle:ca] and [hesle:Wi:ya] above, VC long vowels derived via glottal deletion do not shorten, regardless of a preceding VXC sequence.[22] The fact that these are [-high] vowels might suggest that the shortening rule in (294/296) be stated so as only to apply to [+high] segments:[23]

(313)  Vowel Shortening (revised)

$$X \longrightarrow 0 \;/\; \begin{array}{c} N''' \\ | \\ N^n \\ |\backslash \\ X\; X\; X \\ \phantom{X\;X\;}1 \end{array} \qquad \begin{array}{c} N' \\ |\backslash \\ N\; \backslash \\ |\phantom{N}\backslash \\ X\phantom{N}\backslash\underline{\phantom{X}} \\ \phantom{X}\sqrt{\phantom{XX}} \\ \text{[+high]} \end{array}$$
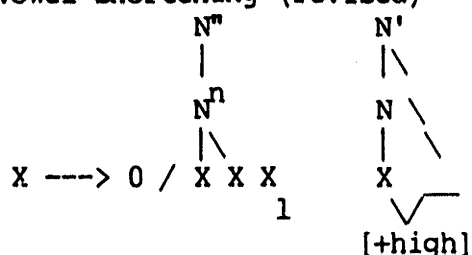
Summarizing the discussion thus far, we have seen that, within the CK analysis, derived VC long vowels in Klamath may be the result of three different processes: Pre-glide epenthesis with subsequent association; glottal deletion with subsequent association; or pre-glide schwa deletion with subsequent association. Of these three rules, only the first creates sequences which undergo the Vowel Shortening rule in (296). Evidence for VC long ([+high]) vowels derived by glottal deletion is unavailable, and as we saw above, long vowels derived by pre-glide epenthesis are clearly not

----------

22. Nor will the earlier rule of Vowel Shortening do here, since [hesle:] would satisfy the third environment: $CC\underline{\phantom{C}}C_o\#$.

23. Unfortunately, there are no examples of [+high] long vowels derived via glottal lengthening in the environment for shortening, so we are unable to judge whether rule (313) is sufficient, or whether such vowels are ever subject to shortening. Our eventual solution, which does not involve a rule of shortening predicts that long vowels derived by glottal deletion will never shorten, regardless of their segmental feature values or their position in the string,

subject to rule (296). If the only evidence for the rule of shortening in (296) is that the rule of Pre-glide epenthesis as stated must be seen to feed it, we are left with an argument which looks circular.

While the rule of vowel shortening posited by CK appears to be empirically motivated, it is not at all clear that this rule is distinct from the rule of pre-glide epenthesis itself. We saw above that one argument for ordering vowel shortening after pre-glide epenthesis but before pre-glide schwa deletion, as evidenced by the output of a rule of deglottalization/devoicing was weakened by the failure of the derived VC long vowel to undergo vowel shortening. For theoretical reasons, there is also reason to doubt that shortening and lengthening via epenthesis are distinct phenomena since the conditions under which pre-glide epenthesis apply will always properly include the environment for vowel shortening. In (314) we restate the two rules in terms of an X-skeleton:

(314) I. Pre-glide Epenthesis    II. Vowel Shortening
         (cyclic)                    (post-cyclic)


$$0 \longrightarrow \underline{X} \; / \; \underline{\quad} \; X' \qquad \underline{X} \longrightarrow 0 \; / \; \underline{X}|X|X\,\underline{X}$$
$$\underset{[+high]}{1\bigvee}$$

According to CK, the rule in I. applies after the formation of "core" syllables, which in Klamath consist in CV(V)C sequences.[24] If this is the case, then sequences preceding the inserted vowel in I. and the long vowel in

----------

24. Actually, the authors do not discuss syllabification of long vowels. Their classification of Klamath as a class III language with core syllables CV,CVC lead us to believe that CVVC is also a core syllable. See following discussion for relevance of a distinction between branching N and branching N' in Klamath.

II. will look as follows at the time of rule application:

(315)   I.   Pre-glide epenthesis          II. Vowel Shortening
             X̲ (X̲) X                            X̲ |X| X
                  1                                    1

Recall that pre-glide epenthesis is claimed to be a cyclic rule, while vowel shortening is post-cyclic. The question which arises then is the following: given that vowel shortening is always fed by pre-glide epenthesis, and given that the structural description for vowel shortening properly includes the structural description of pre-glide epenthesis, is there a way of limiting pre-glide epenthesis so that it does not apply in environments where it would then feed vowel shortening. If we are able to alter pre-glide epenthesis in this way, the rule of shortening can be eliminated altogether. We proceed now to show the theory of lexical phonology and morphology allows us to do just this.

### 3.1.4.3 A Reanalysis of Glide-Vowel Alternations without Vowel Shortening

We propose in this section a solution to the problem of glide vowel alternations in Klamath within a theory of lexical phonology and morphology, such as that developped in Kiparsky(1982,1983,1984), Mohanan(1982), and Halle and Mohanan(1984). One fundamental idea,common to all of these proposals, is that the lexicon has a highly restricted internal structure, consisting of a number of lexical levels or strata. Each stratum is defined by a set of morphological processes and a set of phonological rules. In this model, the morphological and phonological processes are in a mutual feeding relation, accounting for the cyclic nature of lexical rules. Lexical rules are

distinct from post-lexical rules which, given access to elements outside of the lexicon, are non-cyclic. Below we see the model of the lexicon proposed:

(316)  Lexical Phonology and Morphology

```
| underived lexical items |
 --------------------------
              |
              |                              PHONOLOGY
              |
   | LEVEL 1         |  -------------->    --------------------
   | morphology      |  <-------------    | Rule A            |
    ------------------                    | LEVEL w,x         |
              .                           |                   |
              .                           |                   |
              .                           |                   |
   | LEVEL n         |  -------------->   | Rule B,           |
   | morphology      |  <-------------    | LEVEL y,...       |
    ------------------                    |                   |
                                          |                   |
   ------------------------------------   |                   |
   | LEVEL n +1      |  -------------->   |                   |
   | SYNTAX          |                    | Rule C,           |
    ------------------                    | LEVEL z...        |
   |                                       -------------------
    ------------------------------------
```
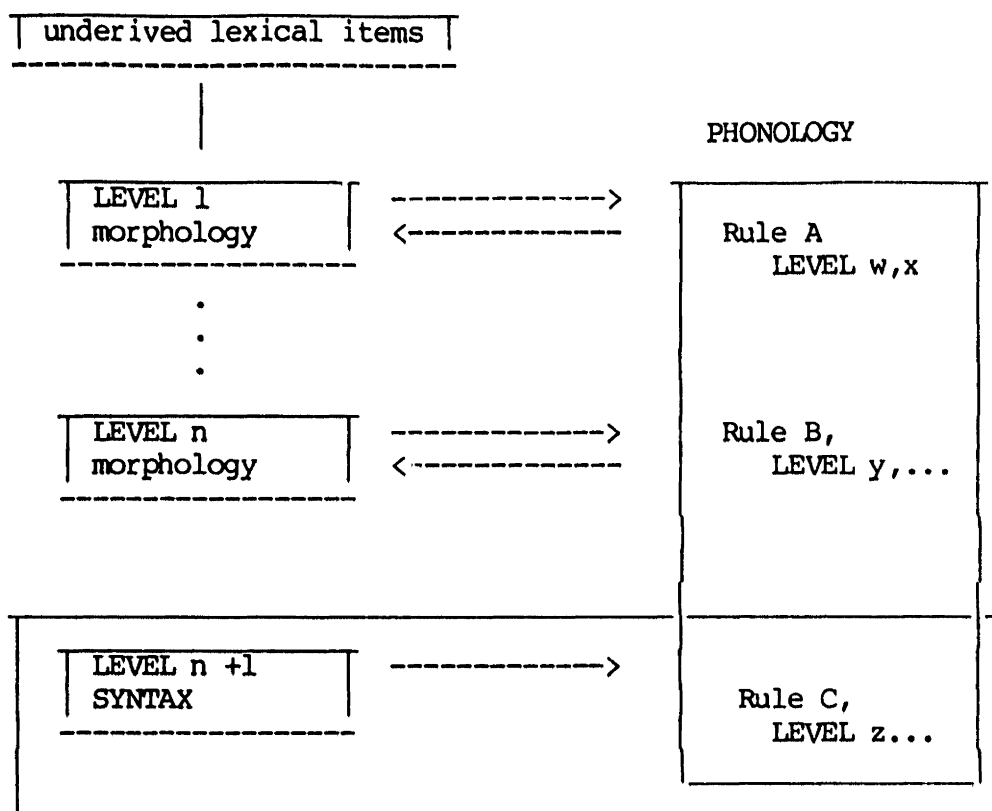
As a first step in attempting to analyze glide/vowel alternations in Klamath without a rule of vowel shortening, we examine syllabification at level 1, where this level includes a stem and all following suffixes.[25] Level 2 is defined by the prefixes which trigger vowel reduction and subsequent deletion. The structure of the Klamath lexicon, then, looks as follows, where details of the phonological component are the focus of

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25. As we saw earlier there is ample evidence, i.e. the rule of initial vowel truncation, that each suffix defines a new cycle. Furthermore, it appears to be the case that the first level of cyclic rule application is that of the stem plus a single suffix. Other level 1 cyclic rules include pre-sonorant epenthesis, and glottal deletion.

discussion:

(317)  The Klamath Lexicon

```
| underived lexical items |
 --------------------------
            |
            |                                      PHONOLOGY

     | LEVEL 1           |   ------------->    | Syllabification, |
     | Suffixation       |   <-------------    | Vowel Truncation,|
      -------------------                      | ? Deletion,...   |



     | LEVEL 2           |   ------------->    | Syllabification, |
     | Prefixation       |   <-------------    | Vowel Reduction, |
      --- ------------- ----                   | Vowel Deletion,  |
                                               | ?-Deletion,...   |

 ------------------------------------------    | Pre-Glide        |
 | LEVEL n +1        |   ------------->        |    Epenthesis,   |
 | SYNTAX            |                         | Deglott./Deasp., |
  -------------------                          | a-Reduction,...  |
 --------------------------------------------
```

Syllabification at level one is motivated by the rules of sonorant cluster
epenthesis and glottal-deletion among others.[26] Recall the
syllable-sensitive rule of glottal deletion, which delinks a glottal stop
immediately dominated by N':

(318)  Glottal Deletion

```
                [+constr. GL]
      ↄ             -|-
                   X   X
                   |  /
                   N /
                   |/
                   N'
```

----------

26. See CK and Levin(1984) for discussion of sonorant cluster epenthesis.

The form [hesle:Wi:ya] (< [hes+[sle?+Wi:y+a]]) illustrates that glottal deletion and subsequent compensatory lengthening apply at level 1, bleeding the level 2 rule of vowel reduction. The rule of glottal deletion then, is evidence that at least N-Placement, and projection must apply at level one before glottal lengthening.

As we saw in Chapter 2, Klamath instantiates an N'-Projection with iterative incorporation into N', and initial and final adjunction to N". The only complex nuclei which exist in Klamath are monosegmental geminates. As proposed earlier, by treating these as a result of N-Placement in accordance with the Condition on Structure Dependent Rules, we do away with any language particular rule of Complex N-formation. From the rule in (318), it appears that at least N-Placement, Project N", and Project N' are operative at level 1, and turn now to evidence which suggests that syllabfication is in fact limited to these rules.

As we saw earlier, what Barker notates as underlying glides surface sometimes as glides, sometimes as short vowels, and other times as long vowels. When immediately preceded or followed by a vowel, whether the vowel is long or short, underlying glides surface, without exception, as glides. We account for this by the rule of N-Placement in (319), which incorporates N"-Projection, and is followed by Project-N':

(319) Klamath N-Placement-1

```
        [-cons,-hi]
             |
    X'  X  ---> X   X      where X₁ = [-cons,-hi]
    1   2        \  |
                  \ N
                   \|
                   N"
```

where $X_1 = $ [-cons,-hi]
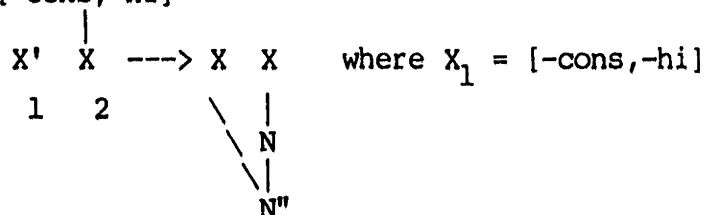
The following derivations illustrate syllabification of pre- and post-nuclear underlying glides:

(320)  a. Project N"            b. Project N'
          /smoqy + a/ (258.d)      /lmen̲ + y + s/ (259.i.a)
          s m  o q y  a            l̄ m  e y  s
          | |  | | |  |            | |  | | |
          X X  X X X  X            X X  X X X
           \ | / \    |             \ | /
            \ N/  \ N                \ N/
             \N'   \|                 \N'
              N"    N"                 N"
Surface:      [smoqya]                [lmeys]

Complex nuclei, as well, project at the N' level, yielding surface glides:

(321)  /cka:W   + dgi        / (D,77)
       'be cold  'turn,become'
          c k  a W d g  i
          | |  |\ | | |  |
          X X  XX X X X  X
           \   |// \     |
            \  N/   \ N
             \N'     \|
              N"      N"
Surface:      [cka:Wtgi]

After N-Placement, and projection of N",N', at level 1, underlying glides which have not been affected by these rules may find themselves in one of three positions: immediately preceded by X', immediately preceded by a branching N' with a simple nucleus, or immediately preceded by a branching N' with a branching nucleus:

(322)     Underlying Glides After N-Placement and Projection
     i.    [-cons,+high]   ii. [-cons,+high]     iii.  [-cons,+high]
              |                  |                        |
           X'  X'             [X̲]X]]  X'              [X̲X̲]X]]  X'
                                 N'                       N'
Surface:      V                  V:                       V

Interestingly though one might expect (322.ii) and iii. above to pair

together with respect to further rules as they both include a stray glide
preceded by N", such is not the case. Rather, those stray glides in the
configurations shown in i. and iii. above surface as short vowels, while
the stray glide in (322.ii) may surface as long or short depending on whether
or not it the form enters level 2 morphology. If it does not enter Level 2,
the stray glide remains stray, and is subject to a rule of pre-glide
epenthesis, a version of which we examined earlier, eventually surfacing as a
long vowel. In (323) we see the realization of underlying glides as short
vowels or long vowels, with respect to the representations above:

(323) i.  X'X'
           hosltis      'feeling'             /hoslt + y + s/ (D,171)
           kaystis      'door'                /kayst + y + s/ (D,199)
           niqLipga     'has a hand inside'   /nig + Ly + bg +a/ (D,284)

     ii.  X]X] X'
           hoqi:s       'breath, life'        /hoq + y + s/  (D,171)
           leci:s       'the weaving'         /lec + y + s/  (D,214)
           ?iLi:tk      'pl. objs. inside;    /?i + Ly + dk / (D,283)
                         id. prisoners'
    iii.  XX]X] X'
           ce:lis       'porcupine'           /ce:l + y + s/  (D,74)
           ci:kis       'dwelling'            /ci:k + y + s/   (D,77)
           ?ino:Libli   'lets s.o back        /?ino: + oLy + bli/ (G,74)
                         inside'

We have been assuming throughout that, after the initial rule of N-placement,
projection of N" and N' is uniform, resulting in just those strings given in
(322). However, the fact that (322.i) and (322.iii) both result in surface
short vowels, whereas (322.ii) feeds a rule of epenthesis, suggests that this
is not the case.

Suppose that after N-placement, core syllabification in Klamath consists of
generating a branching head for N". This would result in projection of N' in
the case of simplex nuclei. However, for complex nuclei, which themselves

constitute branching heads, project-N' would not constitute part of core syllabification. We illustrate the proposed schema below:

(324) Core Syllabification in Klamath
    A.  N-Placement (319) (subject to CSD)
    B.  Where head of N" is non-branching, Project-N'
        (i.e. generate branching head of N")

This version of core syllabification reduces the ternary distinction in (322) to the binary one shown below:

(325)    Underlying Glides After Core Syllabification
    i.    [-cons,+high]  ii. [-cons,+high]
           |                    |
       X'  X'        [X]X]]  X'
                            N'
Surface:      V             V:

Based on this binary distinction, we propose the phonological rule of Glide Vocalization in (326), which itself will feed projection. This rule will vocalize a stray glide if and only if that glide is preceded by an unsyllabified X-slot:

(326)  Glide Vocalization (right to left) (GV)
        [-cons,+high]      [-cons,+high]
            |                |
      X'  X' ---->    X   X
                      \  |
                       \ N
                        \|
                       N"

This rule accounts for the realization of glides in the environment of (322.i) after core syllabification as short vowels. Along with glide vocalization, we propose the statement of pre-glide epenthesis shown in (327):

(327) Pre-glide epenthesis (PGE)
            [-cons,+hi]
               |
    0 ---> X / __ X'

This rule clearly follows GV. The rule of pre-glide epenthesis is followed by the association rule in (328) which in turn feeds the Condition on Structure Dependent Rules, having as its output a single branching nucleus.

(328)    Association Rule 1

```
                    [-cons,+high]
                        /|
                       / |
                      X  X
                      |
                      N
```
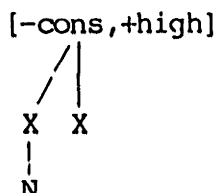
We illustrate the interaction of core syllabification and the three rules above in the following derivations:[27]

(329) Core Syllabification , Glide Vocalization, Epenthesis

```
     a. n i g L y b g a    b. ? i L y d k    c. ? i n o L y b l i
        | | | | | | | |       | | | | | |       | | | |\ | | | |
        X XX X X X X  X       X XX X X X        X X X XX X X X X  X
         \ |/      \ |         \ |/              \ | \ |/      \ |
          \N/       \N          \N/               \N \N        \N
          \N'       \|          \N'               \|  \|        \|
           N"        N"          N"                N"  N"        N"
```

Core
Syllabification

---

```
GV            L y                n.a              L y
              | |                                 | |
              X X                                 X X
               \ |                                 \ |
                \ N                                 \ N
                 \|                                  \|
                  N"                                  N"
```

```
PGE                              y
           n.a                  /|
                               X X
                               |
Assoc.1                        |
Other Rules                    N
Surface   [niqLipga]     [?iLi:tk]          [?ino:Libli]
```

---

---

27. Note that the [+high,-cons] segments notated by Barker as underlying vowels can be viewed here as instances of GV, or as instances of lexical N-Placement. For the moment we assume lexical N-Placement for ease of exposistion.

Core syllabification as stated in (324) along with the phonological rule of N-placement and Pre-glide Epenthesis, will account for the surface distribution of short versus long vowels in all non-prefixal forms.

We showed earlier that core syllabification was a level 1 process, since it fed cylcic rules like glottal deletion at this level. We also have evidence that Glide-Vocalization is a level 1 rule. Take, for instance, a stem like /sipc-/ 'extinguish, put out a fire' which Barker notates as having an underlying vowel. In arguing against a distinctive feature [+syllabic] we account for the consistant realization of the [+high] segment in /sipc-/ as a syllable head either by the rule of Glide vocalization, or by treating it as an instance of lexical N-Placement. We proposed the MPC earlier, a restriction on N-Placement to morpheme peripheral position, so that the stem /sipc-/ must be viewed as underlying /sypc-/ subject to GV. That GV must apply at level 1 is evident from the fact that the first morphological process at level 2, prefixation of a reduplicate affix, will result in **sisipca** (- -> [sis^pca] by vowel reduction). The melody linked or transferred to the reduplicate prefix XX<u>X</u>- is <u>si</u>, not <u>sy</u>, leading us to believe that glide vocalization applies at level 1.

Assessing the status of Pre-glide epenthesis, we have seen that it applies after core syllabification and after Glide vocalization. In ordering PGE within a model of lexical phonology, we follow a proposal of Halle and Mohanan(1984), where rules are seen to apply as late in the derivation as possible. Given no evidence for cyclic application of Pre-glide epenthesis at level 1, we assume it is a post-cyclic rule.

-

Note that so far, our analysis contrasts with the analysis provided by Clements and Keyser, where pre-glide epenthesis is argued to be a cyclic rule which as we saw earlier, feeds vowel shortening. Recall the derivation posited by CK:

```
(330)          [swi [+swin + y + s] ]      Underlying Representation
 1st Cycle:          swin + i: + s          Pre-glide epenthesis
 2nd Cycle:     swi  sw^n   i:  s           Vowel Reduction
                swi  swn    i:  s           Vowel Deletion
                swi  so:n   i:  s           Pre-glide epenthesis
                swi  so:n   i   s           Vowel Shortening
```

A curious fact however, is that, there is no evidence requiring that pre-glide epenthesis apply cyclically. In the derivation above, the application of pre-glide epenthesis at level 2 feeds no phonological rules, and could be assumed to be post-lexical. In fact, aside from the post-lexical rule of vowel shortening, whose very existence is in question, the only rules which must follow this rule of epenthesis and subsequent association are the rules of deglottalization/devoicing and the rule of stress assignment, both which are clearly post-lexical.[28] A possible alternative, then, to positing PGE at level one in order to feed Vowel deletion at level 2, would be to posit GV at level 2 as well, doing away with the Vowel shortening rule. We turn now to an assessment of the feasibility of this proposal.

Given the model of core syllabification proposed above for Level 1, we examine the minimal syllabification required at level 2. Syllabification at

_____

28. The stress rule in Klamath is sensitive to long vowels regardless of whether their length is derived or underlying. See Chapter 4 for details of stress assignment in Klamath.

Level 2 is necessary given the cyclic rule of Vowel Deletion which follows Vowel Reduction. Recall that vowel reduction is responsible for the reduced stem-initial vowel in prefixed forms like [pop^sla] 'd. hatch an egg', from /posl-/. Under the CK analysis, the reduced vowel is deleted in open syllables resulting in forms like [papga] 'd. barks' from /pag-/. Rather than assume a rule of vowel reduction, we assume that level 2 prefixation feeds a phonological rule which delinks the feature matrix associated to the head of the following syllable. This rule results in a syllable head which does not project to the segmental tier.

(331)  Vowel Delinking (Level 2)

$$\begin{array}{c} [\ldots] \\ -\!\mid\!- \\ \mid \\ \sigma\!-\; +\quad [\ldots\; \underline{X}\ldots] \\ N'' \end{array}$$
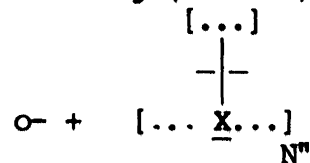
The delinking rule above, a cyclic rule, requires access to information on the syllable plane, illustrating that syllabification precedes this rule at Level 2.

If the empty skeletal slot which results from Vowel Delinking is in an open syllable, then it is subject to a later deletion rule which we examine momentarily. However, if it is not deleted or filled in by other language particular rules like that of [+high]-spread, it will be spelled out as the unmarked vowel in Klamath, a [-high,+back] segment, which in closed syllables is realized as schwa. This is in accordance with the theory of underspecification of Archangeli(1984), where epenthetic vowels are seen to be the result of redundancy rules. The underlying representation of [-consonantal] segments in Klamath along with the universal rules and

complement rules consistant with Archangeli(1984) are given in

(332) A. UR of Klamath Vowels in UT

```
-------------------------------------
|         i/y      e      a      u/w |
-------------------------------------
Back       -       -                 |
High       +                     +   |
-------------------------------------
```

Prediction: /a/ is
/a/ is the epenthetic

B. Universal Rules (Archangeli,1984)
   a. [  ] ---> L / [+Hi,__]
   b. [  ] ---> +L / [-Hi,__]
   c. [  ] ---> -R,+B / [+L,__]
   d. [-L,^B] <---> [-L,^R]

C. Complement rules (given A.)
   e. [  ] ---> [+B]
   f. [  ] ---> [-H]

D. Learned rule
   g. [-B, -H] ---> [-L]

As is clear from forms like **papga**, the empty skeltal slots resulting from rule (331) are subject to a deletion rule in open syllables, the form of which, as we noted above, also necessitates syllabification at level 2. The rule of X-Deletion is given below:

(333)  X-Deletion (Level 2)

$$X \longrightarrow 0 \;/\; \sigma\text{-} + [...[\underline{\phantom{x}}]]$$
$$N''$$

Instead of the rule of pre-glide schwa deletion posited by CK, forms like **sdasdi:nka** from **sdaynka** 'heart' are seen to be the result of the rule of

--------

29. Thanks to D. Archangeli for lengthy discussion of this system and its consequences.

association given in (328) and repeated below:

(334)  Association Rule 1 (328)
                [-cons,+high]
                   /|
                  / |
                  X  X
                  ‾
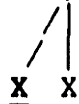
The derivation of [sdasdi:nka] is illustrated below:

(335)          [ sda + [sdaynk + a] ]

```
Level 1            s d  a y n k   a
Core Syll.         | |  | | | |   |
                   X X  X X X X   X
                    \ |/  \    \  |
                     \N/    \    \ N
                     \N'     \    \|
                      N"          N"
```

```
Level 2          s d  a  s d  a y n k   a
Core Syll.       | |  |  | |  | | | |   |
Delink.(331)     X X  X  X X  X X X X   X
                  \ |/  \ |/   \    \  |
                   \N/    \N/    \    \ N
                   \N'    \N'     \    \|
                    N"      N"         N"
```

Post Lexical    s d  a s  d  y n k a
[+high]-spread  | |  | |  |  /| | | |
                X X  X X  X X X X X X
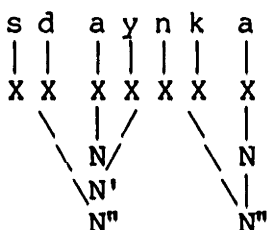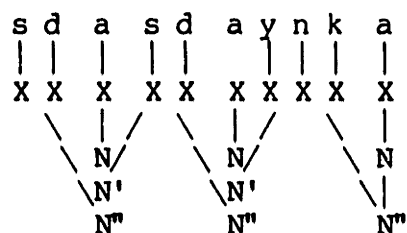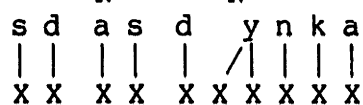
Surface:        [sd^sdi:nka]

To account for the fact that underlying glides surface as short vowels only in the environment determined by the rule of Vowel Shortening which we are trying to eliminate, we suggest that at level 2, Vowel delinking results in desyllabification, and precedes the rule of Glide vocalization. The desyllabification rule we have in mind is formalized below:

(336)  Desyllabification
```
          X  X  X    --->   X  X  X'
           \ | /             \ |
            \N/               \N
            \N'               \|
             N"                N"
```

The rule of desyllabification produces a stray segment which feeds glide vocalization. A derivation is provided below:

```
(337)    [XXX + [dewy] ]
Level 1                        d  e  w y
Core Syll.                     |  |  | |
GV (n.a.)                      X  X  X X
                                \  | /
                                 \ N/
                                  \N'
                                   N"

Level 2
Prefix.      d  e   d  e w y      d  e d   w y      d   d   w  y
Core Syll.   |  |   |  | | |      |  | |   | |      |   |   |  |
V-delink.    X  X   X  X X X ---> X  X X   X X X --> X   X X  X X   X
Desyll.       \  |   \  | /        \  | \   |         \   | \  | \   |
GV             \ N    \ N/          \ N  \ N           \ N  \ N  \ N
                \|     \N'           \|   \|            \|   \|   \|
                 N"     N"            N"    N"            N"   N"   N"
```
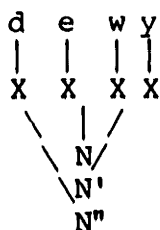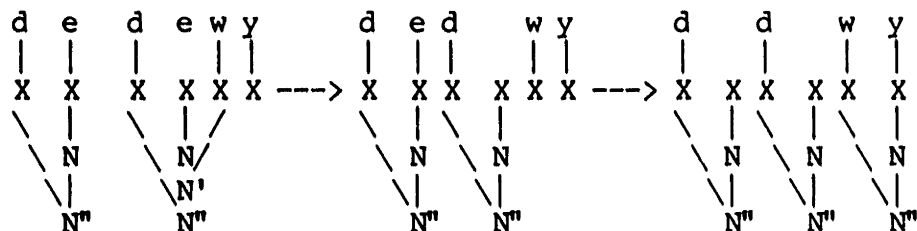
The output of GV is then subject to Vowel Deletion(333), and we arrive at the surface form [dedwi]. We see then that allowing Desyllabification to feed Glide vocalization leads to generation of short vowels precisely where a rule of Vowel Shortening would be applicable. By positing Desyllabification and Glide Vocalization at level 2, we account for the fact that stray glides in the output of level 1 are never lengthened by the post-cyclic rule of pre-glide epenthesis. These glides are vocalized as short vowels as shown above. The rule of Glide Vocalization then bleeds the post-lexical rule of pre-glide epenthesis for just those glides left stray at the output of level 1. The rule of Vowel delinking will also create stay glides at level 2. These segments will feed the post-lexical rule of pre-glide epenthesis, since they are never in the environment for GV.

Treating pre-glide epenthesis as a post-lexical rule which is bled at level 2 by the rule of Glide Vocalization, we predict that pre-glide epenthesis in prefixal forms will only apply to stray glides derived within that level.

Stray glides resulting from level 1 phonology will have been syllabified at level 2 via Glide vocalization, and will not therefore be subject to lengthening at any future point in the derivation.

We illustrate the application of Glide Vocalization and post-lexical Pre-glide epenthesis for the form [swiso:nis]:

(338)                 [swi [+swin + y + s] ]
LEVEL 1
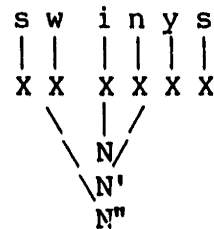
```
                      s w   i n y s
Core Syll.            | |   | | | |
                      X X   X X X X
                          \ | /
                           \ N/
                            \N'
                             N"
```

```
LEVEL 2:      s w   i s   w n       y s
Core Syll.    | |   | |   |   |     | |
V-delink.     X X   X X   X   X X   X X
Desyllab.       \ | /   \   |
                 \ N/    \   N
                  \N'     \N'
                   N"       N"
```

```
              s w   i s   w   n   y s
GV            | |   | |   |   |   | |
Vowel Del.    X X   X X   X   X   X X
                \ | /       \   |
                 \ N/        \   N
                  \N'         \  |
                   N"          N"
```

```
POST-LEX.     s w   i s     w   n   y s
  Pre-Glide   | |   | |    / |   |   | |
  Epenthesis  X X   X X   X X   X   X X
  Assoc.-1      \ | /\   |/       \ | /
                 \ N/  \ N         \ N/
                  \N'   \ |         \N'
                   N"     N"          N"
```
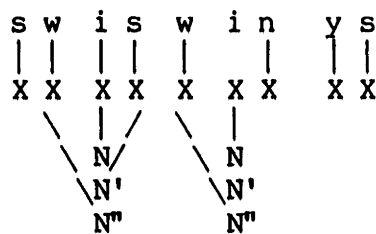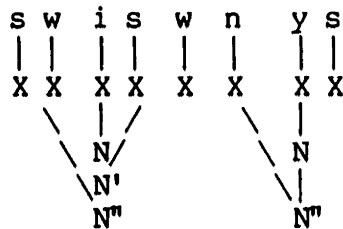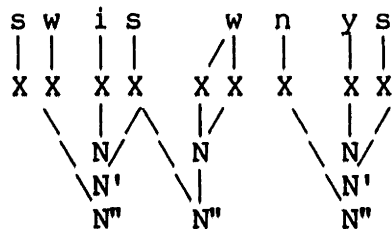
In terms of rules of syllabification, we have the following level-ordered

rules:

(339)  Lexical Phonology of Klamath
    LEVEL 1            Stem + Suffixes
                      Core-syllabification (324)
                      Glide Vocalization (326)
          Cyclic Rules:
                      Glottal Deletion...

    LEVEL 2            Prefixes + [Stem + Suffixes]
                      Core-syllabification (324)
        Cyclic rules:
                      Vowel Delinking (331)
                      Desyllabification (336)
                      Glide Vocalization (326)
                      Vowel Deletion (333) ...

    POST-LEXICAL
                      Pre-glide epenthesis (327)
                      Projection
                        Assoc.-1 (328)
                      Incorporation, Adjunction
                      Deglottalization/Deaspiration...

This account, which does not necessitate a rule of Vowel Shortening, accounts for vocalization of glides as short vowels by a single rule of Glide Vocalization, needed independently in an X-skeleton model to account for Vocalization in stems like /sypc-/ (Barker's /sipc-/). Derived long vowels may be the result of the post-lexical rule of Pre-glide epenthesis ([hoqi:s]), the rule of Association which follows vowel delinking ([sdasdi:nka]), or of compensatory lengthening following glottal deletion ([sle:ca]). The fact that such vowels do not shorten is no longer a mystery, since there is no rule of vowel shortening.

Furthermore, recall some of the exceptions to CK's original rule of shortening: **tatbisap** (< [XX + [taby + s + ab]]) and **salkica** (< [ sX + [1X + aky + ca]]). We predict short vowels in these forms, since they are subject to Glide Vocalization at level 2, following Vowel delinking and

Desyllabification.


## 3.1.4.4 Exceptional Forms


Needless to say, the solution we propose has several apparent exceptions, which we now turn to. The first, and perhaps most serious, exception to the above proposal concerns morpheme-internal stray glides as in the stem /delwg-/ 'attack, pounce on'. In (340) we see that this stray glide surfaces sometimes as a long vowel, and sometimes as a glide, but never as a short vowel:[30]

```
(340)  /delwg-/   'attack, pounce on' (D,112)
       a. delo:ga                [delwg + a]          'attacks'
       b. dedlo:ga ~ dedalo:ga   [XX + [delwg + a]]   'd. attack'
       c. sedlo:ga ~ sedalo:ga   [sX̄ + [delwg + a]]   'refl. attack'
       d. delwak                 [dēlwg]              'attack!'
       e. delwaks                [delwks]             'the attack'
```

The forms in (340.a,d,e) are unexceptional. In (340.a) core syllabification at level 1 yeilds a stray glide which enters the post-lexical phonology and feeds Pre-glide epenthesis. The forms in d.,e. illustrate a level 1 morphologically conditioned rule of epenthesis which applies in the environment V[+son]w__{s,ks}(cf G,74). In this case, epenthesis bleeds the post-lexical application of pre-glide epenthesis. The alternate forms in b.,c., however provide food for thought.[31] The rules above predict

- --------

30. The only other morpheme internal stray glide we have found which has the same behaviour of that in /delwg-/ is the initial glide in /-(o)ygi/ 'up, above, over'(D,290).

31. It is unclear whether both forms are possible for a single speaker. Barker only says that he has recorded both forms. Note that the forms dedalo:ga and sedalo:ga are problematic for any account of reduplication, since the initial stem vowel should not only reduce but also delete in an

*[dedloga] as the output of Vowel Delinking, and Desyllabification followed by Glide Vocalization:

(341)  LEVEL 1
       Core Syllab.

```
                        d   e   l   w   g   a
                        |   |   |   |   |   |
                        X   X   X   X   X   X
                         \  |  /   \     |
                          \ N /     \    N
                           \N'       \  |
                           N"         N"
```

       LEVEL 2
       Core Syllab.

```
       d   e   d   e   l   w   g   a             d   e   d   e   l   w   g   a
       |   |   |   |   |   |   |   | Delink.     |   |   |   |   |   |   |   |
       X   X   X   X   X   X   X   X   ---->     X   X   X   X   X   X   X   X
        \  |    \  |  /   \     |                 \  |    \  |  /   \     |
         \ N     \ N /     \    N                  \ N     \ N /     \    N
          \|      \N'       \  |                    \|      \N'       \  |
          N"      N"         N"                     N"      N"         N"
```

       Desyllab.
       --->

```
       d   e   d   e   l   w   g   a             d   e   d   e   l   w   g   a
       |   |   |      |   |   |   | GV           |   |   |      |   |   |   |
       X   X   X   X  X   X   X   X  --->        X   X   X   X  X   X   X   X
        \  |    \  |      \     |                 \  |    \  |    \     \
         \ N     \ N       \    N                  \ N     \ N    \ N   \ N
          \|      \N'       \  |                    \|      \N'    \|    \|
          N"      N"         N"                     N"      N"     N"    N"
```

       V-Del.
       --->

```
       d   e   d  e  l   w   g   a
       |   |   |     |   |   |   |
       X   X   X   X X   X   X   X   ---> *[dedloga]
        \  |  /   \     |   \     |
         \ N /     \    N    \    N
          \|/       \  |      \  |
          N"         N"        N"
```
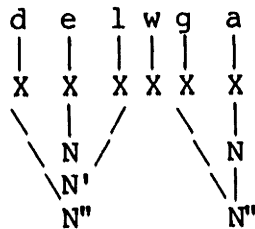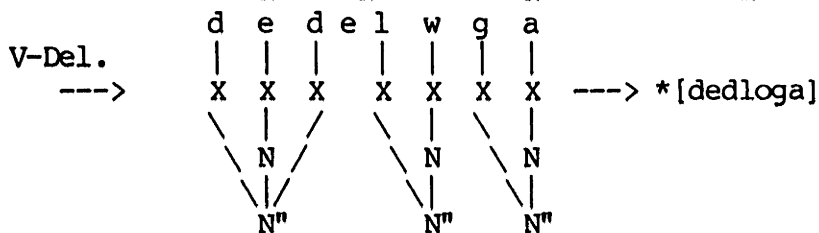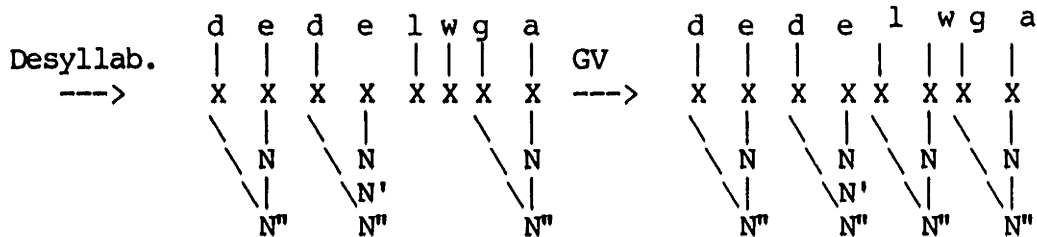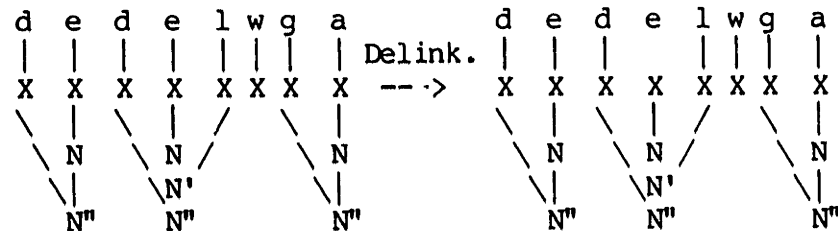
The fact that a long vowel surfaces appears to be intimately related to the fact that an alternate form [dedalo:ga] is found. The occurence of an [a] in this form is evidence that the initial syllable of the stem is closed throughout the derivation, thus not subject to the rule of Vowel Deletion. Could the element responsible for closing the stem initial syllable also give rise to a long vowel in prefixal forms?

----------
open syllable.

We suggest that the underlying representation of the stem /delwg-/ is as shown below:

(342)    d e l   w g
         | | |   | |
         X X X X X X

At the output of level 1, we will have one of the two representations shown below, depending on whether or not the morphologically conditioned rule of epenthesis has applied:

(343)  Output of level 1 Syllabification for /delXwg-/
```
    a.  d  e  l     w g  a        b.  d  e  l     w    k
        |  |  |     | |  |            |  |  |     |    |
        X  X  X X   X X  X            X  X  X   X X   X X
         \ | / \ | \ |                 \ | /    \ | /
          \ N / \ N \ N                  \ N /    \ N/
           \N'   \|   \|                  \N'      \N'
            N"    N"   N"                  N"        N"
```
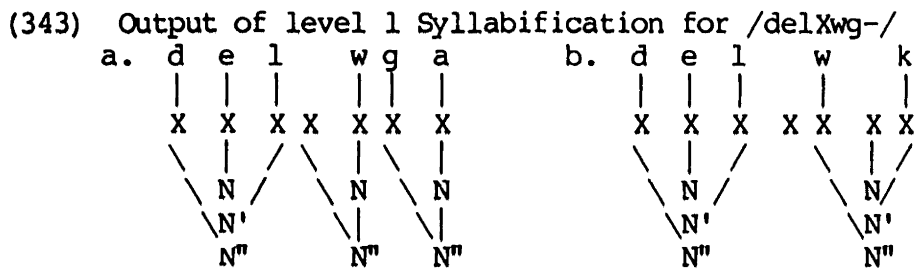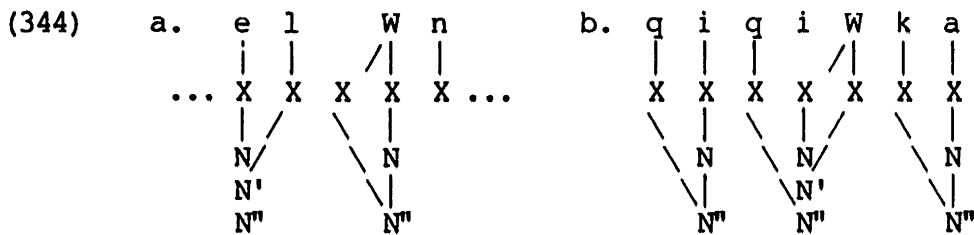
Post-lexically, the empty X-slot in (343.a) is filled by the Association rule and a long vowel results. Prefixation to a form like that in a. above will have two different outputs depending on whether or not Association and subsequent resyllabification precede or follow Vowel-delinking and Desyllabification. If [w] spreads before Desyllabification, and is reinterpreted as a complex nucleus, this N will project onto the stray segment preceding it, leaving the initial syllable subject to X-Deletion. If, on the other hand, the spreading of the [+high] matrix does not occur at level 2, the initial stem syllable after Delinking will remain closed dXl., the X-slot will be realized as the default vowel [a], and post-lexically, the long derived vowel will give rise to resyllabification of [l], yeilding de.da.lo:.ga.

Another apparent exception to the rule system in (339) was also seen as an

exception to the revised shortening rule: ?i:Lo:n^t (< [XX [?i+ elWn +

at]]). This form was argued by CK to be a result of pre-glide epenthesis

which fed the rule of Deglottalization/Deaspiration(309), as distinct from

pre-glide schwa deletion which gave rise to **qiqo:hka** (<[XX+[qi+Wk+a]]), where

Deaspiration does not apply. As should be apparent, /-elWn-/ is exhibiting

the same sort of exceptionality as /delwg-/: a long vowel appears where we

expect a short one. First, we can account for the surface long vowel in

?i:Lo:n^t by positing the underlying form /-elXWn-/, which will feed the

Association rule and eventually result in a long vowel. The fact that this

underlying glide undergoes deaspiration, while the one in **qiqo:hka** does not,

appears to be a result of the intermediate representations shown below:

(344)      a.   e  l    W  n        b.   q  i  q  i  W  k  a
                |  |   /|  |             |  |  |  /|  |  |
           ...  X  X  X  X  X ...        X  X  X  X  X  X  X
                | /  \  |                 \  | \ | /   \ |
                N/    \ N                  \ N  \ N/    \ N
                N'     \|                   \|   \N'     \|
                N"      N"                   N"   N"      N"

A voiceless glide dominated exclusively by N' surfaces as V:h, whereas one

dominated by N" (or later N^O) surfaces as V:.[32]

We turn now the final class of exceptions to the rule schema in (339).

These are the forms with /-akw-/, the directional particle, noted earlier.

In these cases, where we expect a short vowel to surface as a result of

―――――――― .

32. The surface V:h could be related to a general rule of degemination in
Klamath which turns geminate Voiceless or glottal sonorants into sonorant-?
or sonorant-h sequences: **pa:lha** from /pa:lLa/ 'dries on'; **yalyal?i** from
/yalyall'i/ 'clear', however this would require an additional application of
pre-glide epenthesis for /WW/ --->/wh/ ---> X̲wh ---> [o:h].

glide-vocalization at level 1, we find a surface long vowel instead:

(345) Exceptions to Revised Vowel Shortening(314)
    a. wdomko:ca     /wdom-akw-ca/    'just swam across'(D,438)
    b. sponko:wapk   /spon-akw-wapk/  'will lead across'(T,66)
    c. sponko:ca     /spon-akw-ca/    'just led across'(T,66)
    d. hamko:wapk    /ham-akw-wapk/   'will call across'(T,68)

    e. nqenkopga     /nqen-akw-bga/   'is shouting across'(D,269)
    f. stonko        /ston-akw/       'run it across'(D,45)

    g. nqenkwa      /nqen-akw-a/     'shouts across'(D,269)
    h. hemkwa       /hem-akw-a/     'talks across'(D,165)
    i. stonkwa      /ston-akw-a/    'runs a ropelike obj.
                                        across'(D,45)

Recall that the initial vowel of /-akw/ is deleted by the rule of Initial

Vowel Truncation:

(346)   Initial Vowel Truncation

$$\underline{X} \longrightarrow 0 \; / \; \underset{N''}{X] \; +} \; \underline{\quad}$$

In forms (345.a-f) above, the underlying morpheme final glide is in the

environment for Glide Vocalization at level 1. To account for the exceptional

vowel length in the a.-d. forms, we posit the following morphologically

conditioned rule:

(347)  /akw-/ Lengthening (after core syllabification)

$$0 \longrightarrow \underline{X} \; / \; \underline{\quad} \; \overset{\overset{\textstyle W}{|}}{X'}] \; N''$$

This rule, which looks like a lexicalized level 1 version of Pre-glide

epenthesis, will insert an $\underline{X}$ before the final glide of /akw-/ if after core

syllabification the glide is stray and immediately followed by N".

3.1.4.5 Concluding Remarks

An account of glide/vowel alternation in Klamath is possible without reference to C versus V or [+syllabic] versus [-syllabic], as illustrated both by the straightforward translation CK's Vowel Shortening rule into N-bar notation, and by our proposal above which does away with the rule of vowel shortening. We turn now to several facts which argue for a proposal in which syllabicity is purely a metrical property.

First, the segments in Klamath which Barker notates as underlying vowels /o,i/ surface as glides [w,y] when in prevocalic position.[33] Take, for instance, the directional suffix /-odgi/ 'down, down from a height' which surfaces as vocalic in [dasdgi] 'reaches down' (D,279), but as a glide in [boqboqtgyank] 'having become white'. The fact that Barker notates this as a vowel appears to be a function of its usual pre-consonantal or word-final appearance. Positing a [+high] segment unspecified for syllabicity in these cases, we are able to account for the distribution of [i,o] vs. [y,w] by the rule of N‴ projection and glide vocalization without additional mechanisms: Core syllabification followed by Glide Vocalization will result in the
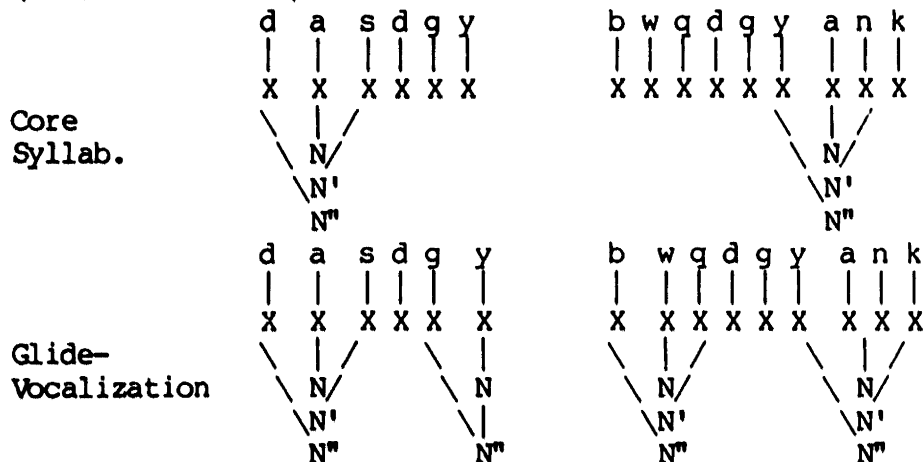
_____

33. In his discussion of semivowels (G,72), Barker states that

> At the phonemic level, two parallel sets of items were established: /o,w,w,W/ and /i,y,y,Y/. The sequences /o:/ and /i:/ also were found...All share the common property of having representations both as phonemic vowels and consonants.

In the proper environments then, all segments are seen to alternate.

following derivations:

(343) More Glide/Vowel Alternations

```
              d a s d g y            b w q d g y a n k
              | | | | | |            | | | | | | | | |
              X X X X X X            X X X X X X X X X
Core           \ | /                        \ | /
Syllab.         \ N/                          \ N/
                 \N'                           \N'
                  N"                            N"

              d a s d g  y           b w q d g y a n k
              | | | | |  |           | | | | | | | | |
              X X X X X  X           X X X X X X X X X
Glide-         \ | /   \ |            \ | /    \ | /
Vocalization    \ N/    \ N            \ N/     \ N/
                 \N'     \|             \N'      \N'
                  N"      N"             N"       N"
```

Other non-alternating segments which Barker notates as underlying vowels, shown in (349.a-h), are either the result of glide vocalization, or exemplify instances of lexical N-Placement:

(349)  a. dmolo      (*dmolo:)    'wild plum'(D,119)
       b. i:         (*i,y)       'for the sake of'(D,176)
       c. o:l        (*ol,wl)     'finishing an action'(D,292)
       d. dot        (*do:t)      'tooth'(D,122)
       e. do:t       (*dot)       'there'(D,124)
       f. tis        (*ti:s)      'father'(D,407)
       g. ti:        (*ti)        'from, a piece of'(D,408)
       h. i          (*i:,y)      'during, while'(D,174)
  (vs.i. y/i/i:                   'noun formant'(D,462))

The long vowels above cannot be the result of pre-glide epenthesis, since they surface as long even when in the environment for Glide vocalization. For example, positing an underlying glide for [do:t] 'there' which does not undergo affixation, would result in *[dot] by Glide Vocalization as shown

below:

(350)  */dwt/

```
        d  w  t
        |  |  |
        X  X  X
         \  |
          \ N
           \|
            N"
```
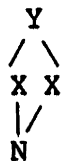
Core syllab. (n.a.)
GV
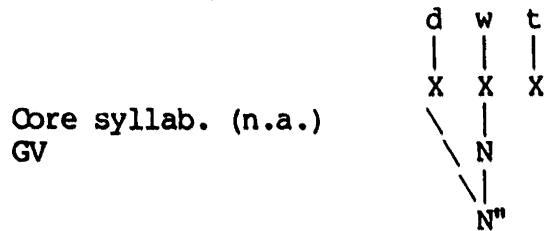
Thus, we must posit underlying length distinctions for the segments above.
Recall that lexical N-Placement is limited by the Metrical Peripherality
Condition proposed in Chapter 2 and repeated below:

The Metrical Peripherality Condition (MPC)
Lexical marking of metrical structure is limited
to peripheral positions.

For (349.b,c,g), then, we may posit lexical N-Placement, as the long segments
are in these cases in morpheme-peripheral position. This will result in the
following underlying representations:

(351)  b.                c.                g.

```
        Y                W  1              t  Y
       / \              / \  |             | / \
      X  X             X  X  X             X  X  X
      |/               |/                     |/
      N                N                      N
```
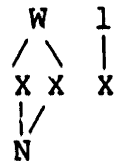
The stem internal glides in (349.a,d,f) will all be subject to Glide
Vocalization at level 1, allowing us to posit underlying [+hi,-cons] stray
segments in just these cases, while the stem final segments in (349.a,h) also
require N-placement in the lexicon to bleed the post-lexical application of

pre-glide epenthesis. The UR for these forms then will be as shown below:

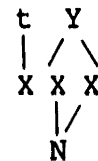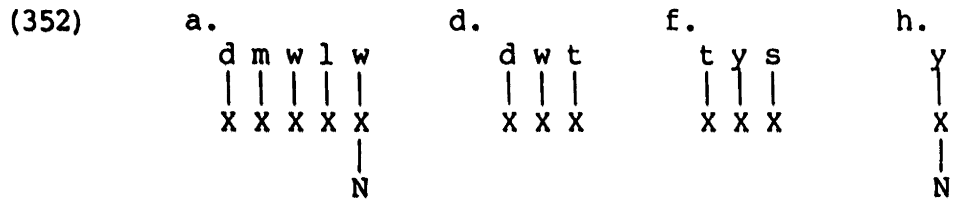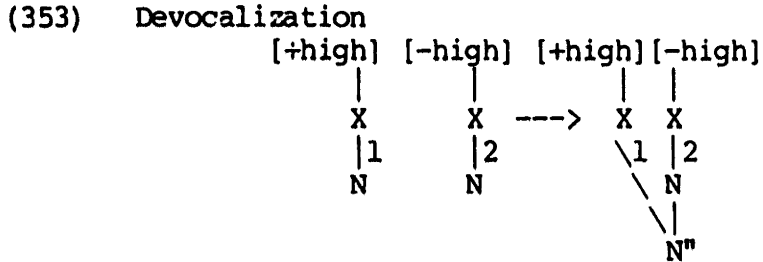(352)    a.            d.         f.         h.

```
        d m w l w         d w t         t y s           y
        | | | | |         | | |         | | |           |
        X X X X X         X X X         X X X           X
              |                                         |
              N                                         N
```

The status of (349.a,d,f) as stems, will result in stray stem-internal glides

being subject to glide vocalization at level 1. Marking the stem-final glides

in (349.a,h) as underlying Ns will have a bleeding effect on the rules of

Projection and pre-glide epenthesis. However, as is clear from a form like

[dmolwalca] (</dmolo + 'al + c + a + a/) 'goes to gather wild plums'(D,119),

lexical N-placement will not have any effect on later devocalization of a

[+high] segment. To account for forms like [dmolwalca], we posit the rule of

devocalization shown below:[34]

(353)    Devocalization

```
        [+high]  [-high]    [+high] [-high]
           |        |          |      |
           X        X  --->    X      X
           |1       |2         \1     |2
           N        N           \ N
                                 \|
                                  N"
```

We see then that accounting for what Barker notates as underlying vowels,

involves marked instances of lexical N-placement, in conformity with the MPC,

in addition to the rules already motivated to account for regular glide/vowel

----------

34. Whether this rule is responsible for glide/vowel alternations such as
those shown in (349) above depends on whether there is evidence for the rule
of glide vocalization on each cycle. If so, then syllabification of /bwq +
dgy + ank/ on the cycle will be [boq]... on the second [[boq]dgi]... and on
the third [[[boq]dgi]ank]. Devocalization then will take boqdgiank --->
bogdgyank.

alternations, with the addition of Devocalization as formulated above. This is just what we expect within a metrical theory of syllabicity, since the distinction between underlying vowel and glide is either solely an instance of N-Placement in the lexicon, or altogether non-existent. Within this framework, the absence of metrical structure will not block the application of structure building rules.

While N-Placement is the only marking available in the lexicon to distinguish syllable heads from non-heads, a feature-based theory of syllabicity allows for another option as well: a segment may be marked underlyingly as [-syllabic]. As such, it will <u>not</u> undergo regular alternations in syllabicity, but will surface consistently as a non-head, in contrast to other segments which are identical with the exception of their underlying property of being [0 syllabic]. In contrast to a feature-based theory of syllabicity, we predict that in Klamath, for instance, there will be no cases of morpheme-final glides which fail to trigger epenthesis or N-placement but nevertheless are <u>not</u> consistently realized as a syllable heads. To our knowledge, this hypothesis is born out by the Klamath data.

Another advantage of this analysis is its treatment of glide sequences. An analysis with vowel shortening predicts lengthening of adjacent glides, providing they are both stray. Then, the shortening rule will shorten the second (as it follows a long vowel) but not the first. However, as predicted by this analysis, sequences of stray glides are subject to the rule of glide vocalization:

(354) Adjacent Stray Glides
    a. gelwipga    [gX̱ + elwy + obg + a]  'visits'(G,74)
    b. galcwibli    [gX̱ + alcwy + bli]  'goes right back up to'(G,74)

(354.b) is of particular interest, since it shows that the rule of glide vocalization is directional and goes from right to left.[35]

Finally, it appears that the stress rules in Klamath are sensitive to the distinction between long and short vowels, but do not distinguish derived from non-derived long vowels. As described by Barker(G,35-36) primary stress in Klamath falls on the last long vowel preceding a juncture, regardless of whether or not the long vowel occurs in an open or closed syllable.[36] In fact Barker argues against an representation of derived long vowels as /iy/ or /ow/ sequences on the basis of the fact that these derived long vowels are stressed in the same way as underlying long vowels:

> ...other vowel-semivowel sequences, such as /ʔoyamna/ "carries a long object around," have a normal stress pattern, while sequences like /iy/ or /ow/ would require primary stress. The statement of stress distribution would be complicated by this analysis.(G,42)

In an analysis which posits a VV versus VC or branching N' versus branching $N^0$ distinction for long vowels as accessed by the single rule of vowel shortening, one must assume a reanalysis takes place before rules of stress assignment. Within the proposed analysis, in which derived long vowels are all the result of spreading of a [+high] matrix to an immediately adjacent unassociated X-slot, we can assume a uniform representation of underlying and derived long vowels as branching nuclei.

--------

35. See the analysis of Berber in Chapter 2 for a rule of vocalization which is non-directional.

36. See Chapter 4, section 1 for details of Klamath stress.

In closing, we point out another interesting consequence of the analysis above, namely that it supports a view of syllabification as an ordered rule system, rather than information present underlyingly, or a one step process of template matching. Core syllabification was seen to be distinct from later rules of incorporation and adjunction, where core syllabification could be succinctly stated in terms of branching head of N". Only after core syllabification was the environment for the rule of glide vocalization, a phonological rule of N-Placement, met. Positing glide vocalization as a lexical rule resulted in its bleeding pre-glide epenthesis in all cases where the environments for both rules were met without having to order one rule with respect to the other, lending further support to a theory of levelled ordering.


## 3.2 On the Segmental Plane


We have seen above that arguments for the feature [+syllabic] as encoded on the skeletal tier are straightforwardly dealt with in terms of internal structural distinctions in the syllable, or by reference to syllabified versus unsyllabified skeletal slots. In this section, we investigate a residue of arguments in which a distinction between [+syllabic] and [-syllabic] is argued for on the melodic plane.


### 3.2.1 Reduplication in Sanskrit and Syllabicity


The first argument concerns the status of glides in Sanskrit, and their

realization in reduplicate and zero versus full grade forms.[37]

Steriade(1985) attributes the fact that certain glides never associate to the nuclear X-slot of a reduplicate prefix to the fact that such glides are underlyingly [-syllabic], in contrast to other glides which are [0 syllabic]. The forms in question are given below:

(355) Sanskrit reduplication: the status of glides

| Root | Full-grade | Zero grade | Gloss |
|------|-----------|------------|-------|
| a. siand | si-syand | si syand | 'move on' |
| b. miks | mi-myaks | mi-miks | 'glitter(?)' |
| c. sup | su-swap | su-sup | 'sleep' |
| d. diut | di-dyot | di-dyut | 'shine' |
| e. wiac | wi-wyac | wi-wic | 'extend' |
| | | | |
| f. swaj | sa-swaj | sa-swaj | 'embrace' |
| g. khya: | ca-khya: | ca-khya: | 'see' |
| h. tyaj(post RV) | ta-tyaj | ta-tyaj | 'forsake' |
| i. dwis | di-dwes | di-dwis | 'hate' |
| j. cyu | cu-cyau* | cu-cyu | 'stir' |
| k. dhwan | da-dhwan | da-dhwan | 'sound' |

Steriade notes that the glides in (355.f-k) never occur as syllabic in the root, that is , they lack a "proper" zero grade. We follow Steriade in every step of her argument with one exception. Instead of assuming that the reduplicate prefix of full- and zero-grade stems is the result of melody copy followed by association, we treat reduplication as an instance of non-linear transfer, where skeletal association is conditioned by presence or absence of segmental information.

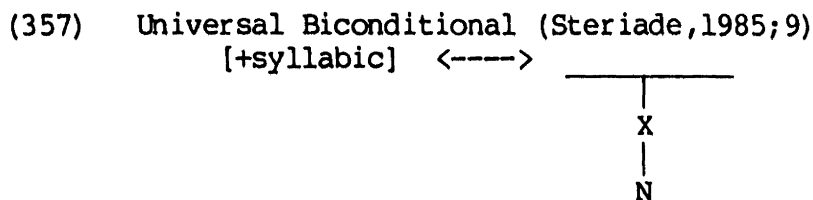We suggest first that the failure of prevocalic glides in (355.f-k) to

---

37. I am indebted to Donca Steriade for bringing these facts to my attention, and for lengthy discussion of the consequences of her analysis for a metrical theory of syllabicity. While the author has attempted to sketch out the problem and some possible solutions within a metrical theory of syllabicity, a more detailed discussion is clearly in order.

appear as syllabic in the reduplicate prefix, can be traced to their failure to undergo N-placement at any stage of the derivation. The rule of N-placement proposed by Steriade(1985) is the following:

```
(356)   (X) X ---->  X   X
          1  2       \1  |2
                      \  N
                       \|
                       o-
```
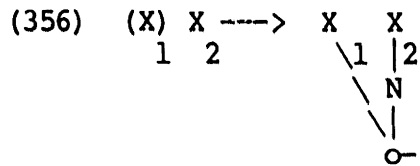
Within Steriade's system, this rule of syllabification is mediated by the universal biconditional given below:[38]

```
(357)    Universal Biconditional (Steriade,1985;9)
         [+syllabic]  <---->  _____
                                    |
                                    X
                                    |
                                    N
```

The interpretation of (357) is not exactly what one would expect. In particular "...any segment that is [+syllabic] must be interpreted as belonging to the nucleus; any segment in the nucleus must be [+syllabic] or non-distinct from [+syllabic]."(p.9) The biconditional in (357) acts to limit the rule of syllabification in (356) in restricting [+syllabic] segments to nuclear position, [-syllabic] segments to non-nuclear position, and in allowing [0syllabic] segments to appear in either nuclear or non-nuclear position. In Sanskrit, all [+consonantal] segments are underlyingly [-syllabic].[39] [-cons] segments are [+syllabic] if [ high] and unspecified

------------

38. Versions of this biconditional can also be found in Steriade(1984) and Levin(1984b).

39. Though specification for this feature may change. Thus, /r/ may become [+syllabic] when stray.

for syllabicity if [+high].

Following Steriade, we assume that the stems in f.-k. have zero grade forms which are identical to their full-grade forms, while the stems in a.-e. have derived zero grade forms which are the result of a rule of X-deletion. In (358.A) we give Steriade's formulation of Zero-grade formation, and in (358.B) a restatement of the rule without reference to [syllabic].

(358)　Zero Grade Formation
　　　　A. Steriade (1985;17)

X ---> 0 /　X X __ X X

　　　　　　　// [+cont,^cons,-^syll]

B.　X ---> 0 /　X X __ X X

　　　　// X

　　　　// [+cont,+cons]

Steriade's formalization of Zero-Grade Formation is meant to capture the fact that the rule is blocked in (355.f-k) where, according to Steriade, vowel-adjacent glides are underlying [-syllabic], as opposed to the stems in (355.a-e) where the corresponding glides are unspecified for syllabicity. Our statement of the rule does not account for this fact. Rather, we propose that the difference between full grade stems in (355) is a matter of presence or absence of segmental material in UR. The full and zero grade forms for swap and swaj are given below:

(359)a. zero grade　full grade　b. zero grade　　full grade
　　　　s U p　　s U p　　　s U a j　　s U a j
　　　　| | |　　| | |　　　| | | |　　| | | |
　　　　X X X　　X X X X　　X X X X　　X X X X

Positing an underlying, segmentally present stem vowel for the full-grade

forms in (355.f-k) accounts for the fact that such forms fail to undergo

zero-grade formation as stated in (358), since this rule deletes a skeletal

slot which is unassociated to the segmental plane. Furthermore, if we alter

slightly the statement of N-placement given in (356) above, we are also able

to account for the failure of the [+high,-cons] segments in (355.f-k) to be

syllabic at any stage in the derivation, in constrast to such segments in

(355.a-e). The change we have in mind is the following:

(360)

```
     [-cons]        [-cons]
        |              |
(X)  X ---->   X      X
     1  2           \1  |2
                      \  N
                       \|
                        N"
```
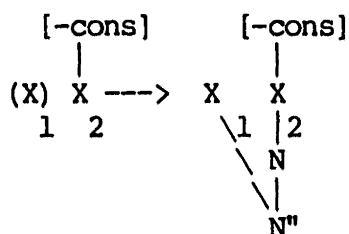
Namely, we suggest that X-slots linked to the segmental tier are syllabified

prior to those which have no featural associations. The results of

N-placement as reformulated above on the URs in (359) are shown below:

(361)a. zero grade   full grade    b.zero grade    full grade

```
   s  U  p      s  U     p        s U   a j        s U   a j
   |  |  |      |  |     |        | |   | |        | |   | |
   X  X  X      X  X   X X        X X   X X        X X   X X
    \  |         \  |   _          \   |            \   |
     \ N          \ N                \ N              \ N
      \|           \|                 \|               \|
       N"           N"                 N"               N"
```
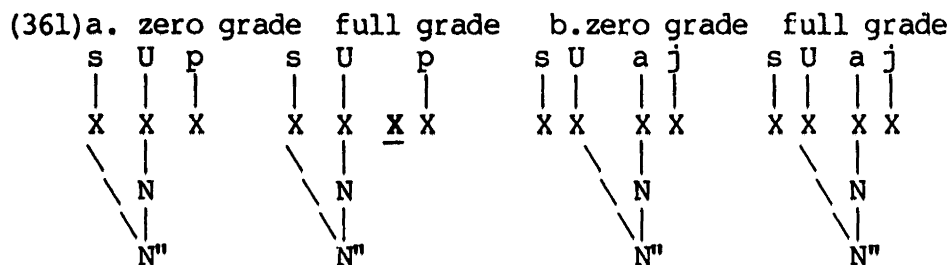
We suggest that the representations above are input to reduplication viewed

as non-linear transfeı. Within such a model, linking is conditioned by the

rules of N-placement themselves, inasmuch as the first X of the reduplicate

skeleton associates with the first segmentally associated X of the stem:

(362) Reduplication in Sanskrit: Pre-linearization

```
    a.              b.              c.              d.
    X  X            X  X            X  X            X  X
   / /            / /            / /            / /
  S  U  p         S  U  p         s  U  a ɟ        s  U  a ɟ
  |  |  |         |  |  |         |  |  | |        |  |  | |
  X  X  X         X  X  X  X      X  X  X  X       X  X  X  X
   \ |            \ |  |          \ |  |           \ |  |
    \ N            \ N             \ N              \ N
     \|             \|              \|               \|
      N"             N"              N"               N"
```
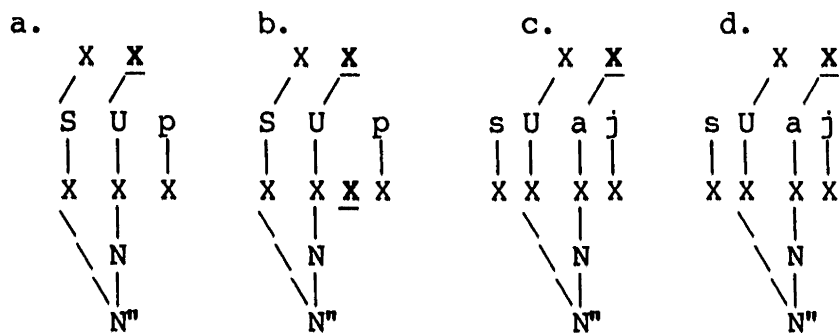
We assume that as soon as the X in (362.b) above is spelled out as [a], the preceding [+high,-cons] is immediately devocalized and taken in under the N" projection.[40] Within this analysis, we are forced to treat the stems in (355.a,d) which appear, like the forms in e.-j. to have no "proper" zero grade, as exceptions to the morphologically conditioned rule of zero grade formation.

While this analysis is in some cases less explanatory than that provided by Steriade, the fundamental question appears to be not whether or not the feature [+syllabic] is evidenced on the segmental plane, but rather, whether or not the copy/associate model of reduplication first proposed by Marantz(1982) or that of non-linear transfer recently proposed by Clements(1985) is to be preferred on empirical grounds.

Recall that the model of reduplication assumed here predicts that segments which function as syllable heads in the stem, will also do so in reduplicate

---

40. This devocalization can be seen as the result of Steriade's rule of glide formation: i,u--->y,w/ __V.

affixes. Recall the cases from Ponapean, where a syllabic nasal in the stem

surfaced as a syllabic nasal in the prefix:

(363) Ponapean Reduplication (type X)

| Stem | Reduplicate form | Prefix | Gloss |
|------|------------------|--------|-------|
| mmed | mmimmed | XXX- | 'full' |
| nnet | nninnet | XXX- | 'to pant' |
| nnar | nninnar | XXX- | 'to see' |
| mpek | mpimpek | XXX- | 'to look for lice' |
| nda | ndinda | XXX- | 'to say' |

Reduplicate prefix          X X X-
Association                  |‾ |
                            X X X X
                             |‾| |‾|
                             m p e k
Linearization:
            X X X X X X   Epenthesis      X X X X X X X
            |‾| |‾| |‾|   --- ------->    |‾| | | |‾| |
            m p m p e k                   m p   m p e k

Surface:      [mpimpek]

In Ponapean, nasals are predictably syllabic in word-initial pre-consonantal
position. Marking such segments as [+syllabic] is redundant, and rendered
unnecessary within a model of non-linear transfer.

Within Steriade's model association of segments to X-slots is free, thus
requiring a stipulation that certain segments which do not associate to such
slots must be marked underlyingly as [-syllabic]. The model of reduplication
put forth here requires a matching of affixal X-slots to stem X-slots,
predicting that the glides in (355.f-k) will never surface as syllabic in the
reduplicate prefix. It appears then that rather come up with a conclusive
argument for or against the feature [+syllabic] on the segmental tier,
Steriade's analysis of Sanskrit forces us to investigate the true nature of
reduplication with respect to syllabicity distinctions. If, as predicted in
the linear model, syllabicity in the reduplicate prefix is dependent on

matrix internal feature specifications independent of stem syllabification, then we are left to conclude that syllabicity must be somehow represented on the segmental plane. If, on the other hand, evidence points to reduplication as a process of non-linear transfer, where syllabicity distinctions in the reduplicate affix consistently parallel those of the stem, we are able to maitain a theory in which syllabicity is uniquely associated with N on the syllable plane.


3.2.2 English /-y/: An Instance of [-syllabic]?

We turn next to properties of the English nominal suffix /-y/, which occurs in the following derived forms:

(364)   /-y/ as Non-syllabic in English
                                        Stem
        a.  delicacy    (*delicacy)     delicate
        b.  presidency  (*presidency)   president
        c.  residency   (*residency)    resident
        d.  agency      (*agency)       agent
        e.  piracy      (*piracy)       pirate
        f.  secrecy     (*secrecy)      secret

The fact that, as illustrated above, the final [-cons,+high] segment does not count as syllabic for the rules of stress (364.a,b,c) or the rule of trisyllabic laxing (364.d-fe), has been noted by various scholars, including Hayes(1982), Kiparsky(1982), and Rubach(1981). Though on the surface this segment inevitably surfaces as vocalic (even when prevocalic as in <u>funnier</u>), the phonological facts lead us to believe that within the lexical phonology, the segment remains unsyllabified. Could this be an instance, then, of a segmental marking of /-y/ as [-syllabic], making it inalterable with respect to lexical syllabification processes?

Borowsky(1984), in an extensive account of syllable-based rules in English, provides us with an account for the exceptionality of /-y/ with respect to phonological rules without reference to a segmental feature [+syllabic]. She argues that this segment, along with other sonorants left stray within the lexical phonology, are only syllabified post-lexically by the rule of sonorant syllabification below:

(365)   Sonorant Syllabification (Borowsky,1984;70)

```
        [+son]      [+son]
          |           |
        X'  --->    X /  ___ ]
                      |
                      N
```
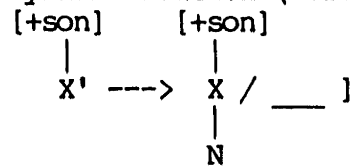
Borowsky argues that this rule is restricted to apply in the post-lexical phonology by the Strict Cycle Condition, as it refers to word-final position. Within the lexical phonology, the final bracket is only visible at the next level up, at which point application of rule (365) will violate the SCC. In the post-'exical phonology, word-boundaries are visible, and so, the

rule is free to apply.[41] An illustrative derivation is provided below:

```
(366)                          [delicat] y]
Lexical Phon.                  d  E  l  I  k  a t    y
  Syllabification             |  |  |  |  |  | |    |
  Final o- -                  X  X  X  X  X  X X    X
  Extrametricality             \  |  \  |  \  | /    |
  Stress                        \ N  \ N  \ N/       |
                                 \|   \|   \N'       |
                                 N"   N"   N"        |
                                  o  /    [  ]       |
                                  | /     EM         |
                                  |/                 |
Post-Lex. Phon.                                      |
  Son.-Syllab.(365)                                  N
```
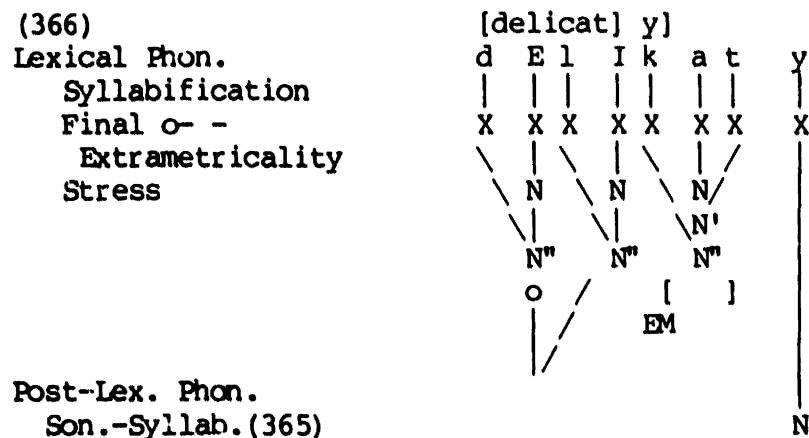
Adopting Borowsky's analysis, we conclude that a diacritic [+extrametrical],
or its segmental counterpart, [-syllabic], is unnecessary in accounting for
the exceptional status of the suffix /-y/. Rather, this segment, like other
stray sonorants, is not syllabified until the post-lexical phonology. The
statement of syllabification algorithms which are sensitive to the
distinction between syllabified and unsyllabified skeletal slots is
sufficient without requiring reference to a feature [+syllabic].

### 3.2.3 The Condition on Structure Dependent Rules and
Geminate Glides in Tigrinya

While the facts from Sanskrit and English require head/non-head or
stray/non-stray distinctions, regardless of the particular theory of
reduplication or syllabification, the final case we will discuss for

---

41. Borowsky (p.71) also argues for the sonorants /r,l/ that the rule of
vocalization is blocked in the cyclic phonology by Structure Preservation, on
the assumption that syllabic sonorants are not distinctive in English. We
however are not in agreement with such a claim, given such apparent minimal
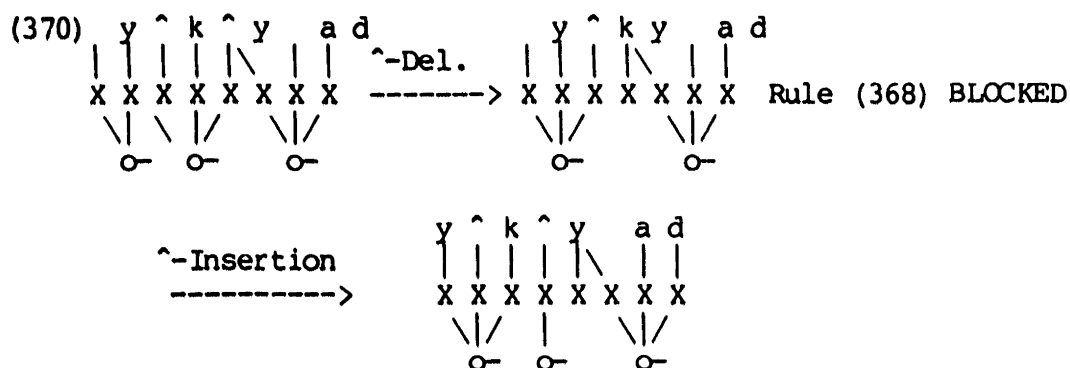claims as [karl] and [kar.l].

representing syllabicity distinctions on the segmental tier is one that has been made on theory internal grounds. The data in question concerns geminate glides in Tigrinya as analyzed by Steriade & Schein(1984). In their revealing study of geminate structures, Steriade & Schein(S&S) conclude that the principle of grammar which excludes geminate structures from taking part in certain phonological processes is the following Applicability Constraint referred to earlier and repeated below:

(367) Applicability Constraint(S&S,1984)
A structure-dependent rule can affect a segmental matrix
by deleting or changing feature specifications contained
in the matrix just in case all skeletal slots associated with
it meet the description of the rule.

Structure dependent rules, in the sense mentioned above are just those rules which require access to syllable structure or skeletal information. Given the formulation of (367), the rules in question are all and only those rules which affect the contents of a segmental matrix. In (368) we see the rule in question from Tigrinya:

(368)  y-syllabification (S&S;p.23)     [+high,-cons]      [+syllabic]
                                             |    ----->       |
                                             X'                X'

      (X' denotes a stray X-slot)

The intermediate forms in (369) below, which have undergone pre-glide schwa deletion, do not undergo rule (368) above, as predicted by the Condition on Structure Dependent rules. Rather, in these cases, a rule of schwa epenthesis will apply as illustrated in the derivations in (370).

(369) Intermediate syllabification of Geminate glides in Tigrinya
   a. /y^s.y.yat/     'sell-REFL-IMPF'
   b. /y^q.y.yad/     'bind-REFL-IMPF'
   c. /m^q.y.yad/      'bind-INF'

(370)
```
        y ^ k ^ y   a d                     y ^ k y   a d
        | | | | |\ | |      ^-Del.          | | | |\ | |
        X X X X X X X    -------->  X X X X X X X   Rule (368) BLOCKED
        \| \ |/  \|/                        \|/     \|/
         o-  o-   o-                          o-      o-
```

```
                                    y ^ k ^ y   a d
      ^-Insertion                   | | | | |\ | |
      ----------->                  X X X X X X X
                                    \|/ |   \|/
                                     o-  o-   o-
```
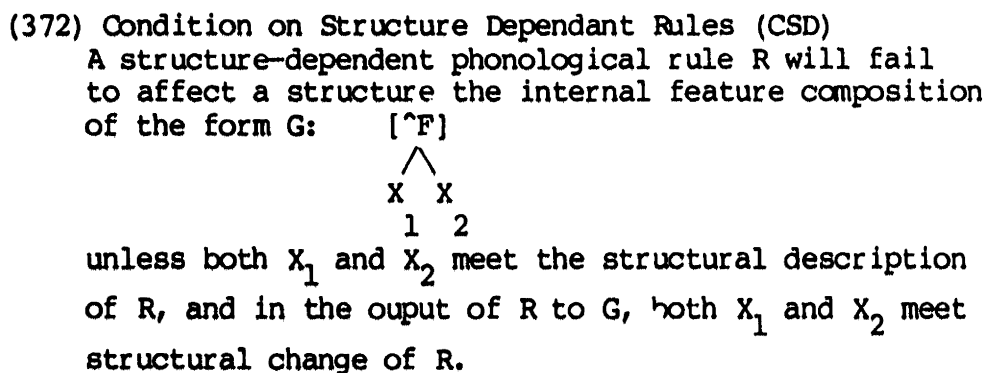
Because the Applicability Constraint is a condition on feature changing rules
alone, the rule of y-syllabification must be formulated as in (368).
However, a slight change in wording of this condition will allow
y-syllabification to be rewrittten as the rule of N-placement shown below:

(371)  Default N-Placement in Tigrinya
```
       [+high,-cons]      [+high,-cons]
           |    ----->        |
           X'                 X
                              |
                              N
```
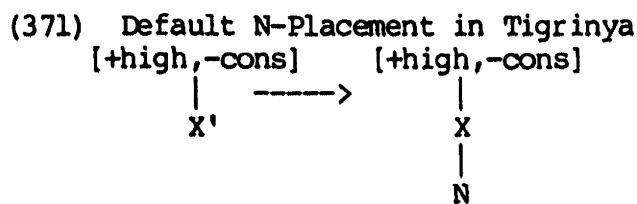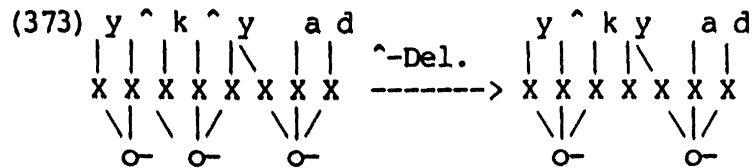
Rules of this sort, as was seen earlier, will be subject to our revised
version of the Applicability Constraint, the Condition on Structure Dependent
Rules, repeated below:

(372) Condition on Structure Dependant Rules (CSD)
      A structure-dependent phonological rule R will fail
      to affect a structure the internal feature composition
      of the form G:    [^F]
                         /\
                        X  X
                        1  2
      unless both $X_1$ and $X_2$ meet the structural description
      of R, and in the ouput of R to G, both $X_1$ and $X_2$ meet
      structural change of R.

While the version of the AC proposed by S&S requires the representation of
[+syllabic] as a distinctive feature, by showing that the CSD as revised

above, is not restricted to segmental feature changing rules, but also accounts for the failure of epenthesis to effect geminate structures, we are able to block N-placement as shown below, since it effects the geminate structure, but neither its input or output is in accordance with the CSD:

```
(373) y ^ k ^ y   a d              y ^ k y   a d
      | | | | |\ | |   ^-Del.       | | | |\ | |
      X X X X X X X X  --------> X X X X X X X
      \| \ |/  \|/                  \|/     \|/
      o- o-   o-                    o-      o-
```

```
Rule R:      [+high,-cons]     [+high,-cons]
                 |      ----->      |
                 X'                 X
```

```
Input      [y]          Output:  * [y]
           / \                     / \
          X'  X                   X   X
```

Thus, where the feature [+syllabic] is motivated by theory internal considerations, so can N-placement be motivated by a theory internal proposal. As we have seen, an analysis of syllabicity as a structural property, rather than a segmental feature, appears to be compatible with the version of the Condition on Structure Dependent Rules proposed earlier. The CSD was originally invoked to rule out syllabification of a monosegmental geminate by two instances of N-placement. What we see in Tigrinya is that the CSD is motivated not only as a condition on N-Placement by redundancy rule, but on phonological rules of N-Placement as well.

## 3.3 Summary and Further Clarification

At the end of Chapter 1, we summarized the challenges for a metrical theory

of syllabicity in terms of three questions which are repeated below:

(374)   Questions for a Metrical Theory of Syllabicity

1.  Within a Kahnian version of syllabification
    algorithms, can such algorithms be devised without
    mention of the feature [+syllabic]?

2.  Is the proper representation of lexically
    predetermined syllable structure a representation of
    structural information on the syllable plane?  If so,
    what conditions hold on association?

3.  Can other evidence pointing to a feature [+syllabic]
    be adequately dealt with be referring to other
    features, or structural properties of the syllable?

In Chapter 2.1 we proposed rules of N-placement, complex-N formation, projection, incorporation and adjunction as the universal set of syllabification algorithms.  None of these rules appeared to necessitate access to a feature [+syllabic].  In 2.2 we turned to the representation of skeletal templates, arguing that such templates were best represented as skeletons with minimally pre-determined syllable structure.  Linking to the skeleton was conditioned by the language specific rules of N-placement.  In this chapter we have turned to question (3) above, questioning the empirical arguments for the feature [+syllabic] as encoded on either the skeleton or the segmental plane.  As we have shown, given well-articulated internal syllable structure, the distinction between syllabified and unsyllabified skeletal slots, as well as the possibility of N-Placement in the lexicon, we are able to account for the same range of data, in certain cases more, while greatly restricting the number and type of possible phonological systems.  We take this as positive proof that a metrical theory of syllabicity is viable, and turn in Chapter 4 for further evidence in support of such a theory.

Before doing so however, it will be instructive to formalize one of the key

distinctions we have been relying on, namely that between a syllabified and an unsyllabified skeletal slot.[42] Throughout the preceding discussion, we have provided evidence that the skeleton is most accurately viewed as a sequence of timing slots which are intrinsically void of any distinctive feature specifications. For instance, in Chapter 1, we show that such labelling leads to unnecessary complications in the statement of morphophonological processes in Mokilese and Ponapean. However, in this Chapter, as well as in the previous one, we point to a number of phonologcial rules which impart to X-slots a certain amount of limited information, namely, whether or not the X-slot is associated or projected to a particular phonological plane. For instance, the rule of Glide Vocalization (326) in Klamath is an N-Placement rule which has as its target unsyllabified [+high,-cons] segments as opposed to previously syllabified segmentally identical segments.

In underlying representation, as noted earlier, the sole distinction is between X' and $\underline{X}$. However, after syllabification rules other than N-placement have taken place, X' is distinct from all skeletal slots which are terminal elements of some N-projection.[43] We suggest here that the diacritics shown below are actually the instantiation of binary valued features indicating projection (or association) or lack thereof to a particular phonological

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42. This distinction between linking or projection onto a certain plane and absence of linking or projection is made use of, with respect to the segmental plane, in our analysis of stress systems which distinguish between full and reduced vowels. See next Chapter.

43. Note that if syllable trees, such as those used throughout are seen as simple bracketing of the skeleton, X' will denote a skeletal slot which is not properly bracketed.

plane:

(375)  Structural Features of the Skeleton

|  | N-Plane | Seg.-Plane | Tonal-Plane |
|---|---|---|---|
| A. + Association/Projection | <u>X</u>, X] | X | X |
|  |  | \| | \| |
| B. - Association/Projection |  |  |  |
|  | X' | X | X |

These binary valued features are the only features encoded in the skeleton, and they encode purely structural information. Thus, <u>X</u> indicates that a particular X-slot does project to the N-tier, while X' indicates that it does not.

The encoding of presence or absence of projection of an X-slot to the N-plane is paralleled by the relation of X-slots to the segmental and tonal planes as shown above. The hypothesis we put forth is that rules which have access to the skeleton have access to information which encodes the +/- value for all associations/projections in a given phonological representation. This contrasts with the particular plane-internal information, which is unavailable to rules which access solely the skeleton. We formalize this hypothesis as follows:

(376)  The Skeletal Access Hypothesis  (SAH)
A rule which has access to a skeletal slot X within a representational system which includes planes $P_1...P_n$, has access to the existence or non-existence of association of X to $P_1...P_n$, but does not have access to any plane-internal information on $P_1...P_n$, except where explicitly noted.

The SAH makes explicit two important predictions which we turn to in the following chapter. First, it implies the existence of rules which, taking skeletal slots as terminal elements, distinguish between presence or absence

of association to the segmental plane, but have no access whatsoever to information on the segmental plane itself. Secondly, it suggests that a rule sensitive to categorial distinctions between $\underline{X}$ and X' may be characterizable by its inability to access further information on the N-plane, or on the segmental plane.

Having accounted for what appear to be the major obstacles for a metrical theory of syllabicity, we now turn our attention to evidence which lends support to such a theory, and which instantiates the predictions of the SAH above. Recall that the X-bar system which is grounded in both categorial distinctions (X' versus $\underline{X}$) and bar-projections ($X^0$, X', X"), is validated by illustration of particular rules systems which are most accurately stated in terms of categorial distinctions or with reference to bar projections. We examine first metrical rules of accent assignment. We claim that all such rules may be stated in terms of N and the N-projection, with no direct access to information on other planes. As such, the theory of accent is shown to support the system of bar-projections limited to $N^0$, N' and N", and to account for the implicational universals between stress of branching constituents within N". We then turn to a theory of skeletal tier transformations which takes as primitive the categorial distinction between syllable heads and syllable non-heads.

# Chapter 4

## X-bar Theory and Phonological Rules

We have just seen how problems which appear to require access to syllabic features on the skeleton or segmental plane can be dealt with in structural terms, either by referring to unsyllabified status of a skeletal slot, X', or by drawing on syllable-internal structural properties, in these cases the distinct projections $N^0$ and N'. On arriving at structurally based solutions to such problems, we are able to hypothesize that the structural category N is the sole determinant of syllabicity in phonological representational systems. As we saw in Chapter 2, N-placement may be lexical, or determined by redundancy rule, or phonological rule. Regardless of its derivation, every $N^0$ is seen to project into the phonology, resulting in maximal syllabic projections on the syllable plane.

We now turn to evidence supporting the X-bar theory of the syllable presented. Recall that the strongest evidence for such a theory will consist in rules which refer crucially to bar-projection level or to category. Here we focus on two phonological components of the grammar which make crucial reference to N, but need not refer to internal structure on other planes. In Section 1 we argue that N and its projections are the relevant domain for rules of accent assignment within a metrical theory of stress. Accent is

assigned to the head of N″, with parametrization of whether or not the head is branching. Given that these rules are stated in terms of head and projections, we not only motivate N, but also N' and N″.

Having established a set of rules referring to projections of N on the syllable plane, we turn in Section 2 to a class of rules which appear to refer crucially to the categorial distinction between syllable heads and non-heads, or X and X' in our notation. These rules, which we will refer to as skeletal-transformations, are shown to insert or delete skeletal slots without specifying projections of such slots to the segmental tier. Investigation of this class of transformations leads us to propose a preliminary set of conditions on their form and output. These conditions are stated in terms of category as well, providing further support for a structural theory of syllabicity.


## 4.1 A Theory of Accent

In this Section we provide evidence that both N, and projections of N, are referred to by phonologcal rules. We examine metrical rules of accent assignment, where accent is defined as the head of a metrical constituent. We provide evidence that the domain of such rules is the maximal projection of N, and that such rules refer to the projections N″, N' and N. X-bar theory is shown to constrain possible accentual systems in three ways: first, given that rules of accent have access to syllable structure alone, with skeletal slots as terminals, it follows from the Skeletal Access Hypothesis (376), that information internal to other planes, including the segmental plane will

not be available; second, given only N',N‴ projections, we disallow rules which refer to intermediate levels of branching; and third, we formulate accent in terms of head of N‴, capturing the posited universal constraint that if a language accents all branching N's, then it must also accent branching $N^0$s, though the reverse is not true. Three putative counterexamples to this claim, rules of accent assignment in Tiberian Hebrew, Seneca, and Capanahua will be shown to further support this theory, when extrametricality, underlying versus derived vowel length, and complex segments are motivated for each case respectively.

In suggesting that a primitive version of X'-theory is operative in the syllable, we essentially limit the maximal structure required by the class of syllable sensitive rules to that shown in (377).

(377)
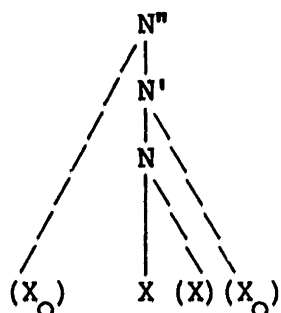


In this section we will examine metrical accent rules, claiming that their precise domain of application is the N-projection, as shown above. By rules of accent, we refer to rules which mark stress-bearing units as heads within a particular domain.[1] Such rules are parallel to rules of N-placement in

_____

1. The existence of ternary feet such as those seen in Cayuvava in Chapter 2, pose non-trivial problems for proponents of a grid-only theory of stress assignment. For this reason, we assume arboreal structure (Hayes,1981;
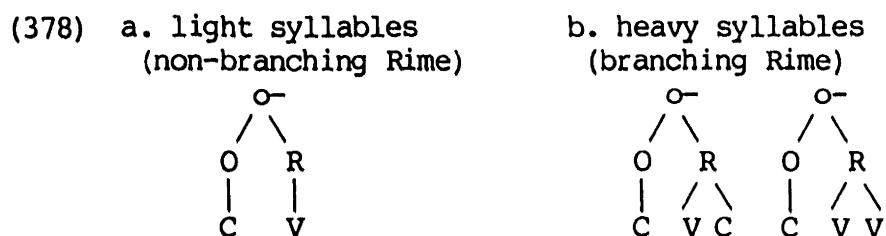
that they establish a head/non-head distinction.

Because stress rules apply within the domain shown in (377), the SAH will account for what appears to be a universal constraint on rules of accent assignment: that they do not have access to segmental information. Rules of accent assignment which appear to distinguish between reduced and non-reduced vowels are shown to involve the same geometric property as non-branching and branching nodes: reduced vowels, represented as syllable heads which do not project to the segmental tier, are non-branching in the strictest sense, since such skeletal slots extend only to a single plane, the syllable plane. Full vowels, on the other hand, are geometrically branching in that they project to both the syllable and segmental planes. Where distinctions between branching N and branching N' are shown to be necessary, so are those between branching and non-branching X, allowing us to capture a wide range of accentual facts by the simple rule: accent the head of N" iff branching.

## 4.1.1 The Hayesian Accentual System

Following a proposal of Halle, and the notion of projection suggested by Vergnaud(1977), Hayes(1981) develops a theory of stress in which rules of accent assignment apply on what he calls the Rime Projection. The Rime projection provides a way of distinguishing heavy syllables from light syllables within a framework where tautosyllabic long vowels occupy two skeletal slots, since in this case, long vowels and tautosyllabic VC sequences both constitute branching rimes, while light syllables have

---

Hammond,1984) which may or may not be supplemented with a metrical grid (cf. Halle and Vergnaud, forthcoming).

non-branching rimes. The types of representations adopted by Hayes are shown in (378):

(378)  a. light syllables          b. heavy syllables
          (non-branching Rime)        (branching Rime)

```
          o-                     o-        o-
         / \                    / \       / \
        O   R                  O   R     O   R
        |   |                  |  /\     |  /\
        C   V                  C  V C    C  V V
```

An example of a stress rule which adheres to the dichotomy in (378) is that of Latin. In Latin, stress falls on the penultimate syllable if and only if it contains a branching rime. Elsewhere, stress falls on the antepenult. Thus we have words like **inimiicus** and **pepercii** but **conficiunt, tenebrae,** and **toga.** Given the representations in (378), we may state the rule of accent for Latin as shown below, where accent is equivalent to obligatory Designated Terminal Element(DTE) of a metrical constituent:

Accent the penultimate Rime iff it is branching.

In addition, Hayes notes that rules of accent very often refer to long vowels and diphthongs in contrast to short vowels or vowel consonant sequences. So for instance, in Khalkha Mongolian(Street,1963), stress falls on the leftmost syllable containing a long vowel, otherwise on the initial syllable. To capture this fact, Hayes adopts the notion of feature projection from Vergnaud(1977). Certain languages will make use of the [+syllabic] projection, of the rime, thus distinguishing long vowels from

both VC sequences and light syllables, as illustrated in (379).

(379) Syllable              [+syllabic] Projection

```
      o-      o-
     / \     / \
    O   R   O   R                    R
    |   |   |   |\                   |
    C   V   C   V C                  V
------------------------------------------------------
      o-      o-
     / \     / \
    O   R   O   R                    R
    |  /\   |  / \                  / \
    | /  \  | /\  \                 /   \
    C V   V C VV   C              V      V
```

An approach utilizing the [+syllabic] projection is forced to hypothesize that in languages in which diphthongs pattern with long vowels for purposes of stress, the weaker halves of the dipthongs are phonologically [+syllabic]. Such a stress pattern is found in Goroa(Seidel,1900), where stress falls on the leftmost long vowel or diphthong, otherwise on a final closed syllable, otherwise on the penultimate syllable. Long vowels and diphthongs in Goroa are both branching on the syllabic projection:

(380) Goroa: Syllabic Projection

        a.  /a:/         b. /a{u,w}/

```
        R                  R
        |\                 |\
        X X                X X
        |/                 |/
      [+syl]             [+syl]
```

On the other hand, for a language like Huastec(Larsen & Pike,1949; Abdias, Everett, and Walker,1984), long vowels must be distinguished from dipthongs (or VG sequences) for purposes of stress. The rule of accent, which determines what Larsen & Pike refer to as the potential contour point, accents the last long vowel in the word, and in the absence of a long vowel, the initial syllable of the word. This stress rule holds for words of all

categories.  Some examples follow:

(381) Huastec Stress

             /
a. cábal   'cooked corn'  b. tólmiyal  'to help someone'

  /             /
 ch?akay  'revolution'   ?unuhuw  'I sold (it)'

  /             /
 caba:l  'earth'    ?unu:hul  'he/we is selling'

  /             /
 cem0a:b  'being killed  juntsiki:l 'at times'

  /             /
 ce:mla:  'death'    bi:noma:c 'one who gave'

d. ch?ejwaliyal 'to give s.o.'

       /
 jalbintsi:ch 'thank you'

          /
e. jalbintsi:chtala:b 'thanks(instr.,nom.)

The first two forms under (381.a,b) above, illustrate that both VG and VC sequences are unaccented in contrast to t following three forms in each column in which stress falls on the last long vowel in the word.  The distinct behaviour of long vowels and diphthongs leads to stress on the long vowel in /?unu:hul/ 'he/we is/are selling', but initial stress in /?unuhuw/ 'I sold (it).  Given the structures in (379), and the stress facts above, the sequences /uw/ and /u:/ in Huastec must be seen to differ minimally with respect to the [+syllabic] projection:

(382) Huastec: Syllabic Projection
     a. /u:/     b. /uw/
       R        R
       |\        |\
       X X       X
       |/        |
      [+syl]     [+syl]

In this case, one cannot resort to use of the feature [-consonantal] since /u/ and /w/ are not distinct with respect to this feature.  If no structural distinction is posited between the two strings in (382), the syllabic
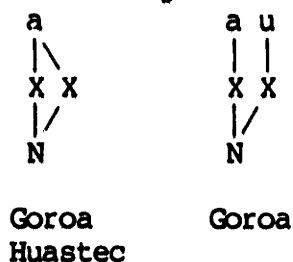
projection must be used to generate the correct stress pattern. If, on the other hand, a structural distinction can be upheld, use of the feature [+syllabic] and projections thereof is no longer necessary. In the following sections we will suggest that all rules of accent are stateable in terms of structural distinctions within the syllable, providing evidence for N-projections. Furthermore, pointing to the absence of available segmental information, we argue against a model in which distinctive features, including [+syllabic], can be accessed through the skeleton.

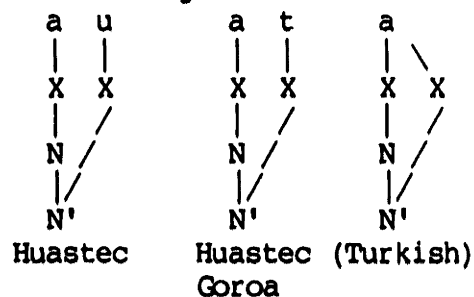4.1.2 Evidence for a Structural Theory of Accent

Because the only difference between the structures in (280) and (382) is the [+syllabic] projection, within a metrical theory of syllabicity, we are forced to represent these as structural differences as shown in (383). Within the metrical theory, the difference between VG sequences in Goroa and Huastec, is translated into a dist:nction between branching N and branching N':

(383)
a.  Branching N          b.  Branching N'

```
    a          a u            a   u       a   t       a
    |\         | |            |   |       |   |       | \
    X X        X X            X   X       X   X       X   X
    |/         |/             |   /       |   /       |   /
    N          N              N  /        N  /        N  /
                              |/          |/          |/
    Goroa      Goroa          N'          N'          N'
    Huastec                   Huastec     Huastec  (Turkish)
                                          Goroa
```

The metrical theory makes different predictions from one using the [+syllabic] projection, in that, as illustrated above, a surface VG sequence within a single language could be either the realization of a branching N, or

a branching N'. Within the segmental theory of syllabicity, the two sequences would appear to be identical segmentally (either both [+syllabic], or both [-syllabic]), and thus would both count as either light or heavy for the purposes of stress assignment.

Facts from Kabaridian(Kuipers,1960), a language of the Circassian family, appear to support the metrical approach. In Kabardian, tautosyllabic diphthongal sequences /^w, aj, ^w, aw/ are produced as [i:,e:,u:,o:] respectively. According to Kuipers, these vowels are often pronounced slightly diphthongal, especially at the end of a word, where j- and w-offglides are usually present,cf. baj 'rich', bajd^da 'very rich', and baj^n 'to be rich', phonetically be:(j). Kuipers describes two different types of tautosyllabic vowel-glide sequences:
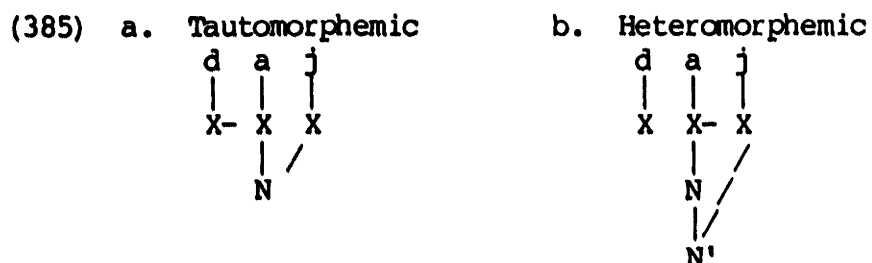
> As a result of fusional juncture, the notations Saj,Saw can refer to two morphologically different states of affairs: in part of the cases a segment Z(a) is combined with a fused segment ja or wa, resulting in Z-ay, Z-aw, and in part of the cases a segment Za is combined with a segment j or w, resulting in Za-j, Za-w, where there is no fusion but a plain combination of an open and a close segment.(p.58)

Under closer scrutiny, the difference between the "fused" and "non-fused" forms appears to depend on the glide, which is always realized when separated from the preceding vowel by a morpheme boundary, and on the quality of the vowel. In the fused forms, the vowel assimilates to the following glides, whereas in non-fused forms, it is more likely to be effected by the preceding consonant:

(384)
```
    a. /d-aj/      [de:(j))]     'nut tree'
    b. /da-j/      [doej]        'coating together with...'
    c. /z-aj-n/    [ze:jn]       'to sleep'
    d. /za'-jn/    [zajin]       'large mouth'
```

We propose that the different phonetic realizations of the vowel-glide sequences in (384.a,b) is a result of differing surface syllabification of these strings. The structural difference we are suggesting is depicted below:

(385)  a.  Tautomorphemic          b.  Heteromorphemic

```
         d  a  j                      d  a  j
         |  |  |                      |  |  |
         X- X  X                      X  X- X
            | /                          | /
            N                          N /
                                       |/
                                       N'
```

Complex nuclei of the type shown in (385.a) are marked in underlying representation in accordance with the MPC. Kabardian contains no rules of complex-N formation, so that derived sequences of [-cons] segments are subject to Project-N', the output of which is shown in (385.b). While the forms in (384.a,b) are clearly compatible with other proposals, in particular one in which the glides are [+syllabic] and [-syllabic] respectively, the forms in (384.c,d) provide evidence for a structural distinction between the two phonetically differing diphthongs. Notice that in (384.d) epenthesis occurs before the final nasal, whereas no such rule applies in (384.c). In his reanalysis of the Kabardian vowel system, Shlonsky(1984) proposes that the predictability of [-high] vowels in Kabardian is a consequence of a rule of epenthesis which inserts a nucleus to the right of an unsyllabified slot after Project-N'', but before Project-N'. Epenthesis feeds a rule of [^]-Deletion which deletes a ^ in an unstressed syllable. Shlonsky's rule of epenthesis is relevent to our dircussion since the glide in /z-aj-n/ does not trigger epenthesis, while that in /za-jn/ does. This leads us to believe that the glide in /-aj-/ is never stray, a fact consistent with the position

that fusion is another word for what we are calling a complex nuclei. A distinction between [+syllabic] and [-syllabic] or [0syllabic] is unavailable here, since the original form of the tautomorphemic VG sequences is often GV, where G is clearly [-syllabic] (cf. Kuipers,pp.58-62). Without a distinction in syllable structure, one is unable to explain the inalterable status of the tautomorphemic VG clusters which in all aspects appear segmentally identical to their heteromorphemic counterparts.

In 2.2 we presented an analysis of Mohawk stress in which structural information was necessary, including the presence or absence of association to the segmental plane, but actual segmental features, including [syllabic] did not play a role. Recall as well our analysis of tense versus lax mid vowels in ancient Greek in 3.1. There we proposed that the mid vowels had two distinct structural representations: $[_{N'}\underline{XX}]$ and $[\underline{XX}]$. Thus it appears that accessing the syllabic projection for purposes of stress assignment still leaves certain structural distinctions unaccounted for, while the metrical proposal, which has no access to segmental information, predicts just such structural distinctions to exist.

While the syllabic projection is underdetermined in terms of the needed structural distinctions discussed above, it also appears to overdetermine the class of possible accentual systems in universal grammar. Given access to the segmental plane, the absence of stress rules sensitive to feature projections other than [+syllabic] or [+consonantal] is left unexplained. In particular, feature projections of [+high],[+round], [+back] etc. are clearly motivated in autosegmental analyses of vowel harmony systems, leading us to ask why such projections do not figure into stress systems. If feature

projections are accessible to accent rules, a system in which the rimes op.,ow.,up.,uw., are accented but ap.,ot.,uk.,uy., are not, (the relevant projection being [+round]) is just as likely as those shown in (383) above.

In fact, Prince(1983) suggests that such gaps might not be accidental. He proposes an alternative to structural accent based on the sonority scale. Noting that accentual rules operate on a hierarchy of inclusiveness of the form VV > VR > VC > V, Prince suggests that

> the heavy-light distinction is really one of sonority, not geometry. A heavy syllable encloses significantly more sonority than a light syllable...Finer distinctions in the sonority hierarchy might also be expected to play a role in determining the heavy and light classes for some languages, or otherwise influence the distribution of stress. We might look for a distinction between high vowels and all others or between the various obstruents, or seek a language where the light-heavy line falls between (say) vowel-liquid and vowel-nasal sequences. Perhaps the stress avoiding character of "reduced" or central vowels can be understood in these terms as well.(p.58)
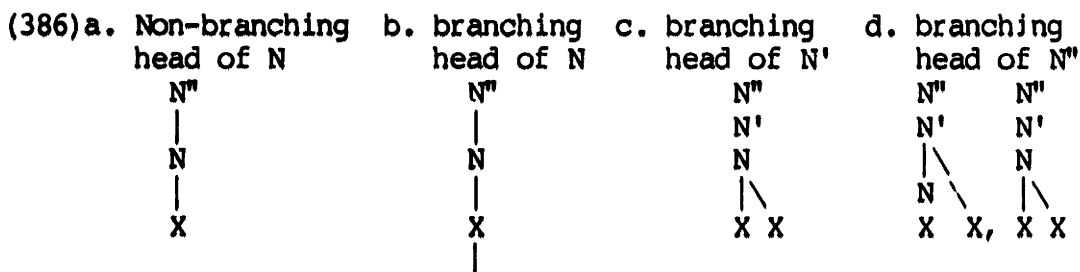
Having looked in vain for stress rules which require finer distinctions in sonority within the rime, it appears that the null hypothesis is that such rules do not exist.[2] We take the strongest claim here and argue that such rules could not exist. Rules of accent are structure building rules sensitive to branching versus non-branching within N‴. Within a theory in which [+syllabic] is not available as a distinctive feature to begin with, the absence of more diverse feature-based systems is not called into question, since the most basic distinctions such as those exemplified in

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2. We refer to sonority distinctions within the rime or N', since the accentual rules we are most familiar with take N' as the domain of accent. However, recent work by Davis(1985) and Everett(1985) points to the existence of rules sensitive to branching at the N‴ level.

(383) must be structural.

If accent is defined on N-projections alone with skeletal-slots as terminal elements, then reference to distinctive features is unavailable. Given accent rules which clearly refer to the internal structure of N″, and the absence of rules which must be stated in terms of distinctive features, we will adopt what appears to be the null hypothesis, and the more restrictive theory, namely that accentual rules have access to the N-tier and nothing more. In accord with the Skeletal Access Hypothesis put forth earlier, skeletal slots as terminal elements of syllables are marked as either projecting or not projecting to the segmental (or other) plane, a property which, as we will see, does appear to play a role in phonological rules of accent assignment as well as in skeletal transformations.

Rules of N-placement, coupled with the proposal that the skeleton is intrinsically featureless, make it necessary to represent tautosyllabic long vowels as branching Ns, while in most cases, tautosyllabic vowel-consonant sequences determine branching N's. In addition, as mentioned above, among phonological representations, we are able to distinguish between X-slots which project to a specific plane, and those which do not. Within such a system, the original dichotomy prosposed by Hayes is reformulated as a four-way division of N-projections, as illustrated in (386).

(386)a. Non-branching     b. branching     c. branching     d. branching
        head of N           head of N        head of N'       head of N″
        N″                  N″               N″               N″      N″
        |                   |                N'               N'      N'
        N                   N                N                |\      N
        |                   |                |\               N \     |\
        X                   X                X X              X  X,   X X
                            |

Non-branching or degenerate heads will only be significant is cases where branching at the N or N' level is non-significant. That is, if a rule of accent is stated as 'Accent the head of N" iff branching', a closed syllable will be accented regardless of whether or not its head is degenerate. This is the case in Mohawk for instance(Michelson,1985;Gorecka,1985) where closed syllables containing epenthetic vowels will be accented like other closed syllables, but open syllables with heads inserted by epenthesis appear not to count at all in the assignment of quantity insensitive feet.

The possibility also exists that both N and N' will branch. In this case we have the following structure:

(387)
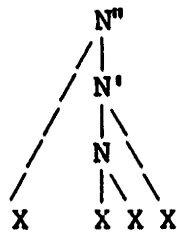


We turn first to a variety of stress rules which motivate the four structurally distinct N-projections in (386). We will show that within a single language, it is necessary to make regular distinctions between branching heads at the $N^0$ and N' level, and N" level. Next, we will illustrate how a statement of accent in terms of X-bar levels accounts for the seeming linguistic universal first noted by Hyman(1977): if a language accents a branching rime, it will also accent long vowels and dipthongs as well. We account for this generalization without predicting, as does Prince(1983), that segmental distinctions are relevent.

Hyman's generalization is a one-way implicational statement, as there are

numerous languages like Huasteco, where long vowels but not closed syllables are accented. In terms of the X-bar schema, this implicational universal falls out from the notion of head in X-bar theory. For the moment, we restate the generalization as follows: if accent branching N', then accent branching $N^0$.

### 4.1.3 Rules Motivating the N-Projection

Latin, as we saw earlier is a case where a branching N' as well as a branching N is accented. By restating the accentual component of the Latin stress rule in terms of head relations, as in (388), we capture the desired dependencies.[3]

(388) Accent the head of N" iff branching. (Latin)

The within X-bar theory, the head of $X^n$ is $X^{n-1}$. So, the head of N" is that projection of N which it immediately dominates. Looking back at (386) then, we see that the head of N" is N in (386.c) while in (386.d) the head of N" is N'. Thus, a statement of accent in terms of head and projection captures the light versus heavy syllable distinction without further stipulation. Other languages having the accent rule given in (388) include Koya(Tyler,1969), Creek (Haas,1977), Yana (Sapir and Swadesh,1960), and Hopi (Jeanne,1978).

However, as is well-known, languages which accent long vowels do not

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3. This rule of accent is of course supplemented with final syllable extrametricality and rules of foot construction. From this point on we will limit our discussion primarily to the accentual component of metrical theory, giving the formulation of later rules of foot/grid construction, clash resolution etc. only where crucial to the argument.

necessarily accent closed syllables. Take for instance Aguacatec Mayan(McArthur & McArthur,1956). In this language, stress falls on the rightmost syllable with a long vowel and in the absence of long vowels, on the final syllable. Several examples are given below.

(389)
- a. há:lu? 'today'
- b. kása?[4]
- c. ?é:q'um 'carrier'
- d. ?úmul 'rabbit'
- e. ?intá: 'my father'
- f. q'us.q'úh 'delicious'
- g. cinhoylíhc 'they search for me'

Recall that because rules of N-placement come under the Condition on Structure Dependent rules, monosegmental geminate syllable heads project onto the N-tier as one and only one N. Given this, the rule of accent in Aguacatec Mayan can be stated as follows:

(390) Accent the head of N' iff branching.(Aguacatec Mayan)

The head of N' is that N projection which it immediately dominates, namely $N^0$. In Aguacatec, branching Ns include the long vowels a:,e:,i:,o:,u:. Other languages exhibiting the accent rule in (390) include Huasteco, as discussed above, and Khalkha Mongolian, Malayalam(Mohanan,1982) and Menomini as analyzed by Pesetsky(1979).

We have claimed thus far that metrical rules of accent have access only to N-projections. Such a claim requires that rules of accent be stated in terms of the projections N, N', and N". The two rules motivated thus far are the

--------

4. A glottal stop is inserted word-finally after a short vowel, so that underlyingly both of these final syllables are non-branching at the N and N' level. No forms with sequences of long vowels were cited.

following:

(391)  a.  Accent the head of N" iff branching.
       b.  Accent the head of N' iff branching.


In each of the languages discussed up to this point, either (391.a) or (391.b) has played a role in stress assignment, but not both. Given this situation, it is not necessarily the case that both the N and N' levels are motivated. For instance, it could be the case the languages with accent rule (391.a) have syllables of the kind shown in (392.A) below, while languages with rule (391.b) have syllables of the type shown in (392.B).

```
(392) A. N"   N"    N"    N"        B. N"    N"    N"        N"
         |    |     |     |            |     |     |\        |\
         N    N     N     N            N     N     N \       N \
         |\   |\    |\    |\           |\    |\    |  \      |\ \
         X X  X X   X X   X X X        X X   X X   X   X     X X X
         |/   | |   | |   |/  |        |/    | |   |   |     |/  |
         V    V V   V C   V   C        V     V V   V   C     V   C
```
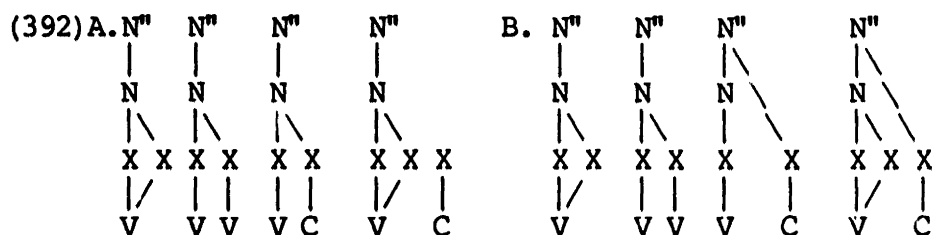
These two syllable types differ minimally in that in the first case, (392.A), any post-nuclear segment may form a complex nucleus, while in (392.B), only categorial heads appear within N, all non-heads being taken in at the N" level. If languages could differ minimally in this respect, the rule of accent could be stated simply as follows: Accent the head of N" iff branching. In languages of type (392.A) both long vowels, (diphthongs) and closed syllables will be accented, while in (392.B) only long vowels (diphthongs) will be accented.[5] This possibility is not available however,

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5. The system in (392.A) is similar to the "nucleus-projection" of Clements & Keyser(1983), though they propose such representations to be available universally. In addition, within the CK proposal, the nucleus projection is not a subconstituent of the syllable, but rather a prosodic category consisting of any and all tautosyllabic sequences of the form V(X), where X

in light of evidence from certain languages which appear to have both rules
of accent in (391).[6]

One such language is Klamth, as described by Barker(1964). Primary stress
in Klamath is said to occur on the last long vowel preceding a juncture,
regardless of whether or not the long vowel occurs in an open or closed
syllable. This is apparantly an instantiation of rule (391.b) above. Thus,
we find the following:[7]

(393) Klamath Main Stress: (391.b)

a.  niśqa:k          'little girl'(G37)

b.  s?awí:ga         'is angry'(G37)

c.  ga:mó:la         'finishes grinding'(G35)

d.  cata:wípga       'is sitting in the sun'(G35)

e.  gawí:napgabli    'is going among again'(G37)

However, in polysyllabic sequences containing no long vowels, primary stress
falls on the penultimate syllable if and only if it is a closed syllable.
The component of the stress rule appears to be an instantiation of (391.a)

---

ranges over single occurences of C and V. Within such a theory, accent must
be determined on the syllabic projection, as put forth by Hayes, for
languages like Huasteco or Goroa, which exhibit rule (391.b). This access to
the segmental tier has the same problems as those discussed above.

6. Also note that this system is incompatible with the generalization noted
in 2.1.6 (227.C), that a segment cannot be interpreted as adjoined if subject
to N'-projection.

7. I have restricted myself for the most part to forms cited in Barker's
discussion of stress, since elsewhere, stress is not marked.

above. Examples of such primary stress follow:

(394) Klamath Main Stress: (391.a)

a. gépgi                  'come'(G37)

b. táktak              'redly'(G36)

c. taktákli             'red'(G36)

d. gatbámbli           'returns home'(G37)

e. gankanktkdámnɔ      'used to habitually hunt'(G37)

f. ldagalblínannwi     'picks a round obj. right back up'

In sequences containing no long vowels, where the penultimate syllable is not closed, primary stress falls on the antepenult, or in disyllables, on the penult:

(395) Klamath Main Stress: Quantity insensitive

a. glégatk            'dead?'(G38)

b. bóco              'wild celery'(G37)

c. ʔápʔota          'promises'(G,36)

d. cáwiga           'is crazy'(G36)

The rules assigning primary stress in Klamath then must be sensitive first to branching at the N level only, and in the absence of long vowels, to branching at the N' level, at least in the penultimate syllable. That is, the first component of Klamath stress assignment is identical to that in Huasteco, while the last is identical to the Latin stress rule. Stress in Goroa(Seidel,1900), as noted earlier, falls on the leftmost long vowel or diphthong. In the absence of a long vowel, stress falls on a final closed syllable, and elsewhere on the penult.The stress rule of Goroa, then,is identical to that in Klamath, with exception that the word tree is left

dominant as opposed to right dominant, and the final syllable is not extrametrical. Given such systems, the hypothesis above, that all rules of accent are stateable in the form "Accent head of N" iff branching", with parameterization of incorporation rules, can not be maintained. Both accent of branching N' as well as branching $N^0$ must be available in Klamath and Goroa, thus lending furthur empirical support to the claim that N-projections, N, N', and N", are accessed by phonologcial rules.

4.1.4 A Reanalysis of Full versus Reduced Vowels

Given access to the N-projections, with X-slots as terminal elements, however, our theory also predicts that a stress rule could distinguish between $\underline{X}$ and $\underline{X}$ , repeated below from (386):

(396)     a. Non-branching Head          b. Branching head
             of N                           of N
              N                              N
              |                              |
              X                              X
                                             |
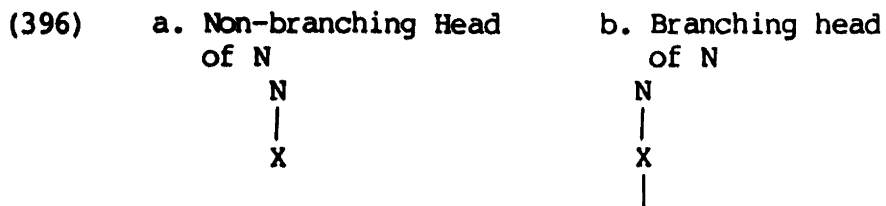
We argue that this is the case in languages which distinguish between full and reduced vowels.

Hayes(1981) argues that full versus reduced vowel distinctions be represented as underlying distinctions in vowel length, translated as we saw above as branching versus non-branching on the [+syllabic] projection, or in its updated form, as a distinciton between branching and non-branching nuclei. His arguments for this representation were twofold. First, he claimed that such a distinction was motivated on phonetic grounds, since full vowels are phonetically longer than reduced vowels. Second, such a

representation would account for the apparent lack of languages having an underlying three-way distinction between reduced vowels, full short vowel, and full long vowels.

In response to the first point, we note that certain systematic phonetic length distinctions never appear to play a role in stress systems. Though vowels are typically longer before tautosyllabic voiced consonants than before tautosyllabic voiceless consonants, such distinctions are consistantly ignored by rules of accent such as those given in (391). The distinction [+round], attested in certain languages is realized phonetically in terms of vowel length as well as a variety of other factors, though again, no such distinction has been found to play a role in stress systems. The fact then that certain vowels are phonetically longer than others does not appear to map consistently onto a short versus long distinction on the skeletal tier.

With regard to the second point, the fact that there are no languages with underlying distinctions between reduced, full, and long vowels is claimed to "follow automatically from the assumption that both the full-reduced and the long-short distinctions must be represented underlyingly as gemination"(Hayes,p.57). However, such an account leaves unexplained the fact that phonological rules, including those of accent, can distinguish between reduced, short, and long vowels.

A case in point is the metrical phonology of Tiberian Hebrew. In Tiberian Hebrew(Prince,1975; McCarthy,1981; Hayes,1981; Rappaport,1984) phonological rules are shown to distinguish between long, short, and ultra-short reduced vowels. Though the majority of ultra-short vowels are derived via vowel-reduction, hateph vowels arise via what McCarthy(1981) has anaylzed as

a lexically idiosyncratic rule of Post Guttural Epenthesis. The epenthetic vowel surfaces as a reduced copy of the preceding vowel, as shown in (397):

(397)
|   | / | | / | |
|---|---|---|---|---|
| a. | ya9mod | ---> | ya9amod | 'he will stand' |
| b. | he9miid | ---> | he9emiid | 'he stood s.o. up' |
| c. | ho9mad | ---> | ho9omad | 'he was stood up' |
| d. | ca9cuu9 | ---> | ca9acuu9 | 'play thing' |

The need for morphologically conditioned phonological rules has been brought under much scrutiny in the work of Marantz(1984,1985). In light of such work, a derivation such as (397.a) above could be replaced with the underlying representation below:

(398)
```
        y   9   m       d
        |   |   |       |
        X X X X X X X X
        |           |/
        a           o
```

After vowel reduction, a later rule of vowel spread, necessary under either analysis, will produce the desired surface forms. Such an analysis differs from that proposed by McCarthy in that certain morphological forms have a marked representation in the lexicon. However, now we see that a representation such as that in (398) exhibits precisely the three-way distinction which Hayes claimed not to exist.[8]

Even if such a distinction is not available underlyingly, it is certainly available within the lexical phonology of Tiberian Hebrew. The rules of main

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8. Note that we posited the same three-way distinction in our analysis of the Sanskrit full/zero grade paradigms.

stress and reduction proposed by Rappoport are sensitive to such distinctions. Reduced vowels, which are all characterized as vowels lacking an associated melody, are not represented on the metrical grid, and are subject to the rule of Vowel Deletion, while full vowels and long vowels are present on the grid and do not undergo Vowel Deletion. Furthermore, long vowels are distinct from short vowels in that only short vowels undergo reduction. Secondary stress appears to accent long vowels but not closed syllables. Finally, the main stress rule must distinguish final open syllables from closed syllables. Thus, it appears that Tiberian Hebrew makes use of the full range of structural distinctions given in (386) and repeated below:

(399) Structural Distinction of Syllable Types in Tiberian Hebrew

```
     a. degenerate   b. non-branching  c. branching    d. branching
        head of N"       head of N"        head of N'      head of N"
          N"               N"                N"              N"
          |                |                 |               N'
          N                N                 N               |\
          |                |                 |\              N \
          X                X                 X X             X X
```

| | a. | b. | c. | d. |
|---|---|---|---|---|
| Accent (Main Stress) | – | – | – | + |
| Accent (Sec. Stress) | – | – | + | – |
| Reduction | + | + | – | – |
| Deletion | + | – | – | – |

We will return to certain exceptional features of the accent rules of Tiberian Hebrew in the following section. For the moment, what is important is that an account of reduced versus full vowels as equivalent to a long versus short distinction will fail to produce the four-way distinction made necessary by the phonological rules of Tiberian Hebrew listed above. We conclude then that the reduced versus full vowel distinction be reanalyzed as

one of branching versus non-branching skeletal slots, where branching is defined as a purely geometrical property of intersecting line segments.

Notice that by relating the status of reduced vowels to their lack of projection onto the segmental plane, we explain straightforwardly why long reduced vowels will never be distinct from short reduced vowels. If length is represented as linking of a single feature matrix to multiple skeletal slots, and if reduced vowels are just those vowels with no associated feature matrices, then it follows that reduced vowels will never be long.

The proposal that full versus reduced vowels in stress systems correspond to segmentally specified versus unspecified skeletal slots as N-terminals also makes a strong prediction, given the theory of Underspecification proposed by Archangeli(1984a): namely, it should follow that "reduced" vowels, treated as metrically weak, correspond to the unmarked or epenthetic vowels of a particular language. As we have seen, the facts from Tiberian Hebrew support such a claim, since "reduced" vowels are essentially empty skeletal slots which receive features via redundancy rules ([^]) or local rules of vowel-spread(the hateph vowels).

Facts from Eastern Cheremis also support an analysis of full versus reduced as an underlying $\underline{X}$ versus $\underline{X}$ distinction. Hayes' description of stress in Eastern Cheremis is as follows: stress falls on the last full vowel of a word, and on the initial vowel if the word contains only reduced vowels. Hayes sights the following examples where full versus reduced vowel is

represented as long versus short

(400)      /                              /
     siincaam        'I sit'        slaapaaz^m    'his hat(acc.)'
     /                              /
     puug^lm^        'cone'         kiid^st^z^    'in his hand'
     /
     t^l^z^n         'moon's'


Stress assignment is accounted for within Hayes' system by the rules in

(401):

(401)    a.  Projecting [+syll] segments within the rime, forms a
         left dominant, unbounded foot at the right edge of the word.

         b.  Form a right dominant word tree.


This account is not altogether consistent with the data presented in Ingemann

and Sebeok(1961).  First, they state that in words in which any final vowel

is immediately preceded by a full vowel, stress may either fall on the final

syllable, or on the penultimate syllable.  Forms illustrating this are given

in (402):

(402)      /                /
     a.  pire       ~    pire           'wolf'
         /                /
     b.  korno      ~    korno          'road'
         /                /
     c.  kits^m     ~    kits^m         'his hand(acc.)'
                          /
     d.  slapaz^m   ~    slapaz^m       'his hat(acc.)'


If the penultimate vowel is [^], then stress will fall on the final vowel or

on the closest full vowel, and in the absence of a full vowel, on the initial

vowel.  Thus we have:

(403)      /                    /
     a.  pug^lmo    ~    pug^lmo        'cone'
         /                    /
     b.  kid^st^ze  ~    kid^st^ze      'in his hand'
         /                /
     c.  t^l^z^n    ~    t^l^z^n        'moon's'


vowel.                         - 297 -

According to I&S, which of the two alternant stress patterns occurs will depend on overriding aspects of intonation, rhythm and other factors.

If we describe the stress patterns in columns I and II separately, we see that column II is merely a rule of word-final stress (right-dominant quantity insensitive word tree.) The column I forms may be accounted for by a rule of quantity sensitive foot construction, given that final syllables are treated either as accented or as extrametrical.

An account in which the final syllable is accented is preferable to an extrametricality solution for two reasons. First, it allows for a unified treatment of the forms in columns I and II above. Secondly, this account is consistent with a particular property of vowel harmony, namely that word-final /ˆ/'s harmonize, though medial /ˆ/'s do not. Underlying /kobastˆ/ 'fur, skin' surfaces as [kobaste], but when suffixed as [kobastˆze] 'it's fur'. If DTE's determine the projection for vowel harmony, such facts follow straightforwardly.

We can account for the forms in column I then by the following rules: Accent the final syllable; accent all "full" vowels; build a quantity sensitive right-dominant unbounded foot; allow word tree to be either left or right dominant (depending on other prosodic factors); interpret word level stress only.[9]

--------

9. The theory of quantity sensitive feet adopted is that proposed by Hammond(1985a), where recessive nodes of QS feet may branch. See Hammond(1985a,1985b) for discussion. The option for left- or right- dominant word tree may be reformulated as a rule of retraction, though not enough evidence is available to determine the conditions on such a rule. Note that

Adopting the hypothesis that rules of accent have access to the the
N-projection alone, the distinction in Eastern Cheremis between the full
vowels /i,e,u,u,o,o,a/ and the reduced vowel /^/ cannot be expressed as a
distinction on the segmental tier. Expressing the reduced versus full
distinction as one of quantity, as Hayes does, runs afoul, as the reduced
vowel /^/ surfaces under harmony as [e],[o] or [o]. In (404) we see harmony
of the inessive suffix /-k^-/:

```
(404)a.  codraste      'to the forest'
     b.  port^sko      'to the house'
     c.  surt^sko      'to the home'
     d.  surt^sk^zo    'to his home'
```

If the vowel of the inessive suffix /-k^-/ is distinguished from that in the
lative suffix /-es-/, as assumed in Hayes and illustrated in (405), then the
harmony rule exemplified in (404) must be anaylzed not only as rightward
spread of the features [+round] and [-back], but also as a lengthening rule,
since the surface full vowel variants of /-k^-/ are indistinguishable from
underlying full vowels.

```
(405)   a. inessive /-k^-/        b. lative /-es-/
               k ^                      e  s
               | |                      |\ |
               X X                      XX X
               |                        |/
             [+syll]                  [+syll]
```

However, if as required within a metrical theory of syllabicity, the
distinction between full and reduced vowels in Eastern Cheremis is
represented as shown in (406), the accents on which stress and vowel harmony

--------

regardless of the particular theory in which rules of quantity sensitivity or
word-tree construction are made, the crucial point of our discussion is
upheld: that reduced versus full vowels exemplify the minimal distinction
predicted between X and X.

depend can be assigned as in (407):

(406) a. inessive /-k^-/          b. lative /-es-/

```
        k                          [ ]  ε
        |                           |   |
       X X                         X   X
        |                           |
        N                           N
```

(407)   A. Accent head of final N"
        B. Accent head of N iff branching


The rule of vowel harmony can then be stated as follows:

(408) Vowel Harmony in Eastern Cheremis
    {[+round],[-back]}

```
      |  \
      |   \
      |    \
     X...X          (Where * signals accent, or DTE of
       |             a foot.)
       N
       *
```


An interesting fact which supports this analysis is the treatment of words

which are lexically accented.[10] One such word is the recent loan word

/botinga/ 'shoe' from Russian /botinki/ 'boots, high galoshes'. According to

Sebeok, the final vowel in this word is unstressed. When in final position,

it surfaces as [a], but when the plural suffix is added, the final vowel

surfaces as a /^/: boting^-blak 'shoes'. Given that stress falls

consistently on the second syllable, and not on the final syllable, as

predicted by (407.A) above, this vowel must be marked as extrametrical in UR,

---

10. While only one example is given by Sebeok(1961), he states: "Unstressed
final /a/ in recent Russian loanwords is also replaced by /^/." Whether or
not this is related to the unstressed quality of post-main stress /a/ in
Russian is unclear.

as shown in (409.a):

```
(409)  a.  b o t i n g a            b.  b o t i n g a   b l a k
           | | | | | | |                | | | | | | |   | | | |
           X X X X X X X                X X X X X X X   X X X X
               |   |   |                    |   |       |     |
               N   N  (N)                   N   N       N     N
Lexical*:      *                            *
(407.B):   *                            *               *
           /                            /               /
Stress: botinga                   boting^blak ~ boting^blak
```

Under suffixation however, the final /a/ is no longer peripheral and
therefore is uninterpretable as extrametrical. If lexical accent is to be
preserved on the stem, the stem final vowel must be skipped over by the
accent rule (407.B). But it will only be skipped if it does not project to
the feature tier. Lexical accent then is preserved by the delinking of [a]
from the X-slot. The surface realization of this vowel as [^] is a
consequence of the redundancy rules [ ]--->[-high], [ ]--->[-round], and [
]--->[+back].[11]

The fact that the "reduced" vowel in Eastern Cheremis is a vowel which in
UR does not project to the segmental tier is apparent in that such a vowel
undergoes rounding and backing harmony while other vowels in final position
do not. In Ossetic(Abaev,1964) evidence for the reduced versus full vowel
distinction as one of underlying X versus X is also available, though in a

---

11. Another possible analysis is to mark the second syllable of /botinga/ as
both DTE at the foot and word level, and to have the feature matrix of /a/
floating in UR. Under this analysis, the final syllable is not marked as EM.
Linking, like vowel harmony will operate on the projection of accented Ns,
thus, linking will be possible in word-final position, as a result of (407.B)
but not under suffixation. This solution is curious in that it requires
lexical accent at two levels, foot and word-tree, however it is supported by
the existence of the form [boting^blak^m] where stress is marked on the
second syllable, indicating that both rules in (407) are overridden.

slightly different form.

The vowel system of Ossetic poses in interesting problem for our proposal, since there appear to be two distinct reduced vowels. The vowels are divided into strong and weak as follows:

(410) Ossetic Vowels:  strong:  a e i o u    weak: ^   ae

/ae/ is described as a low mid central vowel, more fronted than [a], while /^/ is described as "an indefinitely colored vowel, pronounced with the lips and tongue passive; formation-wise, it, like /ae/ belongs to the central vowels, but is more close; in phonetic transcription is is designated by the sign ^." Though the strong vowels can be traced historically to long vowels or diphthongs, and the weak vowels to the short vowels, Abaev notes that in the modern language quantitative distinctions between vowels are not phonemic. However, the two sets of vowels behave differently in the modern language. The weak vowels are subject to weakening and deletion in certain environments:

(411) a. aeznag    ---> ^znag ---> znag      'enemy'
      b. b^ru      --->  bru                 'barrier'

The weak vowels are also inserted as prothetic vowels before consonant clusters:

(412) a. xsar    --->   aexsar             'valor'
      b. st^n    --->   ^st^n              'get up'

If, as predicted within UT, the epenthetic vowel is the unmarked vowel, epenthesis and vowel deletion can be formulated as follows, with no reference to segmental information:

(413)  a.  Vowel Deletion                    b. Epenthesis
           $\underline{X}$ ---> 0 / __ N"              0 ---> $\underline{X}$ / __ X'

Most importantly for our analysis, strong vowels are accented, while weak

vowels are not. The stress rules, as formulated by Abaev follow:

> The occurrence of stress both in separate words and in accentual
> groups, is subject to the following regularities: 1. The stress
> falls only on the first or second syllable of the word or
> word-group. In words adopted from Russian in very recent times,
> this rule is violated -- namely, the stress occurs as in
> Rusian... 2. If there is a strong vowel in the first syllable,
> then the stress falls (with rare exceptions) on the first
> syllable... 3. If there is a weak vowel in the first syllable,
> then the stress falls on the second syllable.(p.11)

Examples are given in (414).

(414)      /
     a.  [sudzag]            'burning'
            /
     b.  [ma-taers]          'do not be afraid!'
              /
     c.  [mae-cin^g]         'my book'
              /
     d.  [saenaefsir]         'grapes'

These facts lend themselves straightforwardly to the analysis we are

proposing, namely that where there is no motivation for length distinctions,

a rule of accent may refer to the presence versus absence of linked segmental

features. Within UT, the weak vowels in Ossetic are analyzed as unspecified

in UR. The fact that vowels inserted by epenthesis may surface as either

[+high] (/^/) or [-high] (/ae/) may be determined by the surrounding

consonants. However, in UR we still must distinguish such near minimal pairs

as /taest/ 'eye' and /t^xt/ 'cheese'. We propose that such minimal pairs be

distinguished by the presence or absence of a floating [+high]:[12]

(415)  a.   t   s t              b.    t [+high] x t
           |   | |                    |         | |
           X X  X X                   X    X    X X

The rule of accent for Ossetic may then be formulated as follows:

(416) Ossetic Accent:  Accent head of N iff branching

Such a rule will be followed by construction of a single binary right-dominant foot at the left-edge of the word, where recessive nodes may not branch.[13]

The alternative analysis suggested by Hayes in which reduced versus full vowels in Ossetic are represented as short versus long on the skeletal tier is faced with a highly marked segmental inventory:[14]

(417)  a:  e:  i:  o:  u:            ae  ^

Crothers(1978), as well as the more recent inventory of the Stanford Universals data base, observes that no language has underlying long and short

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12. The seeming absence of any minimal pairs looks accidental, though a thorough study of the distribution of these two vowels could shed light on certain phonological regularities.

13. An alternative analysis involves a rule of extrametricality instead of the accent rule in (416): make the first N extrametrical iff X. This would be followed by construction of a left-dominant word tree. Whether or not such an analysis is feasible depends on the types of exceptions to Abaev's clause 2. above. In any case, a distinction between X and X is necessary. This distribution of strong and weak vowels is also apparently important for prosody determining to some extent the rythmical accuracy of the verse(p.5), though no data bearing on this is cited.

14. In fact, the underlying inventory for Eastern Cheremis is even more marked, as it would contain a single "short" vowel and multiple "long vowels".

vowels where there is a single short vowel, but multiple long vowels. An alternative to Hayes, that of referring directly to the segmental tier in the formulation of accent rules, is not only unconstrained, but also poses technical problems, since neither /a,e,i,o,u/ or /ae,^/ appear to form a natural class. The analysis proposed above, in which accent rules are seen to distinguish between $\underline{X}$ and $\underline{X}$, lends further support to the claim that rules of accent are limited to the N-projection, and to the representation of the skeletal-tier as a sequence of empty timing slots, in conformity with the Skeletal Access Hypothesis.


## 4.1.5 Summary and Possible Exceptions

Thus far, we have shown that a constrained theory of accent in which rules apply to N-projections provides strong motivation for the X-bar theory outlined above. The structural distinctions motivated thus far appear in (418). The rules of accent proposed up to this point are listed in (419).

(418) Structural Distinction of Syllable Types
```
      a. non-branching  b. branching   c. branching    d. branching
         head of N         head of N       head of N'      head of N"
         N"                N"              N"              N"    N"
         |                 |               |               N'    N'
         N                 N               N               |\    N
         |        .        |               |\              N \   |\
         X                 X               X X             X  X,X X
```
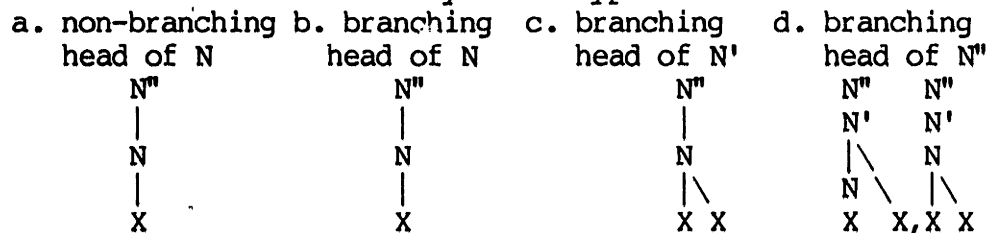
(419) Rules of Accent
 A.  Accent the head of N" iff branching.
 B.  Accent the head of N' iff branching.
 C.  Accent the head of N  iff branching.

Given X-bar theory, if rules of accent are rules of feature assignment to heads of syllables, then it follows that such rules, as listed above, will

refer to the notion "head of $N^X$". The strongest claim then is that accent within metrical theory is constrained to the rule typology listed above. However, there are two apparent classes of counterexamples. The first class consists in languages which are analyzed as accenting closed syllables, but not accenting branching nuclei. The second source of possible counterevidence comes from languages in which the onset, or Spec of N' appears to play a role in stress assignment. We will take each of these on a case by case basis, keeping in mind the arguments laid out above.

4.1.5.1 Accent branching N' but not branching N ?

Tiberian Hebrew, Seneca, and Capanahua have all been analyzed as instances where closed syllables (branching N') must be distinguished from long vowels (branching N) for purposes of stress assignment. In Tiberian Hebrew, the main stress rule(McCarthy,1979;Hayes,1980;Rappoport,1984), which is confined to the last two syllables of the word, stresses a final syllable if and only if that syllable is closed, thus, CVC and CVVC syllables are viewed as accented, while CV and CVV are not. The rule assigning secondary stress accents all syllables with branching nuclei (VV, VVC). In McCarthy's original analysis, final open syllables were marked as extrametrical, and a left-dominant foot was built at the right edge of the word. On the basis of stress shift, and a unified analysis of vowel reduction and pretonic lengthening, Rappoport(1984) suggests the following main stress assignment:

(420)   Tiberian Hebrew Main Stress
        a.  Accent-word final closed syllables
        b.  Construct a bounded left-headed tree at the right
            edge of the word.

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If we can find further support for a right-dominant foot at the edge of the word, the analysis involving final-N extrametricality can be upheld, making Tiberian Hebrew unexceptional with respect to (419.A). In fact, within a constrained arboreal theory such as that argued for in Hammond(1984), where pruning is defined as the sole metrical transformation, restricted to clash environments, extrametricality must be used in TH to create a clash which will subsequently undergo rhythm and destressing.[15] Included then with the stress rules motivated in Hammond(1985a) is the extrametricality rule given below:

(421)   $\underline{X}$ ---> extrametrical / __]

This is essentially the same rule of extrametricality argued for by both McCarthy and Hayes. Though clearly the facts deserve continuing scrutiny, we adopt the extrametricality analysis on both theory internal and empirical grounds. Such an account allows rules of accent to be limited to those given in (419) within a highly constrained theory of metrical transformations.

While the facts from Tiberian Hebrew are consistent with an extrametricality analysis, Seneca stress as analyzed by Stowell(1979) is not so easily dealt with. According to Stowell, stress in Seneca falls on the last non-final even-numbered syllable (counting from the beginning of the word), which is either closed itself, or is immediately followed by a closed

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15. In particular, derivations such as tookal lehem ---> tookal lehem 'she will eat bread.' See Hammond(1984) for a complete discussion of Prune-alpha, and Hammond(1985a) for a purely arboreal treatment of TH.

non-final syllable.  Below are illustrative examples given by Stowell:

(422)  Seneca Stress

             /
a.  wE nO ta? sAs               'they're distributing the goods'
           \  /
b.  ?O? wE nO ta? sah           'they distributed the goods'
       /
c.  ?o?k he yas he:t           'I counted them'
          \      /
d.  ?O kwa tas he ta? tah kOh  'we use it for counting'
         \  /
e.  te ka e O? ta to kEh      'between two guns'
         \   /
f.  te ya ko: nya? so kA: ta:ses  'mandrake'
         \   /
g.  wat ha ak ha* O?        'roads side by side'
       /
h.  wa tek ha* O?         'they are side by side'
         \     /
i.  wat si? ka: ya kah a: tO:s   'rocking chair'

In the examples above, primary and secondary stress falls consistently on even-numbered syllables.  The last two examples show that lexical accent acts as a closed syllable.  Of interest to us is what appears to be the location of the last non-final branching rime within the word.  According to Stowell "Seneca pays no attention to the quality or length of the vowel; instead, is is cued to the branching property of the rime-nodes.  This suggests that the metrical structure which determines the placement of stress is built upon a projection of rime-nodes."(p.63)

Though it appears that long vowels do not figure in stress rules, it just so happens that, in many cases, surface vowel length in Seneca is derived via regular phonological rule.  Several of the lengthening rules are given below:

(423)  Seneca Vowel Alternations(Chafe,1967;p.10)
    a.  A vowel alternates with vowel length after an identical
        vowel.
    b.  Vowel plus vowel length alternates with vowel length plus
        vowel after any vowel.
    c.  Vowel length alternates with zero in a vowel cluster

followed by more than one additional vowel, and after
a vowel preceded by another vowel length in the same
vowel cluster.
d. Any basically weak vowel is automatically followed by
vowel length when the vowel is either final or both
prefinal and even.

In the examples in (422) vowel length in c. and the final two syllables of

f.and i. is derived via (423.d) above. The vowel length of ko: in (422.f)

is a result of the nominal stem /-(h/:)nya?s(a)-/ 'neck,throat' which may be

analyzed as containing an initial empty X-slot:

(424)   a. ? o    n y a ? s a ?         b. w a t e   n y a ? j a ? s
           | | \   | | | | | | |           | | | |\  | | | | | | | |
           X X- X  X X X X X X X           X X X X-X X X X X X X X X
               /                                   /
         [?o:nya?sa?]  'neck,throat'        [wate:nya?ja?s] 'violet
                                            (lit. the neck breaks)'

The length of ka: in [watsihka:yakaha:tO:s] however appears to be underlying:

(425)        /            /
       /-ji?ka:y(a)-/ ~ /si?ka:y(a)-/  'chair(nominal root)'
          /
    a. kaji?ka:ya?              'chair'
         /
    b. kaji?ka:ye:s             'long chair,bench'
            /
    c. watsi?ka:yakaha?t^:s     'rocking chair'
           /
    d. kaji?ka:ya?ke:on^?       'chairman'

But the question of whether or not a: is underlyingly long in this instance

is moot, since the accent indicates that such a syllable acts just as a

closed syllable would.

In fact, all roots listed by Chafe(1967) as having underlying long vowels

are given a lexical accent in their dictionary entry.[16] Such roots appear to obey the same rules as closed syllables in that if they are the last instance of a non-final heavy syllable, they will be stressed in an even syllable, while stress will fall on the immediately preceding syllable if the long vowel is in an odd-numbered syllable. Several examples follow where underlying long vowels are accented by the same rule proposed by Stowell for

_____

16. A lexically marked acute accent on the root indicates what Chafe(1967;p.10) refers to as a basically strong vowel. A basically strong vowel occurs with stress if it is both even and prefinal. If the prefinal vowel of a word is either odd or basically weak, Chafe describes strong stress as occurring on the nearest preceding even vowel that is either basically strong itself, or has somewhere between it and an even pre-final vowel one of the following: a) a basically strong vowel; b) a laryngeal obstruent; c) a cluster of any two obstruents; or d) s plus n or w.

closed syllables:

(426) Seneca: Accented long vowels
   a. /-atkE:ni-/     'be critical'(D,211)

      hotkE:ni:h     'he's critical'

      ?akatkE:ni:h    'I'm critical'

   b. /-atO:nO-/     'to hold a Condolence Ceremony'(D,234)

      ?E:nOtO:nO?s   'they'll hold a Condolence Cer. for s.o.'

      hEnOtO:nO?s    'they're holding a Condolence Cer.'

      ?atO:nOshae?   'Condolence Cer.'

   c. /-kE:yat-/     'put on top, put up'(D,1011)

      kanOhsakE:ya:t  'on top of the house'

      ?akekE:ya:t    'I've put it on top'

      hakOkE:yatani:h  'he's provided it for them'

   d. /-E:wOtE?-/    'be uncle to'(D,51)

      heyE:wO:tE?   'I'm his uncle, my nephew'

      kheyE:wO:tE?   'my neice'

      hOwOyE:wO:tE?  'their nephew'

Given such facts, we may restate the rule of accent in Seneca as follows:

(427)  Seneca Accent
      Accent the head of N" iff branching.

Following the rule of accent, a single right-dominant unbounded foot is built

at the right edge of the word.[17] Then, binary right-dominant feet are built

from left to right. Defooting and stray adjunction incorporate odd-numbered

final accented syllables into the final unbounded foot. Finally,

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17. Here we follow Halle(1983).

left-dominant cola are built from right to left with a right dominant word

tree above. In (429) derivations are given, assuming the following rules:

(428) Seneca Stress Assignment
  a. Accent the head of N''' iff branching.
  b. Build a single Right-dominant quantity insensitive unbounded
     foot at the right-edge of the word, (where recessive nodes
     may not branch)
  c. Build Right-dominant binary quantity insensitive feet
     from left edge (no final EM)
  d. Defoot: | --> 0 / | __
  e. Make final foot extrametrical
  f. Construct a Right-dominant word tree.
  g. Stray adjunction(to right)


(429)  /-kE:yat-/        'put on top, put up'(D,1011)
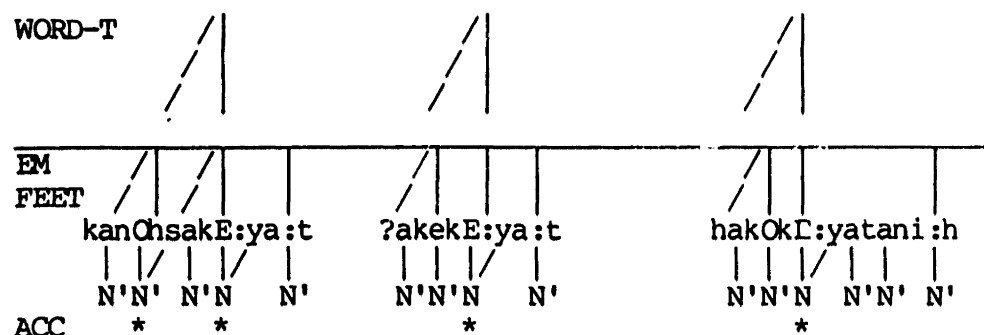


Given that the final foot spans the word up to the first accent, one might

ask what stress pattern occurs if there are no accented syllables in the

word. In this case, no main stress is marked by Chafe. A near minimal pair

appears below, where an underlying long vowel determines main stress, while

no main stress occurs in the absence of an accented vowel:

(430) a. /-atO:r.O-/      b. /-atOni- /    'be of one's father's clan'

  i.  ?atO:nOshae?         ?akatOni:onO? 'people of my father's clan'

  ii. hEnOtO:nO?s          ?akatOni:h    'my father's clan'

The (430.i) illustrates that indeed the vowel in (430.a) is underlyingly long

and that the one in (430.b) is underlyingly short, since neither is subject

to lengthening in this position. The (430.ii) forms show that vowel length

is enough to determine main stress in (430.a), whereas the absence of vowel

length or closed syllables in (430.b) results in a word which has no main

stress. Other words lacking main stress are given below, where in all cases,

all but the final syllable are light, as indicated:

(431) Words without Main Stress
    a.  te.wa.ka.ta.ta.wi:h    'I've traded it'
    b.  ?o.nO.wO.yE?         'it has settled to the bottom'(D,450)
    c.  ?a.ke.ka.we:h        'I'm rowing'(D,950)
    d.  ha.ti.wE.no.ta.tye?s  'the Thunderer's'(D,1816)

In these words, the first unbounded foot spans the entire word and is later

made extrametrical, resulting in the absence of stress altogether. While our

discussion of Seneca is by no means exhaustive, ample evidence for the rule

of accent below has been provided, requiring no modification of the theory

proposed herein:[18]

(432)  Seneca Accent
      Accent the head of N" iff branching.

Having shown Seneca to offer further support to the X-bar theory of

metrical accent, we turn to one final case in which branching N' but not

branching N is said to be accented. The case at hand is that of Capanahua as

analyzed by Safir(1979). All data is from Loos(1969,and p.c.). The stress

rule in Capanahua is quite simply stated:

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18. It should be noted here that if Stowell were to include underlying long
vowels in his rule of accent, we would argue against his approach only in
that it predicts final stress in words like (431.d) above, a point he noted
himself. In contrast to the analysis of Halle(1983) who has a rule of
initial syllable extrametricality with binary left-dominant feet, we choose
the binary right dominant feet with no extrametricality in order to account
for forms with initial stress. Several of these forms appear below, and are
accounted for by the rules in (B.).

Stress in Capanahua falls on the second syllable if it is closed, otherwise it falls on the first syllable.

Several examples of this stress pattern follow:

(433)
a. cósko  'four'      b. sóntako  'young girl'

c. hísis  'ant'       d. yósanbo  'old woman'

e. pískap  'small'    f. cícika  'knife'

An interesting aspect of syllable structure in Capanahua is that the tautosyllabic sequence V? does not count as a closed syllable. Thus, in the following examples, stress falls on the initial syllable, despite the existance of an underlying glottal stop in the second syllable:

(434)    /raka?ti/

Stress    ráka?ti

?-Del.    rákati

Surface  [rákati]

The rule of ?-Deletion deletes a pre-consonantal ? in even-numbered syllables counting from the beginning of the word. One might suspect that the rule of ?-Deletion applies before stress. However, this cannot be the case, since the input to an earlier rule, that given in (435), must feed stress, while its output feeds glottal deletion.

(435)

$$c \longrightarrow ? \;/\; \underset{\underset{\rule{0.5cm}{0.4pt}}{|}}{\overset{\overset{N'}{|}}{X}}$$

The necessary rule ordering is exemplified below:

```
(436)  UR      ka - ric - wi  'go soon'     ka - ric - i  'he goes'
       Stress          /                        /
       Rule 434     ?                        n.a.
       ?-Del        0
                     /                          /
       Surface  [kariwi]                    [karici]
```

Safir(1979) argues against the treatment of V?C sequences as either glottalized consonants or glottalzied vowels. In one case, a rule of nasal deletion accounts for **niki?nkin** ---> **niki?ki**. Safir argues that if the consonant were nasalized, we would not expect only part of the segment to disappear. The same argument is made with respect to the rule of /a/ deletion. This rule takes **tisa?t** ---> **tis?t** and **soka?t** ---> **sok?t**. However, in this case, a rule of vowel copy replaces the lost vowel before -?t, resulting in **tisi?t, soko?t**.

The present theory of autosegmental phonology allows for greater segmental inventories without an increase in features. Thus, glottal stop in Capanahua can be specified underlyingly simply as [+constricted GL], while this feature may also occur in branching structures such as that illustrated below:

```
(437)  Capanahua Complex Segments
                          a  ?
                          |/
                          X
```

Rules of vowel deletion such as the a-deletion rule above, are reformulated as delinking rules with no loss of explanatory power.[19] The rule of

---

19. Notice that the rule of c ---> ? makes much more intuitive sense if c, an affricate is also analyzed as a complex segment. Such a rule might relink the [-cont] feature of /c/ to the preceding vowel, resulting in a complex segment which is again realized as a V? sequence:

?-Deletion can also be formulated as a delinking rule as illustrated below:

(438) Capanahua ?- Delinking

[^F] ?
|/
|/
X /
‾ |⁊‾
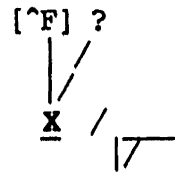
The analysis of tautosyllabic V? sequences as complex segments allows us to

state the rule of accent as follows:

(439) Capanahua Accent
   a. Accent head of N‴ iff branching
   b. Build a single quantity sensitive right dominant foot
      at left edge of word.
   c. Build left-dominant word-tree.

The ?-Delinking rule will operate on a projection of reduction feet. This

feet are binary, left-dominant, built from right to left. The reduction feet

have no relation to stress.

All the cases we have just examined appeared to be counterevidence to the

implicational relationship: if accent branching N' then accent branching N.

This relationship, which follows from the notion of head within X-bar theory,

has been seen to hold given extrametricality in Tiberian Hebrew, the status

of strong and derived long vowels in Seneca, and finally, the representation

of tautosyllabic V? sequences as complex segments in Capanahua. We now turn

to languages in which branching at the N‴ level appears to play a role in

————————

[^Place F]
[BF] /\
[-cont] [+cont]
|/\ /
X X
|/
|/
N'
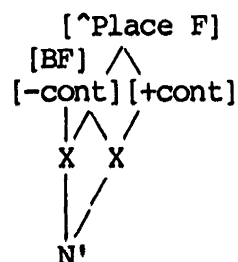
stress assignment.

## 4.1.5.2 Branching of N"

The invisibility of the Specifier (or onset) of N' as a general characteristic of structure-building metrical rules was first noted by Halle and Vergnaud(1980): "... in all languages known to us, stress assignment rules are sensitive to the structure of the syllable rime, but disregard completely the character of the onset"(p.93).

However, it has been argued that there are languages in which rules of stress assignment must refer to branching at the N" level, or to the internal constituency of Spec itself. In this Section we investigate whether or not the theory of accent as outlined above should be modified. Thus far, rules of accent have had access only to N-projections, and have referred specifically to heads of bar-projections. Are there accent rules which refer to branching at the N" level?

Davis(1982,1985) claims that onset-sensitive stress-rules occur in the Arandic languages of Central Australia, Yidiny, and Gadsup, a language of New Guinea. Two other examples of stress rules which are appear to be onset-sensitive are the Northern Paman languages of Australia (Hale,1976),and Piraha (Everett,1984), a language of northern Brazil.[20]

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20. Macuxi Carib as analyzed by (Hawkins,1950) appears to contain a rule of foot construction which feeds a vowel reduction rule. However this rule is not a stress rule, as stress falls consistently on the final vowel of a word. Translating Hawkins' account into current metrical terms, a vowel in Macushi is deleted if that vowel constitutes the recessive node of a foot, where the foot-building algorithm is as follows:build quantity-sensitive

Stress in the Arandic and Northern-Paman languages of Australia is assigned

to the first vowel following the first consonant in the word. As described

by Hale(1976) stress in Uradhi can be assigned by the following rule, which

is apparently shared by all Northern Paman languages:

(440)          V ---> V/ #(V)C __

The same rule in Aranda (Strehlow,1942) will account for primary stress in

the following words: **tarama** 'to laugh'; **imana** 'arm'; **kutunula** 'ceremonial

assistant'; **aralkama** 'to yawn'; **tooturatura** 'marsupial mole'; **ulambalamba**

'fowl(sp.)'.

In other words, it appears as if stress in these languages is assigned to

the initial syllable of the word if and only if the syllable has an onset.

If the initial syllable has no onset, stress falls on the second syllable of

the word. This is the analysis proposed by Davis(1982). We can account for

the facts straightforwardly without any reference to the onset. To do this,

we posit a rule of extrametricality:

---------

right-dominant feet from left to right. However, there are several
exceptions to the rule, as stated above. Hawkins notes that:

> There is one type of consonant cluster in the basic form which
> causes both the vowel preceding it and the vowel following it to
> be retained irrespective of the underlying pattern. In order to
> describe this type of cluster, consonants are divided into two
> groups. Group I consists of p t k s s r. Group II consists of
> ? m n w y. [Note that Group II defines the class of possible
> Codas.-JL] A vowel in the basic form is retained if it precedes
> or follows any cluster of three consonants or a cluster of two
> consonants in which the first consonant is a member of Group
> I.(pp.88-89)

Recent work on Macuxi by C. Neusa(1984) shows no reduction and no consonant
clusters of the exceptional types noted by Hawkins.

(441) Extrametricality in Arandic and Northern Paman
      Make the first X-slot extrametrical.

If the word is vowel initial, the vowel will be made extrametrical and thus invisible to the foot building rule which builds an unbounded left-dominant foot on the left margin. If the word is consonant-initial, making the first X-slot extrametrical will not affect stress placement, since branching at the N''' level does not play a role in rules of accent.[21] The following examples, taken from Hale(1976) illustrate the interaction of the extrametricality rule with the foot-building rule in Uradhi for both consonant- and vowel-initial words.

(442)    a. u  t  a  g  a  k    'dog'       b. m  i  nh  i  ky  i  k    'bird'
            │  │  │  │  │  │                    │  │  │   │  │  │  │
EM         (X) X  X  X  X                      (X) X  X   X  X   X  X
            │     │  │                              │      │     │
           (N)    N  N                              N      N     N
W-Tree      │     /                                 │      /     /
            │    /                                  │
            │                                       │
            /                                       /
Output:  [utagak]                               [minhikyik ]
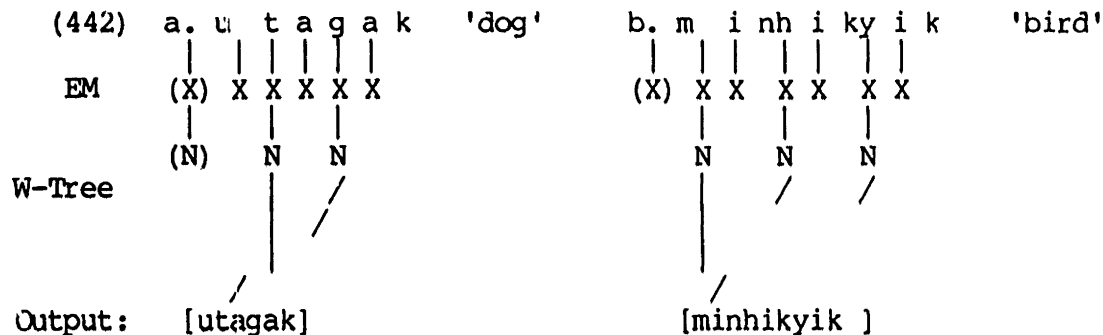
Notice in this example that the property of extrametricality appears to percolate from the head to the maximal projection, but extrametricality within Spec does not effect the status of N''. Such a case might argue for a model in which features of the head percolate to the maximal projection, while features of Spec do not.[22]

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21. Given that stress in these languages is assigned by a quantity insensitive left-dominant tree, accent is altogether beside the point.

22. See Archangeli(1984b) for another examples where extrametricality is seen to percolate within the N-projection. Notice that the data from the Arandic and Northern Paman languages does not make the strongest possible case for EM percolation, since stress assignment in these languages is not quantity sensitive. The test case would be a language with an EM rule identical to

As for the Gadsup language of New Guinea which Davis(1982) points to as another possible counter-example to Spec-invisibility, Frantz and Frantz(1973) say the following:

> Stress in nonphonemic. In analogous environments syllables (A) with aa, e, or o have more stress than those with a, i, or u; (B) with high, rising, or falling tones have more stress than those with low; (C) with a phonetic stop onset have more stress than those wit'. nonstop onset. Combinations of these features lead to varying degrees of noncontrastive stress.(p.413).

(A) is unproblematic, as [e] and [o] can be analyzed as underlying long /i/ and /u/ respectively. The questionnable aspect of this stress rule concerns (C): what kind of stress rule will accent a syllable with a stop onset, but not one with a continuant? Clearly in our account where access to the segmental tier is not available, we would be forced to analyze stops as geminate sequences, or to posit some other geometric distinction between such clusters. Unfortunately, not enough data is available to test this claim.

However, examination of one final example of a language which appears on the surface to have metrical-structure-building rules sensitive to branching N", does appear to limit accent to the N-tier with X-slots as terminals. In Piraha, a language of Central Brazil(Everett,1984 and p.c.) stress falls on the heaviest right-most syllable of the final three syllables of a word, where heaviest is defined on the following scale: CVV > GVV > VV > CV > GV > V , where C=a voiceless consonant, G= a voiced consonant. That the domain of primary stress is limited to the final three syllables of a word is clear

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that of Uradhi or Aranda, but where feet were quantity sensitive. If the first syllable, when vowel initial, was not stressed, regardless of weight, a strong case could be made for percolation of EM at least from N to N'.

from the examples in (443).[23] :

(443) a. poo'gáihiai 'banana'

b. piahaogiso'áipi 'cooking banana(porpoise nose)'

c. kapiigaiito'íi 'pencil'

In (444) we see that it is the rightmost token of the heaviest syllable which is stressed:

(444) a. paohoa'hái 'anaconda/rainbow'

b. bahoiga'tói 'domestic pig'

c. baitoi'sái 'wildcat'

The examples which follow provide the empirical motivation for the scale of

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23. Everett(p.c) has not yet looked systematicaly at degrees of stress other than primary. Thus, it is possible that secondary stress falls outside of the domain of the final three syllables.

syllable weight given above.

(445)   A. CVV vs. GVV                    B. CVV vs. VV
          /                                  /
        i.'kaagai      'word'          i. ?i'siihoai  'liquid fuel'
            /                                   /
       ii. bii'sai     'red'          ii. soioaga'hai 'thread'

        C. CVV vs. CV                    D. CVV vs. GV
            /                              /
        i. ?i'tii?isi 'fish'          i. ''?aagi      'coati'
             /                             /
       ii. ?isi'tai   'feather'      ii. gi'?ai      '2 sg.'

        E. GVV vs. VV                    F. GVV vs. CV
              /                            /
        i. 'giai'bai  'dog'           i. ?apa'baasi      'square'
                /                          /
       ii.  hoaa'gai  'flower'       ii. 'giisogi        'turtle'

        G. VV vs. GV                    H. CV vs. GV
              /                            /
        i.  ?ibi'oi   'liver'         i.  ?abagi        'toucan'
              /                                  /
       ii.  ?a'aibi   'thin'         ii. kagi'hi        'wasp'

Given the available data, it appears that the rule assigning primary stress in Piraha must have access both to Spec and the N-projection, as well as to the segmental character of Spec. However, there is good reason to believe that the rule which assigns primary stress in Piraha is one which has no access whatsoever to the internal structure of the syllable.

Everett notes that voiceless consonants are distinctively longer than voiced consonants and admits to their being treated as geminates. If this is done, then, as suggested by D. Steriade(p.c.), the stress rule can be formulated as one sensitive to approximate phonetic length of syllables, where such length is obtained from an intermediate phonological representation. Thus instead of the syllable weight heirarchy listed above, we need a less abstract representation of syllables over real time. Access

solely to the terminal elements of syllables, i.e. to the X-tier is insufficient in the present theory, since a short vowel and a short consonant are both represented as occupying a single X-slot, giving no indication of the phonetic fact that short vowels are longer in duration than short consonants. Such a representation would look something like that shown in (446), where each vowel is equivalent to three x's and each consonant to two:[24]

| (446) | __CVV__ | __GVV__ | __VV__ | __CV__ | __GV__ | __V__ |
|---|---|---|---|---|---|---|
| | N" | N" | N" | N" | N" | N" |
| | N | N | N | N | N | N |
| X-Tier | XXXX | XXX | XX | XXX | XX | X |
| | | | | | | |
| x-tier | xxxxxxxx | xxxxxxx | xxxxxx | xxxxx | xxxx | xxx |
| ACCENT: | A | B | C | D | E | F |

The rules needed to assign stress could then be formulated as shown below:

(447) Piraha Stress
    A. Accent A,B,C,D,E,F(ordered by Elsewhere Condtion)
    B. Build a single ternary foot at the right edge of the word.
    C. Build Right-dominant (unbounded) word tree.

After each stage of the accent rule(447.A), the final three syllables of each word will conform to one of the eight possible patterns in (448), footed via

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24. I believe D. Everett has recently come up with a similar analysis.

(447.B,C) as illustrated.

(448)
```
     a.  ... N"N"N"]      b.  ... N"N"N"]      c.  ... N"N"N"]
(A)              |                   *                   *
(B)              |           | \|              | |/
(C)              |                   |                   |


     d.  ... N"N"N"]      e.  ... N"N"N"]      f.  ... N"N"N"]
(A)          *                   *  *               *  *
(B)          |/              \| |              | |/
(C)          |                   |                   |


     g.  ... N"N"N"]      h.  ... N"N"N"]
(A)          *   *               *  *
(B)          |  \|              |  \|
(C)              |                   |
```
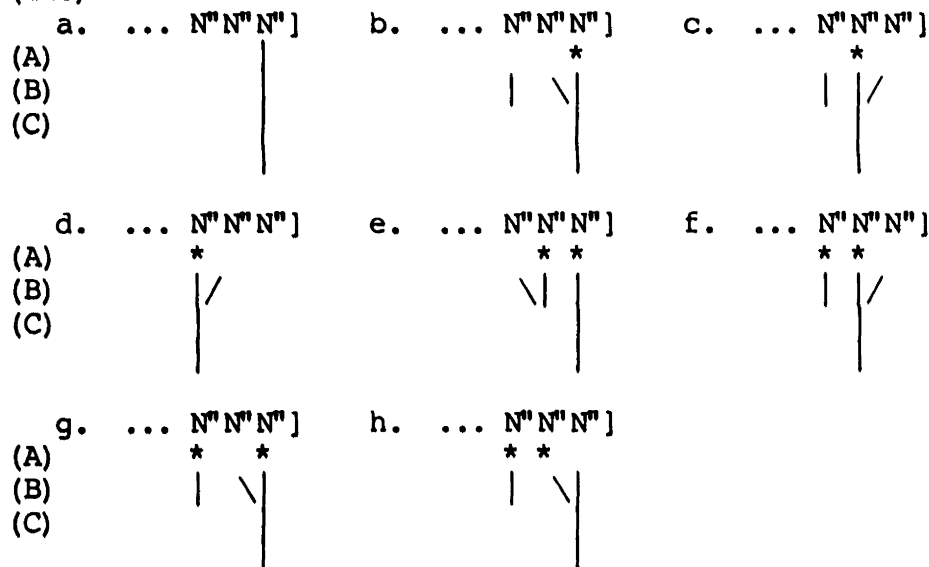
After application of the rules in (447), stray adjuntion incorporates stray syllables into the metrical structure, in particular, in (448.d) above.

Acoustic studies carried out by Everett(1985,p.c.) support such an analysis, showing that in fact voiceless consonants in Piraha are substantially longer than their voiced counterparts. The above analysis, which instantiates a non-iterative ternary foot construction algorithm, is expected within a metrical theory in which head/complement relations are suplemented by rules of adjunction which may be non-iterative (ternary feet) or iterative (unbounded feet.) The analysis also leaves our theory of accent relatively intact, with the possible addition of Rule D.below, which is at the moment a Piraha-specific rule:

(449) Summary: Rules of Accent
   A. Accent head of N" iff branching
   B. Accent head of N' iff branching
   C. Accent head of N  iff branching

   D. Accent N"              iff [...x...] ,x = n.
                                  N"

The theory of accent outlined in this section has been shown to refer to N, N' and N'' and to no more. Having established the empirical motivation for N-projections in phonology, we turn to rules which require categorial distinctions, namely a distinction between X and X'. Such rules, which we refer to as skeletal transformations, are again shown to refer to N, without access to segmental information. By illustrating that certain rules must refer to N and projections of N, we motivate the X-bar proposal outlined in the previous section, and strengthen the view of syllabicity as a structural property.

## 4.2 Towards a Theory of Skeletal Transformations

In this section we offer another class of phonological rules as evidence for a categorial distinction between heads and non-heads of N'' with reference to N as opposed to a distinctive feature [+syllabic]. Such rules, which insert and delete skeletal slots, like the rules of accent just discussed, will be shown to operate on the skeleton and the N-projectin alone. All skeletal transformations will be shown to be sensitive to the distinction between (450.a) and (450.b) below:

(450)    a.    X'                    b.    X

In underlying representation, this dichotomy represents a categorial distinction between syllable heads and non-heads. In this section we merely show how X-tier transformations must be stated in terms of the primitives above, and furthermore cannot be accurately stated in terms of distinctive

features, thereby lending further evidence to a theory where N and not [+syllabic] is the sole determinant of syllabicity.[25]

## 4.2.1 The Set of Possible Transformations

The set of transformations we will be concerned with have as their structural change a change in the X-tier alone. That is to say, we will not be concerned here with rules of linking or delinking of matrices to X-slots, nor with rules which build or delete structure built on the X-tier. Rather, the rules under discussion will be of the type given in (451).[26]

(451) I.  Insertion

$$0 \longrightarrow X \; / \; Y \underline{\quad} Z$$

where Y and Z are variables, and X is a variable ranging over X' and $\underline{X}$.

II.  Deletion

$$X \longrightarrow 0 \; / \; Y \underline{\quad} Z$$

Though the best known cases of X-Insertion are those of prothesis, epithesis, and epenthesis, we include in this class rules of tonic and pretonic lengthening and gemination. X-Deletion includes rules common rules of vowel deletion as well as apocope, syncope, aphaeresis, ekthlipsis,

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25.  See Levin(forthcoming) for a detailed investigation of X-tier transformations.

26.  The existence of movement transformations is left as a topic for further research. Given the status of the skeleton as a string of intrinsically empty timing slots, evidence for movement rules would crucially involve an exchange of position between X' and $\underline{X}$, i.e. a metathesis rule in which syllabicity was reversed: uy ---> wi, $\overline{wi}$ ---> uy, etc. Even here one would have to argue that two empty slots had exchanged positions, while all other structure remained the same.

synaeresis (vowel coalescence), and krasis.[27]


4.2.1.1 Structural Change

A common feature of these two sets of rules is that the quality of the inserted or deleted segment cannot be stated in the rule itself. In the case of common rules of epenthesis the quality of the inserted Nucleus is determined by a phonological rule or by redundancy rules.[28] This is the case in Klamath where the rule of epenthesis is stated as in (452):

(452) Klamath Epenthesis    0 ---> $\underline{X}$ / __ X']

The inserted X-slot is spelled out either as a [+high,-cons] segment as a result of a language-specific association rule, or as an [a] via the redundancy rules of the language. Stating epenthesis as [a]-insertion would require a global rule which changed only derived [aG] sequences into [i:] or [o:]. Thus, the simplest rule of epenthesis appears to be that given above.

Rules of X-deletion have the same property: they are decidedly non-segmental in character. In either of the cannonical rules of vowel

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27. Definitions are perhaps in order here as some of these terms have fallen out of use. Prothesis: the addition of vowels or consonants at the beginning of a word. Epithesis: addition of vowels or consonants at the end of the word. Epenthesis: insertion of vowels or consonants in the middle of a word. Aphaeresis: deletion of a vowel or consonant at the beginning of a word. Syncope: elision of a vowel before a consonant. Apocope: deletion of a single vowel or consonant at the end of the word. Ekthlipsis: deletion of a consonant word-medially. Synaeresis: coalescence of adjacent vowels. Krasis: union of heterosyllabic vowels.

28. In languages which have more than one epenthetic vowel, one rule of epenthesis can be seen to apply before the application of redundancy rules, while the other applies after.

deletion shown in (452), mention of information on the segmental plane would only be redundant:

(453)   Vowel Deletion   a. $\underline{\underset{1}{X}\ \underset{2}{X}}$ ---> $\underset{1}{\underline{X}}$

   b. $\underline{\underset{1}{X}\ \underset{2}{X}}$ ---> $\underset{2}{\underline{X}}$

## 4.2.1.2 Structural Description

In addition to their lack of a structural change on the segmental tier, X-tier transformations crucially involve insertion or deletion of an X-slot in a particular environment. Looking at the form of the rules of epenthesis in (453), we see that they all involve environments where a single X-slot is specified in the structural description and this X-slot is not syllabified. The single X' may either precede or follow the target position. The rules in (453) also illustrate that the structural description of rules of X-insertion

may mention segmental information:

(454)  X-Insertion: Vowel Epenthesis:  0 ---> X̲/ ...X'...

A.  0 ---> X / __ X'        i/u        (Yawelmani;Archangeli)
         N

B.  0 ---> X / __ X'        ^          (Tamazight Berber;Saib)
         N
                [+son]
                  |
C.  0 ---> X / __ X']       G-spread/^   (Klamath)
         N
                [+son]
                  |
D.  0 ---> X / __ X'        e          (Mohawk;Michelson)
         N
                 [r]
                  |
E.  0 ---> X / __ X'        u          (Icelandic;Kiparsky)
         N

F.  0 ---> X / X' __        [-high]    (Kabardian;Shlonsky)
         N

G.  0 ---> X / X __ X'      ^          (Berber;Guerssel)
         N   X'__


In contrast, rules of X'-insertion appear to apply only in the environment of

syllable heads, as illustrated by the rules in (455):

(455)  X'-Insertion

H.  0 ---> X /  # __ X      ?          (Onondaga; Chafe)
                    N

I.  0 ---> X /  X __ #      h
               N

J.  0 ---> X /  X __ X      y          (Berber;Guerssel)
               N   N

K.  0 ---> X /  X __        V-spread   (Onondaga; Chafe)
               N                       (* = DTE of metrical foot)
               *                       * iff head of N' branching

L.  0 ---> X /  X __        C-Spread   (Umpila; Harris &O'Grady)
               N                       * iff head of N" branching
               *

This is so despite the fact that the inserted X'-slot in certain cases, like K., may eventually surface as a vowel. While all the instances of insertion above, with the exception of the tonic gemination rule L., result in surface [-cons] segments, default consonants spelled out by redundancy rules need not be [-consonantal]. In particular, epenthesis in Axininca Campa will insert the vowel [a] or the consonant [t], depending on the phonological environment:

(456) Epenthesis in Axininca Campa

$$0 \longrightarrow \underline{X} / \quad X'] \underline{\quad\quad} X'$$
$$\text{VERB}$$
$$0 \longrightarrow X'/ \quad \underline{X}\ ] \underline{\quad\quad} X$$
$$\text{VERB}$$

The rule as formulated by Payne reads as follows:

(457)
0 ---> [^syllabic,-asp,-back,-delayed,-labial]
       [^syllabic,+low]
                                / ]     X [-^syll]+___+[-^syll]
                                 VERB
Where X contains no ## or ]<sub>NOUN</sub>

i.e. in verb suffixation an /a/ is epenthesized between
consonant clusters at morpheme boundaries and a /t/ is
epenthesized between vowel cluster at morpheme boundaries.

Payne anticipates the rules we have formulated which rely on an articulated theory of underspecification:"...The rule as formulated does not reflect in any way the unmarked nature of the epenthesized segments. For this reason the structural change is quite bulky in terms of number of features. An adequate theory of markedness should allow us to get by with one feature to the right of the arrow...since it has been claimed that the /t/ and /a/ are the unmarked members of their respective syllabicity classes(p.112)."

While use of syllable structure in these rules makes it impossible to

collapse the two by use of say [^syllabic] and [-^syllabic], we propose that the rule of epenthesis in AC can be simplified by positing conditions on the structural description and structural change of skeletal transformations.

In particular, we suggest the following preliminary conditions on skeletal tier transformations:

(458) Conditions on X-tier transformations
    All rules RX are of the form:
      delete/insert X/ Y__Z, where
  I.  X,Y,Z must be single skeletal slots;
  II.  {X}  ^ {X', $\underline{X}$} = 0 ;
 III.  {Y,Z} ^ {X', $\overline{\underline{X}}$} = 0 ;
 IV.  the output of RX is subject to the following filters:
      a. * $\underline{X}$ $\underline{X}$           b. * X' X'
    and where the representation of other tiers is optional.

Given these conditions, the rule of vowel and consonant epenthesis in Axininca Campa can be stated as follows:

(459) Epenthesis in Axininca Campa
    0 ---> X /   X]  __ X
            $\overline{\text{VERB}}$

The condition (458.I) states that either an X' or $\underline{X}$ is inserted. Condition III. requires that either the left or right hand environment contain X' or $\underline{X}$. Condition IV. ensures that insertion will take place iff the environment in (458) is X'__X' or $\underline{X}$__$\underline{X}$. If the environment is either X'__$\underline{X}$ or $\underline{X}$__X' insertion of either X' or $\underline{X}$ will violate the filter in IV.

The structural descriptions of skeletal tier transformations, as well as the structural change, insert/delete X'/$\underline{X}$ refer to the only features of syllable structure available in underlying representation. As we saw earlier, the skeletal tier in underlying representation is a string of X-slots, where X is a variable ranging over X' and $\underline{X}$. X' and $\underline{X}$ together

delimit the basic categorial component of the syllable, defining heads and
non-heads prior to projection. X-tier transformations, as defined in (458)
above then provide the final piece of evidence for an X-bar theory of the
syllable in that they refer crucially not to a segmental distinction, but
rather to one of category.

Having exemplified a theory of accent which relies on the projections of N
as well as a schema of skeletal-tier transformations which refers crucially
to the categories X' and $\underline{X}$, we turn to a closer examination of skeletal-tier
one type of skeletal transformation, that of X-insertion, and the preliminary
conditions proposed in (458). Scrutiny reveals that a metrical theory of
syllabicity    in    which    $\underline{X}$-insertion    and    N-placement    share    formal
characteristics, so do they both appear to obey a unified constraint.


4.2.1.3 X-insertion and Sonority Scales:Evidence from Armenian

In Modern Western Armenian(Bardakjian and Thomson,1977) consonant clusters
in various positions are broken up by an epenthetic [^]. In all cases, as
made explicit in (458.III,IV) such epenthesis is conditioned by the presence
of an unsyllabified X-slot. Of interest is the fact that epenthesis appears
to be sensitive to the same version of the sonority hierarchy as that
required by syllabification in Armenian. Furthermore, $\underline{X}$-Insertion and
N-placement appeared to be constrained by one and the same sonority
condition.

Armenian    syllables    are    generated    via    rules    of    N-Placement,    and
N"-Projection, followed by N'-Projection, and Incorporation into N'and
finally, a rule of N'-adjunction. Complex N's such as those shown below,

motivate the sonority scale given in (461).

(460) Complex N' in Armenian
  a. [+son]>[-son]      b.[+son,+high]>[+son,-high]
  ^zkoys    'careful'     suwrp      'holy'
  tuws.d^r  'daughter'   p^.ruwntk 'fist'
  mart      'man'
  kirk      'book'
  hi.lant   'ill'     c. [+son,+cont]>[+son,-cont]
  inc.bes   'how'      cerm     'warm'
  k^nk.rel  'to incite'  p^.ruwntk 'fist'

  d. [-son][+cont]>[-son][-cont]
  ^sgizp    'beginning'
  ar.hesd   'trade,skill'
  ha.ruwsd  'rich'

  e.[-son,-cont,+ant]>[-son,-cont,-ant]
  bedk      'need'

  f.Adjunction to N'
  asdr      'star'
  baderazm  'war'   but (*mn, nr; kr, z'm):
                 omn  --->  om^n     'someone'
                 manr  --->  man^r    'small'
                 pokr  --->  pok^r    'small'
                 ayz'm --->  ayz'^m   'now'

(461) Armenian sonority scale
  y,w         [+son,+cont,+high]
  l,r         [+son,+cont,-high]
  m,n         [+son,-cont]
  s,z,x,V      [-son,+cont,+ant]
  s',z'       [-son,+cont,-ant]
  d,t,...     [-son,-cont,+ant]
  k,p...      [-son,-cont,-ant]

Given the sonority scale in (461), well-formed syllables in Armenian are

                      ■

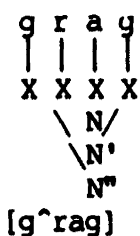seen to be the result of the rules in (462):

(462) Syllabification
    A. N-placement
    B. Project N"
    C. Project N'
    D. Incorporate into N' (non-iterative;subject to decreasing
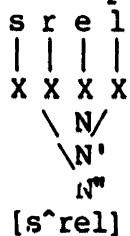                              sonority)

    E. N'-Adjunction[29]:

```
                               N'
                               |\
              N'               N'\
              |                |  \
              X    X --->  X    X
              |1   |2      1    2
          [-son,+ant] [+son]
```
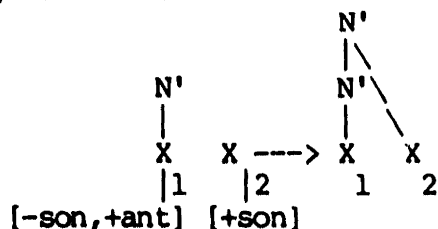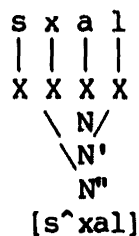
In word initial position then, consonant clusters are not syllabifiable:

```
(463)a. 'fire'        b. 'sharpen'      c. 'mistake'
     g r a y             s r e l           s x a l
     | | | |             | | | |           | | | |
     X X X X             X X X X           X X X X
      \ N/                \ N/              \ N/
       \N'                 \N'               \N'
        N"                  N"                N"
     [g^rag]             [s^rel]           [s^xal]

     d. 'confussion'      e. 'console'
        s' p o t             s p o p e l
        |  | | |             | | | | | |
        X  X X X             X X X X X X
         \ N/                 \ N \ N/
          \N'                  \|  \N'
           N"                   N"  N"
        [s'^pot]             [^spopel]
```
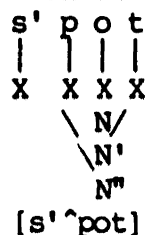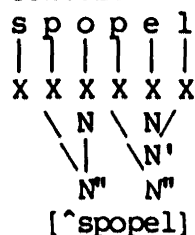
As indicated by the surface forms above, a rule of epenthesis inserts a vowel

either before or after the unsyllabified consonant.[30] If the unsyllabified

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element is [+cont,+ant] and is followed by a [-son,-cont] segment, then an

X-slot will be inserted before the [+cont,+ant] segment. Elsewhere, an

X-slot is inserted after the unsyllabified element. The distinction between

[+cont,+ant] and [+cont,-ant] is illustrated by the surface forms in

(462.d,e) above.[31] Other examples are given below:

(464)
```
     a. nman  ---> n^man        'similar'
     b. zparil ---> ^z.pa.ril   'to be occupied'
     c. zkoys  ---> ^z.koys     'careful'
     d. stapil ---> ^s.ta.pil   'to come to one's senses'
     e. sgizp  ---> ^s.gizp     'beginning'
     f. sdanal ---> ^s.da.nal   'to ge,receive'
```

Before formulating the rule of X-insertion in Armenian, recall the forms

given in (460.f) above, repeated below:

(465)
```
     a. omn   ---> om^n        'someone'
     b. manr  ---> man^r       'small'
     c. pokr  ---> pok^r       'small'
     d. ayz'm ---> ayz'^m      'now'
```

Such facts indicate that X-insertion applies before unsyllabified sonorants

as well as before and after obstruents as seen above. This is not only the

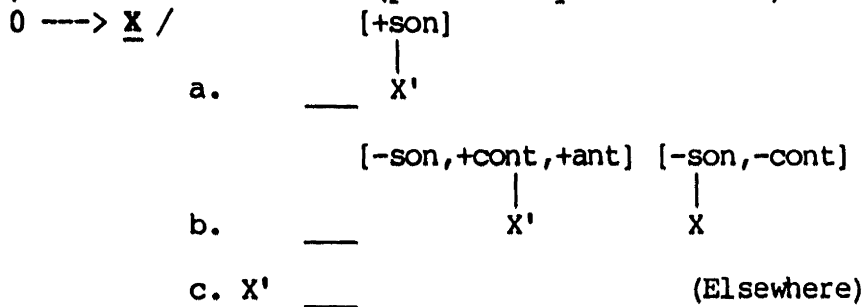case word finally, but word-internally, as well:

(466) adrj'anag ---> a.d^r.j'a.nag      'pistol'

Based on this preliminary set of data, we may state the rule of epenthesis as

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31. Bardakjian and Thomson group /s'd/ with /sd/, based on the form s'dabel
---> ^s'.da.bel 'to hasten'. Given no other forms of this sort, we assume
that /^s'dabel/ is the underlying form.

shown below:

(467) Armenian: Insert-X  (preliminary formulation)

$$0 \longrightarrow \underline{X} /$$

                  [+son]
                    |
     a.    ___  X'

             [-son,+cont,+ant]  [-son,-cont]
                  |          |
     b.    ___      X'      X

     c. X'  ___                (Elsewhere)

Because the environment for X-insertion mentions X', we need not specifiy that $\underline{X}$ is inserted. This is automatically guaranteed by (458.IV) above, since insertion of X' would create an illformed sequence. The rule in (467) accounts for the facts seen this far and is consistent with the conditions on X-tier transformations given in (458). A look at more data reveals that this rule must be directional, applying from left to right:

(468) a. cntal   ---> c^n.tal       'to laugh'
     b. gsdah   ---> g^s.dah      'certain'
     c. sgsil   ---> ^s.g^.sil    'to begin'

Derivations are given below, where N"-projection and N'projection follow each

application of X-insertion.

(469)  b.                                    c.

Syllab.
```
        g  s  d  a  h                       s  g  s  i  l
        |  |  |  | |                        |  |  |  | |
        X  X  X  X X                        X  X  X  X X
           \    N /                            \    N /
            \   N'                              \   N'
             \ N‴                                \ N‴


        g     s  d  a  h                    s  g  s  i  l
        |     |  |  | |                     |  |  |  | |
Rule(466) X  X X  X  X X                    X  X X  X X
           \ N/  \  N /                     N/    \ N /
Syllab.     \N'   \ N'                      N'     \ N'
            N‴     \N‴                       N‴      \N‴


Rule(466)  ---------                        s  g     s  i  l
                                            |  |     |  | |
                                            X  X X X X  X X
Syllab.                                     N/  \ N   \ N /
                                            N'   \|    \ N'
                                            N‴    N‴    \N‴
```

The rule of X-insertion applying from left to right and feeding N‴- and N'-projection after each application, accounts correctly for the appearance of an epenethetic schwa in the following four- and five-member clusters:

(470) a. knkrel          --->   k^nk.rel            'to incite'
      b. pz's'guwtivn    --->   p^.z'^s'.guw.tivn   'medicine'
      c. sgsnag          --->   ^s.g^s.nag          'beginner'
      d. js'krduwtivn    --->   j^s'.k^r.duw.tivn   'exactitude'
      e. hrms'duwk       --->   h^r.m^s'.duwk       'bustle,pushing'

An interesting property of the rule of X-insertion is that is appears to embody the sonority scale distinctions relevant for N'. The sonority scale is split into three parts with respect to the rule of epenthesis, as shown

below:

```
(471)  y,w              [+son,+cont,+high]
       l,r              [+son,+cont,-high]      (466.a)
       m,n              [+son,-cont]
------------------------------------------------
       s,z,x,V          [-son,+cont,+ant]       (466.b)
------------------------------------------------
       s',z'            [-son,+cont,-ant]       (466.c)
       d,t,...          [-son,-cont,+ant]
       k,p...           [-son,-cont,-ant]
```

Given such a correlation, we propose the following ordering constraint on rules of X-insertion:

(472) Sonority Condition on Skeletal Transformations
      Given two rules of X-insertion R1 and R2, where R1
      mentions X'1 and R2 mentions X'2 in their respective
      structural descriptions, the sonority of X'
      determines the ordering of R1 and R2.  If X'1 is more
      sonorous than X'2, then R1 precedes R2.  If X'2 is more
      sonorous than X'1, then R2 precedes R1.

But notice that (472) is a specific case of the proposed universal (161.II.b) which reads:

    Given two Rules B1 and B2 with targets [^G1] and [^G2]
    respectively, if [^G1] is more sonorous than [^G2], then
    B1 applies prior to B.

The hypothesis that (161.II.b), repeated above, is part of universal grammar makes the ordering of rules (467.a,b,c) above unnecessary.  In fact, it should follow that the only intrinsic ordering restrictions on rules of N-placement or N-insertion will involve rules where the segmental status of X' is identical, but structural descriptions differ nevertheless.  I have been unable to find such a rule, and propose the preliminary hypothesis that given a language particular sonority scale, rules of syllabification, including as we have seen skeletal transformations, require no extrinsic ordering with respect to each other within a given language.