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# Papers in Phonology

*Edited by*

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Non-Uniqueness Condition and the Segmentation of the Chinese Syllable

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*I. Introduction*

In this paper, I re-examine the non-uniqueness condition a la Chao (1934), and show that this condition is a by-product of the analysis of the Chinese syllable as CCVC. I argue that the non-uniqueness condition must be avoided since it introduces arbitrariness and indeterminacy into phonological theory, and show that this can be done by reanalyzing the Chinese syllable as CVC. I will then argue that the only motivation for analyzing the syllable is morphophonemic alternation, that while there is morphophonemic evidence for analyzing the prevocalic and post-vocalic portions of the syllable as individual segments, there is none whatsoever for analyzing the prevocalic portion into two segments, and that reduplication and *fanqie* language formation processes which appear to justify the CCVC analysis are better accounted for with a CVC analysis.

*II. The Non-Uniqueness Condition and the Medial Glide*

Most Chinese phonologists assume that a Chinese syllable beginning with an alveopalatal consonant [tɕ], [tɕʰ] or [ɕ] always contains a medial alveopalatal glide [j] or [ɥ], before which neither the alveolar sibilants [ts tsʰ s] nor the retroflex sibilants [tʂ tʂʰ ʂ] nor the velar obstruents [k kʰ x] may occur. Therefore, they believe that [tɕ tɕʰ ɕ] are in complementary distribution with either [ts tsʰ s] or [tʂ tʂʰ ʂ] or [k kʰ x], as shown in (1), and that there is no unique solution to the phonemic status of [tɕ tɕʰ ɕ], i.e. these sounds could derive from either underlying /ts tsʰ s/ or underlying /tʂ tʂʰ ʂ/ or underlying /k kʰ x/. This situation is referred to by Chao (1934) as the non-uniqueness condition in phonemic analyses.

(1) Complementary distribution of [tɕ tɕʰ ɕ] in the CCVC analysis

| | ow | aw | an | aŋ | jow | jaw | jan | jaŋ |
|---|---|---|---|---|---|---|---|---|
| ts | tsow | tsaw | tsan | tsaŋ | | | | |
| tsʰ | tsʰow | tsʰaw | tsʰan | tsʰaŋ | | | | |
| s | sow | saw | san | saŋ | | | | |
| tʂ | tʂow | tʂaw | tʂan | tʂaŋ | | | | |
| tʂʰ | tʂʰow | tʂʰaw | tʂʰan | tʂʰaŋ | | | | |
| ʂ | ʂow | ʂaw | ʂan | ʂaŋ | | | | |
| k | kow | kaw | kan | kaŋ | | | | |
| kʰ | kʰow | kʰaw | kʰan | kʰaŋ | | | | |
| x | xow | xaw | xan | xaŋ | | | | |
| tɕ | | | | | tɕjow | tɕjaw | tɕjan | tɕjaŋ |
| tɕʰ | | | | | tɕʰjow | tɕʰjaw | tɕʰjan | tɕʰjaŋ |
| ɕ | | | | | ɕjow | ɕjaw | ɕjan | ɕjaŋ |

From the display in (1), we can see that the non-uniqueness condition is a consequence of the assumption that the allophonic alternation between [tɕ tɕʰ ɕ] and other consonants is triggered by an alveopalatal medial glide. If we assume that the medial glide is not an independent segment, but intrinsic secondary articulation of the onset consonant, then we can show that the alveopalatal consonants are no longer in complementary distribution with other consonants, as shown in (2), and that the non-uniquemess condition therefore no longer exists.

(2) Contrastive distribution of [tɕ tɕʰ ɕ] assuming the nonexistence of medial glide

| | ow | aw | an | aŋ |
|---|---|---|---|---|
| ts | tsow | tsaw | tsan | tsaŋ |
| tsʰ | tsʰow | tsʰaw | tsʰan | tsʰaŋ |
| s | sow | saw | san | saŋ |
| tʂ | tʂow | tʂaw | tʂan | tʂaŋ |
| tʂʰ | tʂʰow | tʂʰaw | tʂʰan | tʂʰaŋ |
| ʂ | ʂow | ʂaw | ʂan | ʂaŋ |
| k | kow | kaw | kan | kaŋ |
| kʰ | kʰow | kʰaw | kʰan | kʰaŋ |
| x | xow | xaw | xan | xaŋ |
| tɕ | tɕow | tɕaw | tɕan | tɕaŋ |
| tɕʰ | tɕʰow | tɕʰaw | tɕʰan | tɕʰaŋ |
| ɕ | ɕow | ɕaw | ɕan | ɕaŋ |

Thus, whether there is a non-uniqueness condition in Chinese crucially depends on the existence of medial glides in this language. If such glides exist, then since the alveopalatal consonants [tɕ tɕʰ ɕ] are in complementary distribution with some other consonants in preglidal positions, we must treat them as allophonic variants of those other consonants whose identity is non-unique, and hence the non-uniqueness condition. Otherwise, if such glides do not exist, as I propose, then the alveopalatal consonants are independent phonemes on a par with other consonants, and there is no allophonic alternation between them and any other consonants; and hence there is no non-uniqueness condition.

From a metatheoretical point of view, admission of the non-uniqueness condition implies that analyses of underlying representations can be arbitrary and indeterminate, and thereby undermines the psychological reality of underlying representations and of phonological rule systems. Therefore, it should be avoided. To do so, we must re-examine the analysis of the Chinese syllable, and determine if there is any justification for the existence of the medial glides.

## *II. Analyzing the Chinese Syllable*

Traditionally, the Chinese syllable is analyzed as composed of up to four segments CCVC (cf. Hartman (1944), Chao (1968), Wang (1972), inter alia), as in [ɕjɛn], with the second C slot anchoring one of the three glides [j ɥ w]. Although this view is accepted by most Chinese phonologists, it has been challenged by a number of authors. Chan (1985) argues that in Cantonese, the syllable initial consonant sequences [kw kʰw xw] are in fact labialized consonants [kʷ kʰʷ xʷ]. Duanmu (1990) adamantly denies the existence of the medial glide and argues for a CVC analysis for all Chinese languages.

To find out which side of the debate is more reasonable, we may ask why the Chinese syllable is analyzed into four but not three or five segments. One answer would be that we hear four different sounds in a syllable such as [ɕjɛn], i.e. [ɕ], [j], [ɛ] and [n]. However, if this were true, then the maximal number of segments in a Chinese syllable ought to be five, i.e. CCCVC, because presumably one could hear five different sounds, i.e. [t], [ɕ], [j], [ɛ] and [n], in a syllable such as [tɕjɛn]. We may also ask why the affricate [ts] is treated as two separate segments in English, but as a single segment in Chinese and Russian, even though we may hear two sounds in the affricate, i.e. [t] followed by [s].

With regard to the last question, the answer is clear: [ts] is treated as two separate segments in English, because there are such morphophonemic alternations as [kæt] vs [kæts] in English; and is treated as a single segment in Chinese and Russian, because there are no morphophonemic processes that combine [t] and [s] into [ts] in Chinese or Russian. Therefore, the ultimate justification for segmenting the speech sound is morphophonemic alternation, but not auditory impression or anything else.

Returning to the analysis of the Chinese syllable, we might assume that the syllable is an atomic linguistic unit in Chinese if there were no evidence to the contrary, in which case no analysis of the Chinese syllable would be necessary. However, there is ample evidence that portions of the Chinese syllable may be responsible for or affected by phonological processes. It is this kind of evidence that justifies the segmentation of the Chinese syllable.

One example of such evidence is the well-known process of r-suffixation in Mandarin, where the diminitive suffix *-r* replaces the postvocalic portion of the stem-final syllable it is attached to, as shown in (3). Clearly, the postvocalic portion is affected by the r-suffixation process.

(3) Mandarin r-suffixation

| | | | |
|---|---|---|---|
| [pa] | + [ɹ] | > [paɹ] | "handle" |
| [pʰan] | + [ɹ] | > [pʰaɹ] | "plate" |
| [pʰaj] | + [ɹ] | > [pʰaɹ] | "card" |
| [pɑw] | + [ɹ] | > [pɑɹ] | "package" |
| [kɤ] | + [ɹ] | > [kəɹ] | "song" |
| [kən] | + [ɹ] | > [kəɹ] | "root" |
| [ʂəŋ] | + [ɹ] | > [ʂəɹ] | "rope" |
| [pej] | + [ɹ] | > [pəɹ] | "cup" |

As a second example, there is a liaison process in Mandarin that causes the postvocalic portion of a syllable to become geminate before the sentential particle-*a*, as shown in (4). In this case, the postvocalic portion of the presuffixal syllable is responsible for the liaison process.

(4) Liaison

| | | | |
|---|---|---|---|
| [ʐɤ] | + [a] | > [ʐɤ.a] | "oh hot" |
| [lej] | + [a] | > [lej.ja] | "oh tired" |
| [xaw] | + [a] | > [xaw.wa] | "oh good" |
| [nan] | + [a] | > [nan.na] | "oh hard" |
| [ləŋ] | + [a] | > [ləŋ.ŋa] | "oh cold" |

Since the postvocalic portion of a syllable can be responsible for or affected by phonological processes, we concede that it is a legitimate segment.

As a third example, we note that there is a voicing assimilation process in Mandarin which causes the prevocalic portion of a syllable to become voiced, if this portion occurs after another syllable and if it is voiceless, unaspirated and non-continuant, as shown in (5).

(5) Voicing assimilation

| | | | | | |
|---|---|---|---|---|---|
| [wej] | "minute" | + [po] | "wave" | > [wej.bo] | "microwave" |
| [tʰaj] | "desk" | + [təŋ] | "lamp" | > [tʰaj.dəŋ] | "desk lamp" |
| [ny] | "female" | + [kuŋ] | "worker" | > [ny.guŋ] | "female worker" |
| [tʲɛn] | "electricity" | + [po] | "wave" | > [tʲɛm.bo] | "electric wave" |
| [tʲɛn] | "electricity" | + [təŋ] | "lamp" | > [tʲɛn.dəŋ] | "electric lamp" |
| [tʲɛn] | "electricity" | + [kuŋ] | "worker" | > [tʲɛŋ.guŋ] | "electrician" |

Finally, we know that there is a place assimilation process in Mandarin which causes a syllable-final [n] to become homorganic with the prevocalic portion of the following syllable if that portion is non-continuant, as shown in (6). Since the exact place of articulation of the syllable final [n] is dependent on the prevocalic portion of the following syllable, we say that that portion is responsible for this process.

(6) Place assimilation

| | | | | | |
|---|---|---|---|---|---|
| [tʲɛn] | "electricity" | + [po] | "wave" | > [tʲɛm.bo] | "electric wave" |
| [tʲɛn] | "electricity" | + [təŋ] | "lamp" | > [tʲɛn.dəŋ] | "electric lamp" |
| [tʲɛn] | "electricity" | + [kuŋ] | "worker" | > [tʲɛŋ.guŋ] | "electrician" |
| [tan] | "bullet" | + [pʲʰɛn] | "piece" | > [tam.pʲʰɛn] | "shell fragment" |
| [tan] | "bullet" | + [tʰow] | "head" | > [tan.tʰow] | "bullet head" |
| [tan] | "bullet" | + [kʰəŋ] | "pit" | > [taŋ.kʰəŋ] | "shell crater" |

Since the prevocalic portion of a syllable may be either responsible for or affected by a phonological process, we concede that it is also a legitimate segment.

So far I have demonstrated that the prevocalic and the postvocalic portions of the syllable should each be analyzed as a segment. We now proceed to see if there is any morphophonemic evidence for analyzing the prevocalic portion into two separate segments. There appear to be two sorts of such evidence: one comes from onomatopoetic reduplication, and the other from secret languages called the fanqie languages. We will have a close look at each sort of evidence in the following two sections.

*III. The Onomatopoetic Reduplication Processes*

There are two morphological patterns of onomatopoetic words that seem to derive from monosyllabic onomatopoetic words with reduplication processes that apparently involve medial glides. There is no evidence that such processes are productive. However, for the sake of exposition, let us assume that they were, and find out if they could prove anything about the putative existence of medial glides.

One such process, call it primary reduplication, reduplicates a monosyllabic onomatopoetic word, with the onset consonant of the reduplicated portion replaced by [l], and the other process, call it secondary reduplication, reduplicates the result of primary reduplication, with the vowels in the reduplicated portion being [i] and the onset consonant alternating between alveopalatal and non-alveopalatal, as shown in (7).

(7) Onomatopoetic reduplication processes

| | Base | | Primary | | Secondary |
|---|---|---|---|---|---|
| a. | pʰa | - | pʰa.la | - | pʰi.li.pʰa.la |
| | tʂa | - | tʂa.la | - | tɕi.li.tʂa.la |
| | pʰaŋ | - | pʰaŋ.laŋ | - | pʰiŋ.liŋ.pʰaŋ.laŋ |
| | taŋ | - | taŋ.laŋ | - | tiŋ.liŋ.taŋ.laŋ |
| b. | ɕi | - | ɕi.li | - | ɕi.li.ɕi.li |
| | ku | - | ku.lu | - | tɕi.li.ku.lu |
| | xu | - | xu.lu | - | ɕi.li.xu.lu |
| | po | - | po.lo | - | pi.li.po.lo |
| | tiŋ | - | tiŋ.liŋ | - | tiŋ.liŋ.tiŋ.liŋ |
| | tuŋ | - | tuŋ.luŋ | - | tiŋ.liŋ.tuŋ.luŋ |
| | xuŋ | - | xuŋ.luŋ | - | ɕiŋ.liŋ.xuŋ.luŋ |
| c. | kʷa | - | kʷa.la | - | tɕi.li.kʷa.la |
| | xʷa | - | xʷa.la | - | ɕi.li.xʷa.la |
| | kʷaŋ | - | kʷaŋ.laŋ | - | tɕiŋ.liŋ.kʷaŋ.laŋ |

These alternations represent what Yip (1992) refers to as reduplication with fixed melodic material. Since, according to Hartman (1944) and Chao (1968) inter alia, the Mandarin vowel [i] derives its back and round features from a preceding glide [j], the alternations [tɕ-k], [tɕ-tʂ], [ɕ-x] etc. do seem to suggest that [tɕ tɕʰ ɕ] are allophonic variations of [k kʰ x] or [tʂ tʂʰ ʂ] before the glide [j]. To find out if this is true, we need a detailed analysis of these processes.

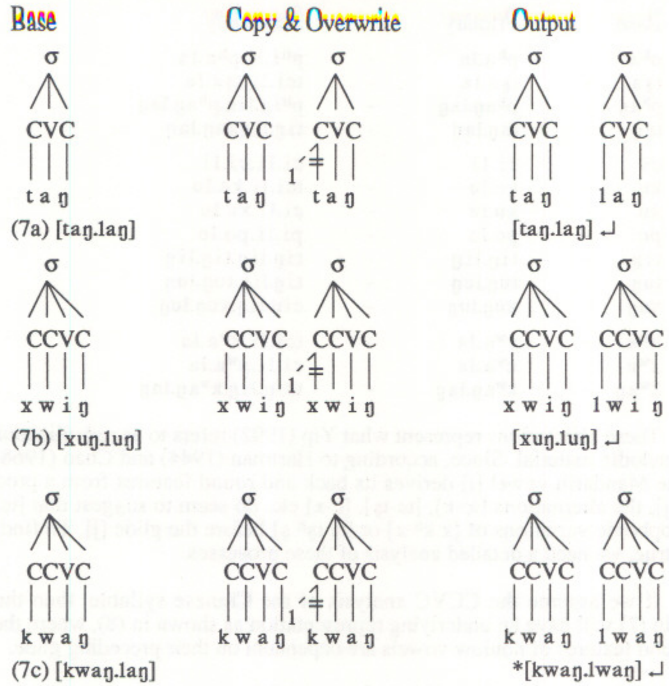
If we assume the CCVC analysis of the Chinese syllable, then the base forms in (7) will have an underlying representation as shown in (8), where the back and round features of nonlow vowels are dependent on their preceding glide.

(8) Underlying representation of base forms in (7)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a. | pʰa | tʂa | pʰaŋ | taŋ | | | |
| b. | kji | kwi | xwi | pwə | tjiŋ | twiŋ | xwiŋ |
| c. | kwa | xwa | kwaŋ | | | | |

Following McCarthy & Prince (1990), we assume that reduplication with fixed melodic material involves copying the melodic material of the base morpheme onto the reduplicative template and subsequent overwriting of the copied base material with the fixed melodic material. Specifically, to derive the primarily reduplicated forms, we assume that each base form is reduplicated with a monosyllabic suffixal template, where material under the first C slot is overwritten with [l]. With one example from each of (7a), (7b) and (7c), we provide a sample derivation of primary reduplication as shown in (9).

(9) Derivation of primary reduplication

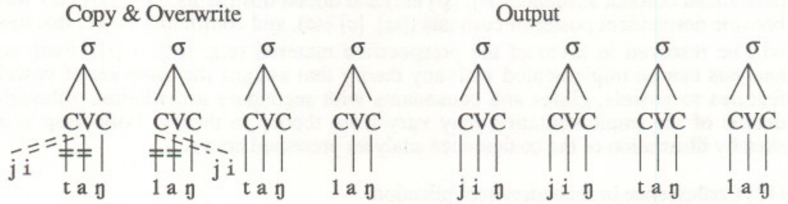



There is an apparent problem with this analysis. The output of (7c) should be [kwaŋ.laŋ], not *[kwaŋ.lwaŋ], as expected. To fix this problem, we may adopt the position that deletion of base material is forced by the phonotactics as suggested by Steriade (1988) and McCarthy & Prince (1986, 1990). We notice that the medial glide [w] (assuming it exists) has a limited distribution between [l] and [a], i.e. *[lwaŋ], *[lway] and *[lwa] are impossible syllables, though [lwan] is possible[1]. Thus, the non-occurrence of *[kwaŋ.lwaŋ] may be due to a phonotactic constraint on *[lwaŋ] which forces *[kwaŋ.lwaŋ] to be realized as [kwaŋ.laŋ]. Of course, some stipulation is needed to ensure that resolution of the phonotactic constraint does not yield *[kwaŋ.waŋ].

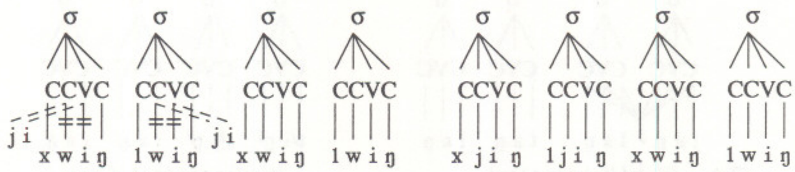
We now turn to the secondary reduplication. We assume in this case that a disyllabic base form is reduplicated to a disyllabic prefixal template, where each syllable is prespecified with a sequence [ji]. This awkward analysis may produce correct results when there is a medial glide in the base form, but it also produces wrong results when there is not such a glide there, as shown in (10).

[1] Unfortunately, since no onomatopoetic words end with /n/, and since this putative reduplication process is not productive, it is impossible to find out whether *[kwan.lwan] is acceptable.

(10) Derivation of secondary reduplication



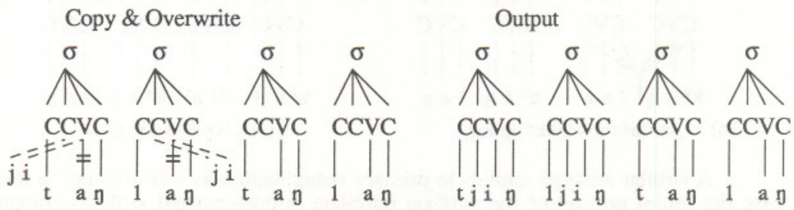

(7a) [jiŋ.jiŋ.taŋ.laŋ] *[jiŋ.jiŋ.taŋ.laŋ] ↵



(7b) [ɕiŋ.liŋ.xuŋ.luŋ] [ɕiŋ.liŋ.xuŋ.luŋ] ↵

A possible solution to the problem in (10) is to ensure that there are always two prevocalic C slots in a syllable, so that the prespecified material always skips the material under the first C slot and only overwrites the material under the second C slot and the V slot, as shown in (11). This means that in syllables that do not have a medial glide, an empty C slot must be maintained just in order for the overwriting process to produce the correct result. Such an approach is unprincipled, because there is no independent motivation for this putative empty C slot. Furthermore, the supposition that overwriting starts with the second segment is also dubious, because, as McCarthy & Prince (1986) points out, it is a commonplace of phonology that rules count moras, syllables or feet, but never segments.

(11) A sample derivation of overwriting under an empty C slot

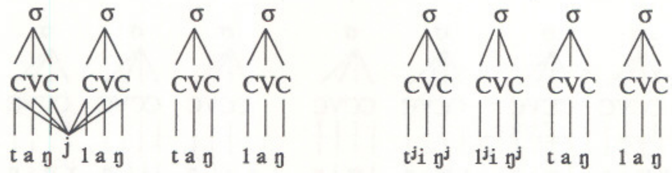



(7a) [tiŋ.liŋ.taŋ.laŋ] [tiŋ.liŋ.taŋ.laŋ] ↵

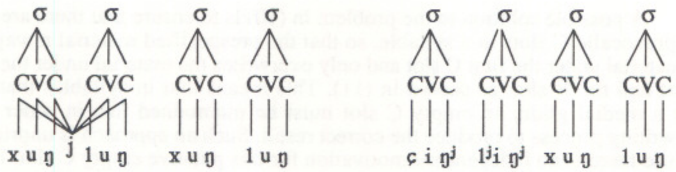
To solve these problems, let us assume that the entire prefixal template is prespecified with vowel features appropriate for [j], e.g. [+high,-back], and that the overwriting process is coalescence, not replacement, of an old segment with the prespecified material. For example, overwriting a consonant with the prespecified [j] simply means adding the vowel features of [j] to the consonant to yield a palatalized consonant ([$p^j$], [$t^j$], [$s^j$], [$ʂ^j$], [$k^j$] etc), and overwriting a vowel with [j] means adding the vowel features of [j] to the vowel to yield a vowel with conflicting features (e.g. [a] + [j] → [+high,-high,+back,-back]). These forms will then be adjusted by language specific structure preservation rules. Specifically, the palatalized coronal stridents ([sʲ], [ʂʲ] etc) and dorsal obstruents ([kʲ], [xʲ] etc) will become nonstrident posterior coronals ([tɕ], [ɕ] etc), and conflicting vowel features will be resolved in favor of the prespecified material (e.g. [aʲ] → [i]). Such an analysis can be implemented with any theory that assigns the same set of vowel features to vowels, glides and consonants with secondary articulation, although details of the implementation may vary from theory to theory. Following is a sketchy illustration of the coalescence analyses presented above.

(12) Coalescence in secondary reduplication

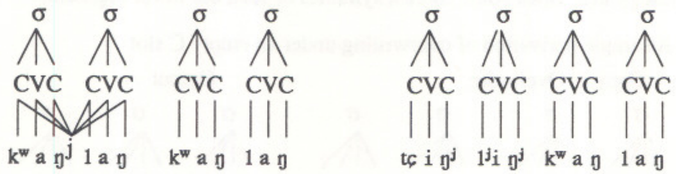
After copy and coalescence — After structure preservation




(7a) [tʲaʲŋʲ.lʲaʲŋʲ.taŋ.laŋ] — [tiŋ.liŋ.taŋ.laŋ] ↵



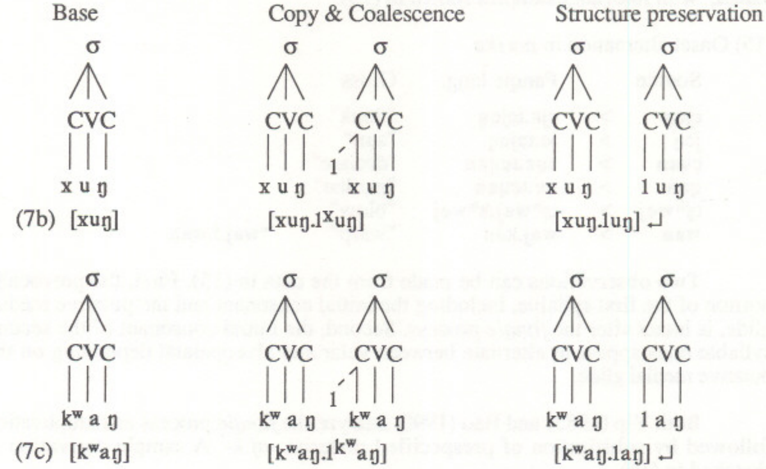

(7b) [xʲuʲŋʲ.lʲuʲŋʲ.xuŋ.luŋ] — [ɕiŋ.liŋ.xuŋ.luŋ] ↵




(7c) [kʷʲaʲŋʲ.lʲaʲŋʲ.kʷaŋ.laŋ] — [tɕiŋ.liŋ.kʷaŋ.laŋ] ↵

A similar analysis applies to primary reduplication as well, though in this case the initial portion of the suffixal template is prespecified with consonant features appropriate for [l], and structure preservation rules will delete the vowel features of any secondarily articulated [l] resulting from the coalescence process if it constitutes a violation against phonotactic constraints, as shown below.

(13) Coalescence in primary reduplication




Under these analyses, the medial glide becomes totally superfluous, because the change from [k] to [tɕ], [tʂ] to [tɕ], or [x] to [ɕ] as we see in (7) is due to the coalescence of a reduplicated non-alveopalatal consonant with prespecified vowel features, not to the spreading of vowel place features from a following medial glide. Therefore, the onomatopoetic reduplication processes do not justify the CCVC analysis of the Chinese syllable at all. In fact, a better account for the onomatopoetic reduplication processes can be made by adopting the CVC analysis, because we no longer need to stipulate about skipping the first C slot or maintaining an empty C slot.

*IV. The* Fanqie *Languages*

Another source of possible evidence for the medial glide is the formation of certain secret languages called *fanqieyu,* or fanqie languages. According to Chao (1931), there are three varieties of fanqie languages in Mandarin (Peiping), known as *maika, meika* and *manta*, respectively. In these languages, every monosyllabic content morpheme is reduplicated, with the rhyme of the first syllable replaced by a prespecified rhyme and the onset of the second syllable replaced by a prespecified onset, as shown in (14).

(14) *Fanqie* languages

| Variety | Source | | Fanqie lang. | Gloss |
|---|---|---|---|---|
| maika | mɑ | > | mai.kɑ | "mother" |
| meika | mɑ | > | mei.kɑ | "mother" |
| manta | mɑ | > | man.tʰɑ | "mother" |

Yip (1982) and Bao (1990) provide quite detailed analyses of these *fanqie* languages. What is relevant here is whether or not the *fanqie* process in these languages provides any evidence for the existence of the medial glide. We start with *maika,* with relevant examples shown in (15).

(15) Onset alternation in *maika*

| Source | | Fanqie lang. | Gloss | |
|---|---|---|---|---|
| ɕjɑŋ | > | ɕjɛ.tɕjɑŋ | "think" | |
| jɑŋ | > | jɛ.tɕjɑŋ | "sun" | |
| ɕɥan | > | ɕɥɛ.tɕɥan | "declare" | |
| ɥan | > | ɥɛ.tɕɥan | "garden" | |
| tʂʰwej | > | tʂʰwaj.kʰwej | "blow" | |
| wan | > | waj.kan | "warp" | *waj.kwan |

Two observations can be made from the data in (15). First, the prevocalic portion of the first syllable, including the initial consonant and the putative medial glide, is intact after the *fanqie* process. Second, the initial consonant of the second syllable does appear to alternate between velar and alveopalatal depending on the putative medial glide.

Both Yip (1982) and Bao (1990) analyze the *fanqie* process as reduplication followed by substitution of prespecified material *-aj.k-*. A sample derivation is sketched in (16).

(16) Sample derivation of *maika*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ɕjɑŋ | > | ɕjɑŋ.ɕjɑŋ | > | ɕjaj.kjɑŋ | > | ɕjɛ.tɕjɑŋ | "think" |
| ɕɥan | > | ɕɥan.ɕɥan | > | ɕɥaj.kɥan | > | ɕɥɛ.tɕɥan | "declare" |
| tʂʰwej | > | tʂʰwej.tʂʰwej | > | tʂʰwaj.kʰwej | | | "blow" |

According to this analysis, [tɕ] is derived from [k] before a medial glide [j] or [ɥ]. However, with the coalescence hypothesis proposed in the previous section, the same result can be derived without resorting to the medial vowel. And there is some evidence that this is a better approach.

Notice that the surface *fanqie* form of the last word in (15) [wan] "warp" is not the expected *[waj.kwan], but the unexpected [waj.kan]. There are half a dozen words in Chao (1931) that fall into this pattern, and all of them start with a labial glide. No word starting with an alveopalatal glide behaves in this way. To explain the different behavior of these initial glides, Yip (1982) assumes that while [j] and [ɥ] associate with the second C (= G) slot of the syllable, [w] associates with the first one, which is later overwritten by [k], as shown in (17).

(17) Yip's (1982) account of syllable initial glides in *maika*

```
Skeleton      C G V C  C G V C
                  | |  |
                  a j  k

Skeleton +      j ɑ ŋ      j ɑ ŋ
melody          | + +      | | |
              C G V C  C G V C = jaj.kjaŋ
                  | |  |
                  a j  k

Skeleton +    w   a n  w   a n
melody        |   + +  +   | |
              C G V C  C G V C = waj.kan
                  | |  |
                  a j  k
```

Bao (1990) charges that nothing in Yip's theory prevents one from associating [j] with the initial C and [w] with G, and thereby yielding incorrect results. In his alternative analysis, he proposes that while [w] is syllable-initial, [j] and [ɥ] are not, because they are preceded by a phantom syllable-initial "zero consonant" represented as #. He then proceeds to claim that the syllable-initial glide [w] is lost in *maika* words because it is replaced by the prespecified [k], whereas [j] and [ɥ] are preserved because the prespecified [k] only replaces the syllable-initial phantom "zero consonant" #, as shown in (18).

(18) Bao's (1990) account of syllable initial glides in *maika*

| Base | | Reduplication | | Maika | | Struc. Preserv. |
|---|---|---|---|---|---|---|
| #ja | → | #ja.#ja | → | #jaj.kja | → | yɛ.tɕja |
| wan | → | wan.wan | → | wai.kan | | |

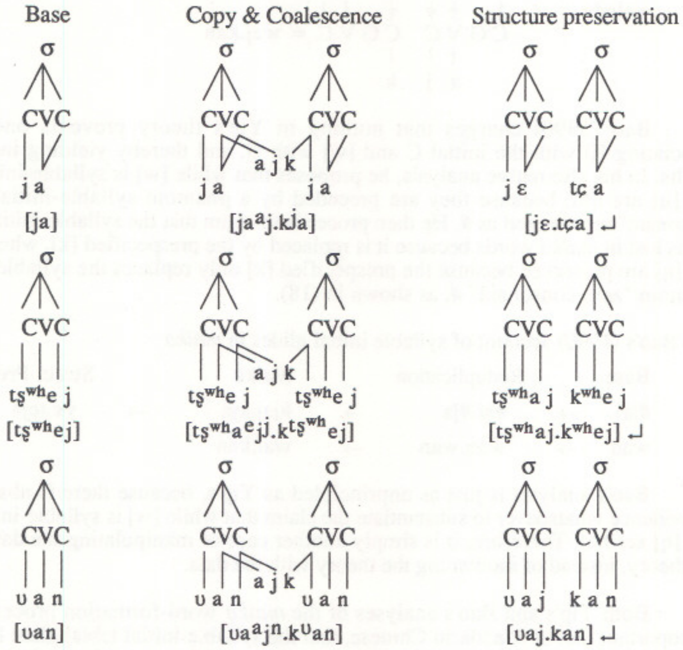
Bao's analysis is just as unprincipled as Yip's, because there is absolutely no evidence whatsoever to substantiate the claim that while [w] is syllable-initial, [j] and [ɥ] are not. Therefore, it is simply another case of manipulating the data to fit the theory, instead of motivating the theory with the data.

Both Yip's and Bao's analyses of the *maika* word-formation process miss an important fact of Mandarin Chinese, that the syllable-initial labial glide has two phonetic forms in free variation: one is a rounded bilabial approximant [w] and the other an unrounded labiodental approximant [ʋ]. For example, "warp" is either [wan] or [ʋan]. The putative medial glide never undergoes such free variation. For example, "close" is [kwan] but never *[kʋan]. The alveopalatal glides [j] and [ɥ] are also not found in any kind of free variation.

Since rounding of the labial glide is optional, we may assume that this segment is underlyingly specified for labiality but not for rounding, and that it later receives the optional [+round] feature by default, probably as an enhancement to its labiality. On the other hand, the labialized consonants must be underlyingly specified as [+round], because they contrast with their nonlabialized counterparts in rounding (e.g. [k] vs [$k^w$]). In addition, all the alveopalatal and alveopalatalized consonants must be fully specified for their vowel features, because they are either contrasting with their nonalveopalatalized counterparts in these vowel features (e.g. [t] vs [$t^j$]) or phonetically [+high] and [-back] (e.g. [j] and [ɥ]).

Since the labial glide is not specified with any vowel features, coalescing it with [k] in the *maika* word-formation process will not produce a [k] with the vowel feature [+round], but instead will produce a [k] with the consonant place feature [labial], which will be deleted by structure preservation rules. Since labialized consonants, alveopalatal consonants and alveopalatalized consonants are all specified with some vowel features, coalescing them with [k] will definitely produce a [k] with some vowel features, which in turn may be adjusted by structure preservation rules of this language (e.g. [kʲ] → [tɕ]). Following is an illustration of this new analysis of *maika* word-formation.

(19) *Maika* word-formation reanalyzed




A similar analysis applies to the word-formation process in the meika variety of *fanqie* language, although in this case, the structure preservation rules no longer apply to the onset consonants, as shown in (20).

(20) Onset non-alternation in *meika*

| Source | | Fanqie lang. | Gloss |
|---|---|---|---|
| ɕʲɑŋ | > | ɕʲej.kʲɑŋ | "think" |
| jɑŋ | > | jej.kʲɑŋ | "sun" |
| ɕʷan | > | ɕʷy.kᶣan | "declare" |
| ɥan | > | ɥy.kᶣan | "garden" |

Thus, the *fanqie* language does not justify the existence of medial glides either, and at least one *fanqie* process, the one that involves different behavior of the syllable-initial glides, cannot be analyzed in any principled way if one assumes the CCVC analysis of the Chinese syllable.

*V. Conclusion*

The above discussion shows that there is not any reliable morphophonemic evidence for the existence of the medial glides. The assumption about the existence of these glides leads to at least three problems: a) the non-uniqueness condition, b) problematic or impossible analyses of onomatopoetic reduplication and *fanqie* language formation, and c) the distributional mystery that only the putative medial glides may occur in the second prevocalic C slot of the syllable.

To avoid all these problems, we must deny the existence of the medial glides in Chinese, reject the CCVC analysis of the Chinese syllable, and reanalyze the putative prevocalic consonant sequences as single consonants with secondary articulation, as shown in (21).

(21) Reanalysis of putative consonant-glide sequences

| Cj | Cj | Cɥ | Cw | Cw | Cw | Cw |
|---|---|---|---|---|---|---|
| pj (pʲ) | nj (ȵ) | nɥ (ȵʷ) | tw (tʷ) | kw (kʷ) | tsw (tsʷ) | tʂw (tʂʷ) |
| pʰj (pʰʲ) | lj (ȴ) | lɥ (ȴʷ) | tʰw (tʰʷ) | kʰw (kʰʷ) | tsʰw (tsʰʷ) | tʂʰw (tʂʰʷ) |
| mj (mʲ) | tɕj (tɕ) | tɕɥ (tɕʷ) | nw (nʷ) | xw (xʷ) | sw (sʷ) | ʂw (ʂʷ) |
| tj (ȶ) | tɕʰj (tɕʰ) | tɕʰɥ (tɕʰʷ) | lw (lʷ) | | | ʐw (ʐʷ) |
| tʰj (ȶʰ) | ɕj (ɕ) | ɕɥ (ɕʷ) | | | | |

An apparent negative consequence of this reanalysis is the increase of the Mandarin phonemic inventory by 29 new phonemes. However, this increase is not necessarily a bad thing, because once the second prevocalic C slot is eliminated, it is no longer necessary to state the complicated cooccurrence restrictions regarding the putative CC sequence, such as no glides may occur in the first C slot and only glides may occur in the second C slot, no glides may follow [f], no labial glide may follow a labial consonant, the rounded alveopalatal glide must not follow an alveolar obstruent if the following vowel is nonhigh, etc. Thus, while we increase the phonemic inventory, we also simplify the rule system, and end up with a less abstract analysis of the phonemic system. I thus conclude that in Mandarin Chinese, the syllable structure is CVC, there is no such thing as medial glides and there is no non-uniqueness condition.

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# Theoretical Consequences of Metathesis in Maltese

Elizabeth V. Hume

## 0. Introduction

Consonant/vowel metathesis describes the process whereby the linear ordering of segments in a string switches. Traditionally, metathesis has been described through the use of transformational notation, as exemplified below.

$$\text{(1)}\quad \underset{1}{V}\ \underset{2}{C}\ \underset{3}{C}\ \underset{4}{V}\ \underset{5}{C}\ \underset{6}{V} \rightarrow 1\ 2\ 4\ 3\ 5\ 6$$

Although major advancements have been made to eliminate the use of this type of notation in processes such as assimilation and dissimilation, the formal mechanisms used to represent metathesis in nonlinear phonology have changed little. Many current analyses continue to make use of a linear transformational notation and hence, treat metathesis as a one-step operation.

In this paper, I present evidence from Maltese Arabic showing the inadequacy of this representation of metathesis. Rather, I argue that metathesis must be viewed as the product of several independent operations, each of which constitutes an elementary operation in nonlinear phonology. The implications of this study extend beyond the representation of metathesis as they also bear directly on the representation of total vowel movement across an intervening consonant. As a means of introduction, I begin by briefly outlining the problem being addressed in this paper.

In Maltese Arabic, the plural imperfective stem of first measure triliteral verbs is typically comprised of three adjacent consonants, preceded by a prefix of the form CV- and followed by the invariable plural suffix [-u], e.g. *ji+bdl+u* 'they change'. However, there is a large class of plural imperfectives which contain a stem vowel to the left of the medial consonant, e.g. *jifirdu* 'they separate'. The vowel's quality is typically identical to the underlying vocalic melody of the stem, i.e. /i/, /a/, /o/ or /e/, and the vowel only occurs when the medial stem consonant is sonorant, which includes [m, n, l, r].

In earlier works, it has been claimed that the presence of the plural stem vowel is the result of consonant/vowel metathesis (e.g. Brame 1972, Puech 1979, Berrendonner et al. 1983): underlyingly, the stem vowel occurs to the right of the medial stem consonant but by metathesis, the consonant and vowel switch positions. To anticipate the discussion in section 4, I will briefly outline the motivation for this approach.

There is an independently motivated assimilation rule in Maltese which is of particular relevance. This rule, Guttural Assimilation, changes an underlying /i/ to [a] when adjacent to a guttural consonant, i.e. [ħ ʔ]. This rule applies bidirectionally changing, for example, /i/ in perfective verbs such as /liħiʔ/ to [laħaʔ] 'he reached'. Guttural Assimilation also applies across morpheme boundaries affecting the imperfective prefix vowel.

The relevance of Guttural Assimilation to consonant/vowel metathesis relates to plural imperfectives of this last category. Consider, for example, the verb [jaħilbu] 'they milk', derived from underlying /jV+ħilib+u/. It will be noticed that although the prefix vowel undergoes Guttural Assimilation and surfaces as [a], the plural stem vowel does not, and is consequently realized as [i]. An adequate analysis must be able to account for the failure of Guttural Assimilation to apply in such cases.

As noted above, in previous analyses it has been claimed that the plural stem vowel occurs in its surface position as the result of consonant/vowel metathesis. Moreover, metathesis is crucially ordered before Guttural Assimilation. Thus, at the point in the derivation in which Guttural Assimilation applies, the plural stem vowel occurs to the right of the medial sonorant consonant and is not affected by the rule. Following the application of Guttural Assimilation, the second stem vowel (still /i/) switches positions with the medial sonorant consonant and surfaces as [i], as desired.

While this analysis is well-motivated for verbs such as [jaħilbu], it is unable to account for the full range of plural imperfectives. There are verbs for which the ordering of Guttural Assimilation before metathesis yields the wrong results. Consider, for example, [jifilħu] 'they are strong', derived from /jV+filiħ+u/. In this instance, applying Guttural Assimilation prior to metathesis would yield *[jifalħu], since the final stem vowel would first change from /i/ to [a], and then by metathesis, surface incorrectly as [a] to the left of the medial sonorant consonant.

Although some form of consonant/vowel metathesis is well-motivated, it will be shown that the traditional view of metathesis is unable to account for the full range of imperfective plurals in Maltese. The problem is associated with the view of metathesis as a one-step operation, frequently expressed by means of linear tranformational notation, as in (1) above. I argue that metathesis in Maltese is more appropriately viewed as the product of three elementary operations: delete, insert and associate. The first two characterize independently motivated rules of Maltese: Syncope and Epenthesis, respectively. The third operation, associate, takes the form of a universal association convention which maps a floating melody onto an unspecified slot of the prosodic template. When these three operations are sequenced within a single derivation, the product is metathesis. As will be seen, this analysis also provides a simple account of the realization of the imperfective prefix vowel.

This analysis is similar in some ways to that proposed by Kenstowicz (1981) for Palestinian Arabic. Although the data in the two languages differ in many respects, the traditional view of metathesis is shown to be descriptively inadequate in both cases. Kenstowicz rejects the metathesis approach since, as he states, "metathesis merely duplicates the work of syncope and epenthesis" (p.460). Although he incorporates syncope and epenthesis into his analysis, Kenstowicz nonetheless assumes that metathesis continues to exist in phonology as an independent one-step operation. I would suggest, however, that the reason for this duplication stems from the fact that consonant/vowel metathesis is in fact the product of more than one operation. By analyzing metathesis in this manner, it is unnecessary to maintain the traditional one-step approach as well.

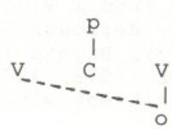
The analysis presented in this paper also bears directly on the representation of total vowel movement and the organization of consonant and vowel place features. Processes of vowel movement across an intervening consonant serve as a good testing-ground for nonlinear models of feature organization. Within the well-motivated view of assimilation as spreading, the features of consonants and vowels must be sufficiently disjunctive to allow for the spreading of vowel features across those of a consonant without violating the No Crossing Constraint (Goldsmith 1976), which I state in (2).

(2) No Crossing Constraint
Association lines linking features on the same tier may not cross.

McCarthy (1989b) has convincingly shown the inadequacy of current models of feature geometry to account for cases of consonant/vowel metathesis, a process which he treats as spreading a vowel's features across those of a consonant. To remedy this problem, he attributes metathesis to planar V/C segregation and further suggests that metathesis *implies* planar segregation. With the melodies of consonants and vowels arrayed on separate planes, vowel features are able to spread freely across a consonant without crossing association lines, as illustrated in (3).

(3) Vowel spreading with planar segregation (based on McCarthy 1989b)

e.g.




Evidence from Maltese suggests, however, that not all cases of C/V metathesis can be attributed to planar segregation. Like other Arabic dialects, Maltese's verbal morphology is templatic, comprised of a prosodic template, a consonantal root and a vocalic melody, with each serving a specific semantic function in varying degrees. Following

McCarthy's arguments, this then would seem to be a case in which we might expect planar segregation to be applicable. I argue, however, that this account is not available since at the point in the derivation in which metathesis, or more specifically, total vowel movement, occurs, the planes of consonants and vowels must be conflated.

With an enriched model of feature geometry there is an alternative means of representing vowel movement which does not require complete planar V/C segregation. In this model, emanating from the work of Clements (1989, 1991), Herzallah (1990), and Hume (1991, 1992), vowel place and height features form a unit dominated by a Vocalic node, which is able to spread freely across intervening consonants, which do not bear such a node. The spreading of the vowel features in Maltese presents strong evidence for the Vocalic node as an independent constituent in feature organization and, furthermore, shows that total vowel movement across intervening consonants need not imply complete consonant/vowel segregation.

The organization of this paper is as follows. After the preliminaries of section 1, I focus in section 2 on the typical formation of the imperfective, first measure, thus providing essential background information for subsequent discussions. Following this, I elaborate on the problem associated with accounting for the class of imperfective plurals which have traditionally been analyzed as involving consonant/vowel metathesis. I show that although some account of metathesis must be maintained, the traditional view of metathesis as a one-step operation is inadequate. In section 4, I present an alternative account and I show how this analysis accounts not only for the realization of the metathesized vowel but, in addition, for that of the imperfective prefix vowel. Finally, I discuss implications of this study for the representation of total vowel movement and the organization of place features.

## 1. Preliminaries

The dialect under investigation is standard Maltese Arabic, spoken on the mediterranean island of Malta, situated approximately 60 miles south of Sicily and 180 miles east of the Tunisian coast. My data are drawn from a wide range of sources which include Aquilina (1959), Berrondonner et al. (1983), Borg (1973), Brame (1972, 1973), Bugeja (1984), Busuttil (1981), Butcher (1938), Puech (1978, 1979) and Sutcliffe (1936). These data are consistent with the variety of Maltese spoken by my consultants[1].

In (4) and (5) below, I give the phonemic inventory of standard Maltese Arabic for reference.

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[1]Several people associated with the Permanent Mission of Malta to the United Nations graciously served as consultants. I am particularly grateful to Mr. Michael Bartolo, Mr. Tony Borġ and Mr. George Vella and, in particular, Mr. Anton Mifsud-Bonnici.

(4) Vowels[2]:

| | | | |
|---|---|---|---|
| | i | | u |
| | e | | o |
| | | a | |

(5) Consonants:

| | Labial | Labio-dental | Dental | Palato-alveolar | Velar | Pharyngeal | Laryngeal |
|---|---|---|---|---|---|---|---|
| stops | p b | | t d | | k g | | ʔ |
| fricatives | | f v | s z | ʃ [ʒ]* | | ħ | |
| affricates | | | t͡s d͡z* | t͡ʃ d͡ʒ | | | |
| nasals | m | | n | | | | |
| liquids | | | l r | | | | |

* d͡z occurs only in a few Italian/Sicilian loanwords
* [ʒ] occurs only before voiced obstruents

## 2. First Measure Triliteral Verb[3]

### 2.1 Typical Formation of the Imperfective

Of particular interest to the present paper are imperfective verbs of the triliteral verb, first measure. The imperfective of the verb 'to break' is illustrated in (6) below. As can be seen, both singular and plural forms bear a prefix of the form CV-. The invariable suffix [-u] is added to plurals.

(6) Imperfective, e.g. 'to break'

| | | | |
|---|---|---|---|
| 3rd masc. sing. | já+ʔsam | 3rd plural | já+ʔsm+u |
| 3rd fem. sing. | tá+ʔsam | | |
| 2nd singular | tá+ʔsam | 2nd plural | tá+ʔsm+u |
| 1st singular | ná+ʔsam | 1st plural | ná+ʔsm+u |

I follow Aquilina (1959) and Puech (1979), among others, in positing that the imperfective is derived from the canonical form -CVCVC-, a bisyllabic template which corresponds in form to the third person masculine singular of the perfective verb, e.g. [ʔasam] 'he broke'. It will be

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[2]In addition to the vowels in (1), Maltese also includes the diphthong [iə] (orthographically ie) in its vowel inventory (see e.g. Aquilina 1959).

[3]There are certains verbs in which one of the root consonants is orthographically 'h' or 'għ'. I have not included this class of verbs in the discussion in this paper since although they pattern in a manner similar to triliteral strong verbs, there are certain significant differences. In particular, the orthographic consonant is generally not realized phonetically. Providing a full analysis of these verbs is beyond the scope of this work. However, I refer the reader to the insightful discussions in, most notably, Brame (1972) and Puech (1979).

noticed, however, that in the stem of the singular imperfective there is only one vowel, and in the plural, there are no vowels. Thus, in claiming that these forms are derived from a bisyllabic stem, some account must be given of the absence of vowels in the imperfective. Brame (1973) convincingly argues that the lack of vowels is due to a more general rule of vowel deletion which is described in its preliminary formulation in (7).

(7) Syncope (preliminary formulation):
V̆-> ø / C__ C V
A short unstressed vowel in a non-final open syllable deletes.
Domain of application: first measure

Note that stress assignment in Maltese is similar to that of most Arabic dialects in that stress generally falls on a final superheavy syllable. If there isn't one, the penultimate syllable is stressed if heavy (or if there are only two syllables), otherwise the antepenult is stressed (see e.g. Brame 1972, 1973).

The application of Syncope in the imperfective is illustrated in (8). Stress falls on the prefix vowel and the first stem vowel is subsequently deleted. The output of the first cycle yields the form of the singular imperfective. With the addition of the suffix -u in the second cycle, the context for Syncope is once more defined and the second stem vowel deletes.

(8)

| | | |
|---|---|---|
| 1. | Input | CV̧+CVCVC |
| | Stress | CV̧CVCVC |
| | Syncope | CVCCVC |
| 2. | Input | CV̧́CCVC+u |
| | Syncope | CVÇCCu |
| | | [CVCCCu] |

Independent evidence for Syncope comes from the observation that this rule also accounts for the realization of perfective verb forms of the first measure, for example. This is illustrated in (9) below, where I give the perfective of the verb [ʔasam]. Once again, the verb stem is derived from a bisyllabic canonical template, corresponding to the form of the third person masculine singular perfective.

(9) Perfective, first measure triliteral verb

| | | | |
|---|---|---|---|
| ʔásam | -> | [ʔásam] | 'he broke' |
| ʔásam+et | -> | [ʔásmet] | 'she broke' |
| ʔasám+t | -> | [ʔsámt] | 'I, you (sg.) broke' |
| ʔásam+u | -> | [ʔásmu] | 'they broke' |
| ʔasám+na | -> | [ʔsámna] | 'you (pl.) broke' |
| ʔasám+tu | -> | [ʔsámtu] | 'we broke' |

Thus, by positing an underlying bisyllabic template -CVCVC- in conjunction with the independently motivated rule of Syncope, we are able to derive the typical formation of singular and plural imperfectives.

## 2.2 Vowel Quality

In this section I provide some relevant background concerning the vowel quality of perfective and imperfective verbs. For more detailed discussions, I refer the reader to Puech (1979) and Hume (1992).

Listed in (10) below are representative examples of imperfective and perfective verbs. To the right of each set of verbs, the underlying quality of the stem vowel is indicated. Although in some verbs the surface quality of vowels may differ, I claim that each stem has an underlying vocalism of a single quality, /i/, /e/, /o/ or /a/. This claim will be seen to be of particular importance in accounting for the realization of the imperfective prefix vowel and the stem vowel which occurs in the class of imperfective plurals evidencing metathesis. The analyses in this section owe much to the insights of Berrendonner et al (1983) who were the first, I believe, to suggest that each stem is associated with a single vowel quality in UR.

(10)

| Imperfective 3rd p.m.sg. | 3rd p.pl. | Perfective 3rd p.m.sg. | Stem Vowel | |
|---|---|---|---|---|
| jo+ktor | jo+ktr+u | kotor | /o/ | 'to increase' |
| jo+ħtob | jo+ħtb+u | ħotob | /o/ | 'to propose marriage' |
| jo+nfor[4] | jo+nfr+u | nafar | /a/ | 'to expose' |
| ja+ʔsam | ja+ʔsm+u | ʔasam | /a/ | 'to break' |
| ja+ħbat | ja+ħbt+u | ħabat | /a/ | 'to strike, hit' |
| je+ħbel | je+ħblu | ħebel | /e/ | 'to rave' |
| je+ħber | je+ħbru | ħeber | /e/ | 'to predict' |
| ji+kʃef | ji+kʃf+u | kiʃef | /i/ | 'to discover' |
| ji+nzel | ji+nzl+u | nizel | /i/ | 'to descend' |
| ja+ħdem | ja+ħdm+u | ħadem | /i/ | 'to work' |
| ja+ʔbel | ja+ʔbl+u | ʔabel | /i/ | 'to agree' |
| ji+lħaʔ | ji+lħʔ+u | laħaʔ | /i/ | 'to reach' |
| ji+tħan | ji+tħn+u | taħan | /i/ | 'to grind' |
| ji+ftaħ | ji+ftħ+u | fetaħ | /i/ | 'to open' |
| jo+bzoʔ | jo+bzʔ+u | bezaʔ | /i/ | 'to spit' |

In many verbs, the surface quality of all vowels within a given verb stem is identical (excluding, of course, the imperfective plural suffix which is invariably [u]). This is the case in verbs such as [kotor]/[joktor] 'he increased/he increases', [ħabat]/[jaħbat] 'he struck/he strikes', and

[4]This verb is representative of a small class of verbs in which the vowel quality of the imperfective is systematically realized as [o], regardless of the quality of stem vowels in the perfective (see Hume 1992 for related discussion).

[ħeber]/[jeħber] 'he predicted/he predicts'. Given the absence of vowel alternations in these cases, we may assume, in accordance with the null hypothesis, that there is a vocalism of a single quality in underlying representation. In the first case it is /o/, in the second it is /a/, and in the third it is /e/. Note that for each of these verbs, the quality of the imperfective prefix vowel is identical to that of the underlying vocalic melody.

In other forms, the quality of vowels within a given verb may differ. In [nizel]/[jinzel] 'he descended/he descends', for example, the prefix vowel and the first stem vowel surface as [i] whereas the stem-final vowel is [e]. There is strong evidence to suggest, however, that the underlying vocalism of the stem is /i/. To maintain such a claim, we are required to posit that the quality of the stem-final vowel is /i/. This position is well-motivated given the fact that [i] regularly alternates with [e] (Brame 1972, 1973; Puech 1979; Berrendonner et al. 1983). We see this alternation in the perfective, e.g. [nizel] 'he descended', [nzilt] 'I, you (sg.) descended'(note that the first stem vowel is deleted by the rule of Syncope.) This alternation is evidenced more widely as exemplified by the third person feminine suffix.

(11) 3rd pers. fem. suffix [-it]~[-et]
(examples from Brame 1972:26)
[ħatf+i̲t+kom] 'she grabbed you' cf.[ħatf+e̲t] 'she grabbed'
[bezʔ+i̲t+l+ek] 'she spit to you' cf.[bezʔ+e̲t] 'she spit'

As these examples illustrate, [e] occurs when followed by a single word-final consonant, otherwise the vowel surfaces as [i]. Following Puech (1978), we may account for this alternation by the rule of I-lowering given in (12).

(12) I-lowering
i -> e/ __C#
The vowel /i/ is realized as [e] before a single word-final consonant.

With the rule of I-lowering, we are able to account for the i~e alternations in verbs such as [nizel]/[jinzel] by positing a single underlying vocalism /i/. Thus, the stem is derived from /nizil/. It is important to emphasis that, consistent with the verbs discussed just above, the imperfective prefix vowel is identical in quality to the underlying vocalism.

I turn now to verbs in which the vowel sequence of the perfective is [a-e], as exemplified by [ħadem] 'he worked'([jaħdem]/[jaħdmu] 'he works/they work'). For such verbs, it is also claimed that the underlying vocalism is /i/. Positing /i/ as the quality of the final stem vowel is well-motivated given that the final stem vowel shows i~e alternations, e.g. [ħadem] 'he worked', [ħdimt] 'I, you (sg.) worked'(see I-lowering in (12)).

This still leaves the [a] quality of first stem vowel of the perfective and the prefix vowel to be accounted for. A property shared by all [a-e] verbs such as [ħadem] is the occurrence of a guttural consonant, i.e. [ħ ʔ], in stem-initial position. McCarthy (1989a) and Herzallah (1990) argue, based on a wide range of evidence, that these consonants are members of a natural class which may be characterized by the articulator feature [pharyngeal]. In Herzallah's study of Palestinian Arabic, she provides strong evidence that the vowel [a] is also best characterized as [pharyngeal]. Given the common place specification of these sounds, I would suggest that by positing an underlying /i/ vocalism, the quality of the vowel [a] in verbs such as [ħadem] is the result of assimilation to an adjacent guttural consonant. Following Brame (1972), the rule describing this change appears in (13)[5].

(13) Guttural Assimilation:
/i/ -> [a]% __ [ħ ʔ]
The high front vowel /i/ changes to [a] when adjacent to [ħ ʔ] (mirror image).

Partial motivation for this rule comes from the observation that although [e, o, a] may occur adjacent to a guttural consonant in underived verb forms[6], e.g. [ħebel] 'he raved', [boloʔ] 'he was past his prime', [ħabat] 'he struck', [i] is excluded. The rule of Guttural Assimilation accounts for this distributional gap.

Further evidence comes from an examination of verbs such as the following.

(14)

| Imperfective | | Perfective | |
|---|---|---|---|
| 3rd p.m.sg. | 3rd p.pl. | 3rd p.m.sg. | |
| ji+lħaʔ | ji+lħʔ+u | laħaʔ | 'to reach' |
| ji+sħaʔ | ji+sħʔ+u | saħaʔ | 'to pound' |
| ji+t͡ħan | ji+t͡ħn+u | t͡aħan | 'to grind' |
| ji+t͡ʃħad | ji+t͡ʃħd+u | t͡ʃaħad | 'to deny' |

It will be noticed that in each of these verbs, the imperfective prefix vowel surfaces as [i], despite the fact that the quality of the stem vowels is [a]. Recall that in the groups of verbs discussed previously, the surface quality of the prefix vowel is identical to that of the underlying vocalism of the stem. In keeping with this generalization, we posit /i/ as the underlying melody for verbs in (14). The realization of the stem vowels as [a] is accounted for by Guttural Assimilation since in each of these verbs there is a guttural consonant in at least medial position. Thus, by assuming that the underlying vocalism of the verbs in (14) is

[5] For the purposes of this paper, the descriptive rules in this section are sufficient. For a nonlinear characterization, see Hume (1992).
[6] [u] does not occur in verb stems of the first measure.

/i/, we correctly predict the prefix vowel to be identical in quality to the underlying vocalism.

To anticipate the discussion below, the quality of the prefix vowel is best analyzed as being the result of assimilation to the stem's vocalism. For our present purposes, I refer to this rule as Prefix Vowel Assimilation, stated in prose in (15). In section 5, I return to the question of how this rule is formally represented.

(15) Prefix Vowel Assimilation (PVA) (preliminary formulation):
The imperfective prefix vowel assimilates in quality to the underlying vocalism of the stem.

The partial derivations of the imperfective and perfective of the verb 'to reach' are given in (16).

| (16) | jV+liħiʔ | liħiʔ |
|---|---|---|
| Prefix Vowel Assim. | jiliħiʔ | n/a |
| Syncope | jilħiʔ | n/a |
| Guttural Assim. | jilħaʔ | laħaʔ |
| | [jilħaʔ] | [laħaʔ] |
| | 'he reaches' | 'he reached' |

Note that for the prefix vowel to surface as [i], Guttural Assimilation must apply after the prefix vowel has acquired its quality from the stem vocalism. Were this not the case, we would incorrectly predict the prefix vowel to surface as [a].

Reconsider now verbs such as [ħadem]/[jaħdem] 'he worked/he works'. With the rules of I-lowering and Guttural Assimilation, we may posit /i/ as the underlying vocalism. As shown in (17) for the verb 'to work', the imperfective prefix vowel first acquires the vowel quality of the underlying vocalism, i.e. /i/. Consistent with the ordering in (16), Syncope then applies to delete the first stem vowel of the imperfective. Guttural Assimilation then applies. This changes the imperfective prefix vowel, as well as the first stem vowel of the perfective to [a]. Note that Guttural Assimilation applies bidirectionally: right to left in the imperfective and left to right in the perfective. The final stem vowel lowers to [e] by the independently motivated rule of I-lowering. (The ordering of Guttural Assimilation before I-lowering is not crucial to this account.)

| (17) | jV+ħidim | ħidim |
|---|---|---|
| Prefix Vowel Assim. | jiħidim | n/a |
| Syncope | jiħdim | n/a |
| Guttural Assim. | jaħdim | ħadim |
| I-lowering | jaħdem | ħadem |
| | [jaħdem] | [ħadem] |
| | 'he works' | 'he worked' |

Similar to the preceding example, the underlying vocalic melody of verbs such as [fetaħ]/[jiftaħ] 'he opened/he opens' is also /i/. Motivation for this view comes first, from the fact that the prefix vowel surfaces as [i]. Second, it will be observed that the final stem consonant is a guttural consonant. Given the independently motivated rule of Guttural Assimilation, positing /i/ as the underlying quality of the stem-final vowel comes at no extra cost. Remaining to be accounted for is the stem-initial vowel of the perfective which surfaces as [e]. As observed by Berrendonner et al. (1983), in all surface vowel sequences, [a] is only preceded by [e] within the stem; [i] is excluded from this position. I account for this gap for positing /i/ as the underlying quality of the first stem vowel. Due to the effect of a following pharyngeal vowel, the vowel /i/ lowers to [e]. This is stated descriptively as the rule of A-assimilation in (18).

(18) A-assimilation
/i/ -> [e]/ __ C a

As shown in (19), A-assimilation applies after Guttural Assimilation. The second vowel changes to [a] due to Guttural Assimilation, and the first vowel lowers to [e] due to the effect of the following vowel [a].

| (19) | /fitiħ/ | |
|---|---|---|
| Guttural Assim. | fitaħ | |
| A-Assimilation | fetaħ | |
| Output | [fetaħ] | 'he opened' |

By taking into account the rules of Guttural Assimilation and A-assimilation, both stem vowels of the perfective verb in (19) are treated as underlyingly /i/. Consequently, like all other verbs presented above, we posit a single vocalism in underlying representation. Furthermore, the quality of the imperfective prefix is once again identical to the underlying vocalism.

In this section I have argued that each verb stem has a vocalic melody of a single quality in underlying representation. Moreover, the imperfective prefix vowel is typically identical in quality to this melody. One rule, Guttural Assimilation, has be shown to account for the vowel quality in a number of verbs. It will be seen that this rule also plays a central role in the discussion of plural imperfectives evidencing metathesis. Of particular relevance is the assumption that Guttural Assimilation applies after general Tier Conflation. In the following section I elaborate on why this is so.

## 2.3 Guttural Assimilation and Tier Conflation

In McCarthy's (e.g. 1979, 1981) analysis of Classical Arabic, he argues that consonantal and vocalic melodies map onto the prosodic template prior to the phonology. Moreover, the melodies of consonants and vowels are compeletely segregated. As applied to Maltese Arabic, the perfective verb [ħadem] /ħidim/ 'he worked', which is comprised of the consonantism /ħdm/, the vocalism /i/, and the bisyllabic template CVCVC, can be characterized as in (20).

```
(20)  ħdm, i
      ħ    d    m
      |    |    |
      C  V C  V C
          \  /
           i
```

Of particular importance is the fact that the vowel /i/ is multiply-linked to both V-slots of the prosodic template. Were, on the other hand, /i/ linked to each V-slot individually as in (22), the configuration would violate the Obligatory Contour Principle, stated in (21), since it contains identical adjacent instances of /i/.

(21) Obligatory Contour Principle (McCarthy 1988)
Adjacent identical autosegments are prohibited.

```
(22)  ħdm, i
      ħ    d    m
      |    |    |
      C  V C  V C
         |    |
      *  i    i
```

McCarthy (1986), following Younes (1983), motivates a process of general Tier Conflation which conflates the consonantal and vocalic melodies at a specific point in the phonology, thus resulting in the linear ordering of consonants and vowels. The application of general Tier Conflation to the representation in (22) is given in (23).

```
(23)  ħ    d    m
      |    |    | Tier Conflation
      C  V C  V C        →        C  V  C  V  C
         \   /                    |  |  |  |  |
           i                      ħ  i  d  i  m
```

Recall that two rules must apply in order to derive the correct surface form [ħadem] from underlying /ħidim/: Guttural Assimilation and I-lowering. Of particular relevance to subsequent discussions is the observation that Guttural Assimilation must apply after general Tier Conflation in order to obtain the correct result. As noted above, after general Tier Conflation has applied, the multiple-linking of non-skeletal adjacent elements is eliminated (see (23)). Given this configuration, only the first stem vowel will undergo Guttural Assimilation, as desired. I-lowering is also correctly predicted to apply only to the stem-final vowel.

```
(24)    C V C V C   Guttural Assim.  C V C V C
        | | | | |   I-lowering       | | | | |
        ħ i d i m        →           ħ a d e m  → [ħadem]
```

Conversely, if we were to assume that Guttural Assimilation applied prior to Tier Conflation, as in (25), we would incorrectly predict both stem vowels to surface as [a]. This results from the fact that Guttural Assimilation is defined on /i/, and since /i/ is multiply-linked to both V-slots, both vowels would be affected.

```
(25)
       ħ   d   m                    ħ   d   m
       |   |   |   Guttural Assim.  |   |   |
       C V C V C         →          C V C V C  — *[ħadam]
          \ /                          \ /
           i                            a
```

Consequently, in order to obtain the correct surface forms, it is important to assume that vowels undergo Guttural Assimilation after the application of general Tier Conflation.

## 3. Plural Imperfectives

### 3.1 The Problem

In section 2.1, it was shown that the typical form of the imperfective plural, first measure triliteral verb, consists of a stem made up of three consonants. This stem is derived from a bisyllabic template, -CVCVC-, with vowel deletion accounted for by the rule of Syncope. In (26), I provide representative examples of verbs which constitute exceptions to this general formation. These involve verbs in which the medial stem consonant is sonorant, i.e. [m n l r], and where a vowel occurs to the left of this consonant. Note that the quality of the vowel is identical to the underlying vocalism of the stem, indicated on the right. Given that the forms in (26) form a regular class of exceptions, an adequate analysis of the imperfective must address a number of questions. First, how do we account for the presence of the stem vowel which occurs in only this subset of plural imperfectives? And second, what are the factors which determine the surface quality of the plural stem vowel? Is it predictable and if so, how?

(26)

| Imperfective 3rd p.m.sg. | 3rd p.pl. | Perfective 3rd p.m.sg. | Stem Vowel | |
|---|---|---|---|---|
| ja+ħrab | ja+ħarb+u | ħarab | /a/ | 'to run away' |
| ja+ħrat | ja+ħart+u | ħarat | /a/ | 'to plough' |
| jo+bloʔ | jo+bolʔ+u | boloʔ | /o/ | 'to be past one's prime |
| jo+frok | jo+fork+u | forok | /o/ | 'to limp' |
| jo+brod | jo+bord+u | barad | /a/ | 'to file' |
| ji+fred | ji+fird+u | fired | /i/ | 'to separate' |
| ji+dneb | ji+dinb+u | dineb | /i/ | 'to sin' |
| ja+ħleb | ja+ħilb+u | ħaleb | /i/ | 'to milk' |
| ja+ʔleb | ja+ʔilb+u | ʔaleb | /i/ | 'to overturn' |
| ji+flaħ | ji+filħ+u | felaħ | /i/ | 'to be strong' |
| ji+sraʔ | ji+sirʔ+u | seraʔ | /i/ | 'to steal' |
| je+ħmez | je+ħemzu | ħemez | /e/ | 'to pin' |

One potential means of accounting for the presence of the plural stem vowel in the forms above is to posit that the vowel fails to undergo Syncope and as such remains to the left of the medial sonorant consonant throughout the entire derivation. This could be achieved by reformulating the rule of Syncope such that it applies just in case the medial stem consonant is [-sonorant], as stated in (27).

(27) Syncope II:
$V \rightarrow \emptyset$ / C ___ $C_1$ V
Condition: if $C_1$ is a medial stem consonant then it must be [-sonorant]

The application of the revised Syncope rule is illustrated in the derivation of [jokorbu] in (28). As can be seen, the first stem vowel fails to delete since it is followed by a medial sonorant consonant. With the addition of the plural suffix, the final stem vowel does delete, as desired. Thus, by blocking syncope from applying just in case the medial consonant is [+sonorant] we are able to derive the correct form of [jokorbu].

(28)

| | |
|---|---|
| | jV+korob |
| Prefix Vowel Assim. | jokorob |
| Syncope | -blocked- |
| ------------------------------- | |
| Input | jokorob+u |
| Syncope | jokorbu |
| | [jokorbu] 'they groan' |

Despite this approach's success in handling verbs such as [jokorbu], it has two principal weaknesses. First, we are required to include the seemingly arbitrary stipulation that the rule applies just in case the medial consonant is [-sonorant]. Second, and more importantly, the analysis is unable to account for the surface quality of the stem vowel in verbs such as [jaħilbu] 'they milk', derived from /jV+ħilib+u/. As shown in section 2.2 above, the realization of the prefix vowel as [a] is due to Guttural Assimilation: the prefix vowel first assimilates to the underlying vocalism /i/, then assimilates to the stem-initial guttural consonant, thus surfacing as [a]. Note that if we were to assume that the first stem vowel of the plural imperfective did not undergo Syncope, as in (29) below, this vowel would also be expected (incorrectly) to undergo Guttural Assimilation.

| (29) | jV+ħilib |
| --- | --- |
| Prefix Vowel Assim. | jiħilib |
| Syncope | -blocked- |
| Input | jiħilib+u |
| Syncope | jiħilbu |
| Guttural Assimilation | jaħalbu |
| | *[jaħalbu] |
| | ([jaħilbu] 'they milk') |

Restricting the directionality of Guttural Assimilation to apply from right to left is not a possible solution since, it will be recalled, Guttural Assimilation also applies from left to right, e.g. [ħaleb] < /ħilib/ 'he milked'. (The final stem vowel is realized as [e] by I-lowering.) Consequently, it cannot be assumed that the plural stem vowel remains to the left of the medial sonorant consonant throughout the entire derivation.

As pointed out by Puech (1979), the quality of the stem vowel in verbs such as [jaħilbu] 'they milk' may be correctly accounted for if we assume that the plural stem vowel originates to the right of the medial consonant but then undergoes metathesis after the application of Guttural Assimilation. Berrendonner et al. (1983) make use of the following transformational notation to describe metathesis.

(30) Metathesis:

$$\begin{array}{cccccc} V & C & R & V & C & V \\ 1 & 2 & 3 & 4 & 5 & 6 \end{array} \rightarrow 1\ 2\ 4\ 3\ 5\ 6 \quad \text{(where R = nasal or liquid)}$$

I follow the essentials of Puech's analysis to illustrate this point. In order for the second stem vowel to resist deletion, the rule of Syncope must be revised once again as in (31).

(31) Syncope III:

$V \rightarrow \emptyset \; / \; C_1 \, \_\_ \, C\ V$

Condition: if $C_1$ is a medial stem consonant then it must be [-sonorant]

Although the rule's revision is trivial, it is nonetheless successful in blocking Syncope from applying to the second stem vowel when preceded by a sonorant consonant. The derivation of 'they milk' incorporating this revision is given in (32).

(32)

| | |
|---|---|
| Input | jV+ħilib |
| Prefix Vowel Assim. | jiħilib |
| Syncope | jiħlib |
| ------------------------------ | ------------------------------ |
| Input | jiħlib+u |
| Syncope | -blocked- |
| Guttural Assimilation | jaħlibu |
| Metathesis | jaħilbu |
| Output | [jaħilbu] 'they milk' |

In this analysis, the first stem vowel deletes, yet Syncope fails to apply to the second vowel since it is preceded by a medial sonorant consonant, i.e. [l]. Thus, Guttural Assimilation changes only the prefix vowel to [a]. Metathesis then applies and the medial consonant and following vowel switch positions. Through the crucial ordering of Guttural Assimilation before Metathesis, the plural stem vowel is correctly realized as [i]. It is important to note that if the ordering were reversed, we would predict the stem vowel as well as the prefix vowel to surface as [a], identical to the output in (29).

I would suggest that the view that the plural stem vowel originates to the right of the medial consonant is the correct approach. Any analysis in which the stem vowel were to remain to the left of the medial consonant throughout the derivation would run into problems for precisely the reasons indicated above. Nonetheless, there are also problems associated with this approach as it now stands. First, we are again required to formulate Syncope in such a way as to include the ad hoc stipulation that it applies just in case the medial consonant is [-sonorant]. Yet, more importantly, there are a number of verbs that the analysis in (32) will not account for. Consider, for example, the verb [jifilħu] < /jV+filiħ+u/ 'they are strong' (cf. [jiflaħ] 'he is strong'). Identical to the verb [jaħilbu], the metathesized vowel surfaces as [i]. However, as illustrated in column I in (33), applying Guttural Assimilation *before* Metathesis as is required in (32) causes the metathesized vowel in the verb 'to be strong' to surface incorrectly as [a].

(33)

| | I. | II. | |
|---|---|---|---|
| Input | jV+filiħ | jV+filiħ | Input |
| Prefix Vowel Assim. | jifiliħ | jifiliħ | Prefix Vowel Assim. |
| Syncope | jVfliħ | jVfliħ | Syncope |
| ------------------------------ | ------------------------------ | ------------------------------ | ------------------------------ |
| Input | jifliħ+u | jifliħ+u | Input |
| Syncope | -blocked- | -blocked- | Syncope |
| Guttural Assim. | jiflaħu | jifilħu | Metathesis |
| Metathesis | jifalħu | n/a | Guttural Assim. |
| Output | *[jifalħu] | [jifilħu] | Output |

The ordering needed to obtain the correct result is given in column II, in which Metathesis applies before Guttural Assimilation. In other words, the vowel first shifts to the left of the medial consonant and then Guttural Assimilation fails to apply since the context of the rule is not met, i.e. /i/ is not adjacent to a guttural consonant. Note that Guttural Assimilation does apply stem-internally in the singular imperfective of this verb, i.e. [jiflaħ] 'he is strong'. For verbs such as [jifilħu] then, Metathesis must apply before Guttural Assimilation, the exact opposite ordering from that needed to obtain the correct result in (32).

The problem then is this: in order to account for forms such as 'to be strong' in (33), Guttural Assimilation cannot apply when the stem vowel is still to the right of the medial consonant; in other words, Metathesis has to precede Guttural Assimilation. Yet, for verbs such as 'to milk' in (32), Guttural Assimilation cannot apply when the stem vowel is already to the left of the medial consonant. Rather, Metathesis has to follow Guttural Assimilation. Thus, in order to account for all forms correctly, Guttural Assimilation needs to apply *after* the point in which the second stem vowel has left its position to the right of the medial consonant so that the final stem vowel in [jifilħu] will not be affected, but *before* the final stem vowel resurfaces to the left of the medial consonant, so that the metathesized vowel in [jaħilbu] will not be affected. Put another way, when Guttural Assimilation applies, the plural stem vowel cannot be "visible" to the rule. As such, the vowel will retain its underlying quality when it surfaces to the left of the medial consonant.

Given the common view of metathesis as a one-step operation, accounting for the realization of the plural stem vowel in all verbs is problematic. The solution to this problem, I would suggest, lies in viewing metathesis as the *product* of more than one operation. These include delete, insert and associate. As I show in the following sections, the first two operations are independently motivated rules of Maltese phonology: Syncope and Epenthesis, respectively. The third operation, associate, takes the form of Vocalic Mapping, a universal association convention. Before elaborating further, however, the question of why a vowel should occur in these plural imperfectives is addressed.

## 4. The Solution

### 4.1 Syllable Structure Conditions

All plural imperfectives which contain a stem vowel share the property of having a medial sonorant consonant. As will be seen in this and the following sections, the presence of the plural stem vowel is required due to restrictions on the distribution of sonorant consonants in Maltese syllables.

In general, word-internal sequences of the form CRC, where R represents a sonorant consonant ([m,n,l,r]) do not occur in Maltese (Aquilina 1959, Brame 1972, Puech 1979, Sutcliffe 1936). In addition to the plural imperfectives seen above, we also observe that in the plural of certain nouns, for example, the vowel [i] occurs before a sonorant consonant when this consonant would otherwise occur medially between two consonants, e.g. *frieʃ* 'mattress'/*ifirʃa* 'mattresses', *znied* 'flint'/*izinda* 'flints', cf. *lsien* 'language'/*ilsna* 'languages'.

With respect to initial consonant clusters in Maltese, in words where a sonorant consonant is followed by another consonant, the cluster is preceded by a vowel. Consequently, there are no word-initial consonant clusters beginning with a sonorant consonant. This is seen, for example, in nouns with the definite article prefix given in (34). Before nouns beginning with a consonant, the prefix surfaces as [il-] whereas before vowel-initial nouns, its form is [l-][7].

| | | |
|---|---|---|
| (34) | il+belt | 'the city' |
| | il+fellus | 'the chicken' |
| | il+ʔattus | 'the cat' |
| | il+ħitan | 'the walls' |
| | il+moʔdief | 'the oar' |
| cf. | l+abt | 'the armpit' |
| | l+omm | 'the mother' |

As a further example, in verbal nouns a consonant cluster beginning with a sonorant consonant is preceded by the vowel [i]. In the forms on the right, the vowel does not occur since the initial consonant is non-sonorant.

| | | | | | |
|---|---|---|---|---|---|
| (35) | irbiit | 'act of tying' | cf. | ʔtiil | 'act of killing' |
| | infiiʔ | 'act of paying' | | tliib | 'act of praying' |
| | (from Brame 1972:34-35) | | | | |

A similar situation arises with respect to word-final consonant clusters: sonorant consonants rarely occur as the final member of a complex coda. This observation is based on my examination of approximately 31,000 words in the Maltese lexicon of Busuttil (1981). Numerous examples of final consonant clusters comprised of two non-sonorants (continuant or non-continuant) occur, e.g. *irmosk* 'trash', *ʔabd* 'ready money', *dalwaʔt* 'soon, now'. Final geminates also frequently occur, e.g. *boll* 'sting ray', *bonn* 'swelling in the groin', *daʔʔ* 'he played, sounded' (cf. *daʔ* 'he tasted, experienced'). Moreover, many examples with sonorant consonants followed by obstruents can be found, e.g. *bint* 'daughter', *dars* 'dental', *kelb* 'dog'. However, only five words were found which contain a sonorant consonant as the final member of a consonant cluster. In each case, the final consonant is a nasal and the preceding consonant is a liquid, i.e. *buʔarn*

[7]The definite article assimilates completely to a following coronal consonant (see e.g. Comrie 1980).

'horned beetle' (*ʔarn* 'horn'), *skalm* 'oar peg', *sorm* 'backside, rear', *infern* 'hell, infernal'.

The organization of Maltese syllables, as discussed above, falls out naturally from the observation, dating at least as far back as Sievers (1881) and Jespersen (1904), that the sequencing of segments within a syllable is associated with the sonority of the segments involved. The most sonorous segments are vowels, followed in decreasing sonority by glides, liquids, nasals, fricatives and stops. Cross-linguistically, recurrent syllable patterns emerge which show sonority generally rising toward the syllable peak and then falling away from the peak. The sequencing of segments within the syllable in Maltese can be properly accounted for by Jespersen's (1904, 1950) Sonority Principle.

(36) Sonority Principle (Jesperson 1950:131)
Between a given sound and the peak are only found sounds of the same, or a higher, sonority class.

The Sonority Principle expresses the observation that as you move out from the syllable peak, sonority cannot increase. It may, on the other hand, decrease or alternatively, remain relatively constant. It is then not surprising that complex codas comprised of an obstruent followed by a sonorant consonant do not occur in Maltese. Similarly, complex onsets made up of a sonorant consonant followed by an obstruent are also correctly predicted to be absent. Moreover, the observation that word-internal sequences of CRC (where R is a nasal or liquid) do not occur in Maltese is consistent with the Sonority Principle: a medial sonorant consonant is more sonorous than both a preceding and following nonsonorant consonant. As I show in the following section, when such sequences do arise, Epenthesis applies to allow for the syllabification of all consonants.

## 4.2 Epenthesis

As observed in the forms in (34) and (35) just above, the vowel [i] precedes a word-initial sonorant consonant which would otherwise form a complex onset with a following consonant of lesser sonority. Without this vowel, the sonorant consonant would be unsyllabifiable given the Sonority Principle in (36). I would suggest that the initial vowel is inserted by Epenthesis in order to provide a nucleus for an unsyllabifiable consonant (see (37)).

(37) Epenthesis: $\emptyset \rightarrow \underline{V}$ / __ C'
(where $\underline{V}$ characterizes an empty V-slot and C' an unsyllabifiable consonant)

Informally stated, a V-slot is inserted before an unsyllabifiable consonant. In the absence of feature-filling assimilation rules, this vowel receives the feature values [coronal, +high] and surfaces as [i] by default (see section 5 below for further evidence for these default values).

Sutcliffe (1936) notes that in certain words, a medial sonorant consonant need not be preceded by a vowel. Interestingly, in each of these cases, the medial sonorant is adjacent to a sonorant consonant, e.g. *jilmħu* 'they perceive', *iħmla* 'stacks of wheat', *imarmru* 'they murmur', *izmna* 'times'. The non-application of Epenthesis in these cases is consistent with the Sonority Principle since the medial consonant is syllabifiable in all forms. In the first three examples, the nasal is able to form a consonant cluster with an adjacent [l] or [r]. In the last example, [m] is able to syllabify with the following syllable forming the complex onset [mn] since the [m] is of the same relative sonority as the [n].

Sutcliffe (1936) also observes that although a vowel generally occurs before a word-initial consonant cluster beginning with a sonorant, a vowel is not required when the preceding word ends in a vowel (see (38) below), suggesting that Epenthesis is a phrase-level rule. I assume then that Epenthesis is post-lexical since it applies both within and across word boundaries.

(38) ma kenuʃ inʔas minn tmenin bit͡ʃt͡ʃa li nd͡ʒiebu
'the pieces brought were not less than eighty'
(Sutcliffe 1936:16)

In this section I have motivated Epenthesis as a rule of Maltese which provides a nucleus for an unsyllabifiable consonant. In the following section I discuss the role of Epenthesis in accounting for metathesis in plural imperfectives.

### 4.3 Syncope and Vocalic Mapping

Above it was noted that earlier analyses of the plural imperfective have attributed the position of the stem-initial vowel to consonant/vowel metathesis. In Puech's (1979) account, the second stem vowel of the plural fails to undergo Syncope since the medial root consonant is [+sonorant]. The medial consonant and following vowel then undergo metathesis (see (32)). However, I have shown that this account is unable to account for the quality of the stem vowel in all verbs. Given the independently motivated rules of Syncope and Epenthesis, in conjunction with the language's syllable structure conditions, an alternative solution presents itself.

In accounting for the presence of the plural stem vowel, I would suggest that Syncope applies to all verbs, including those in which the medial consonant is [+sonorant]. Consequently, it is unnecessary to include the ad hoc stipulation that Syncope fails to apply just in case the medial consonant is [+sonorant]. Note that by applying Syncope to all verbs, a medial sonorant consonant is left in an unsyllabifiable position due to the Sonority Principle. As shown above, Epenthesis typically applies in a situation such as this. Thus, I assume that by Epenthesis a V-slot is inserted to the left of the medial consonant and, as such, the medial consonant is able to syllabify as the coda of the newly-formed syllable. Within this approach the fact that a vowel occurs to the left of the medial sonorant falls out directly from the language's syllable structure conditions, in conjunction with the independently motivated rules of Syncope and Epenthesis. A full derivation illustrating the application of these rules will be given below.

However, before doing so it is still necessary to account for how the epenthetic vowel acquires its quality in plural imperfectives. In the discussion of Epenthesis in section 4.2, it is claimed that in the absence of feature-filling assimilation, the epenthetic vowel surfaces as [i] by default. This was seen in the forms in (34) and (35) in which the epenthetic vowel is realized as [i] (see also discussion of the imperfective prefix vowel below). Given that the plural stem vowel is [i] in certain verbs, e.g. [jaħilbu], it might be argued that the plural stem vowel is simply a default vowel. Attributing the quality of this vowel to default assignment fails, however, since we would expect the stem vowel in the plural forms on the left in (39) to be [i] as well.

| | | | | |
|---|---|---|---|---|
| (39) | jo+korb+u | 'they groan' | jo+krob | 'he groans |
| | ji+solħ+u[8] | 'they skin' | ji+sloħ | 'he skins' |
| | je+ħemz+u | 'they pin' | je+ħmez | 'he pins' |
| | ja+ħarb+u | 'they run away' | ja+ħrab | 'he runs away' |

Rather, as shown above, the quality of the plural stem vowel is identical to the underlying vocalism of the stem. This then raises the question: if the final stem vowel is deleted, how does the quality of this vowel surface on the metathesized (epenthetic) vowel?

It is commonly assumed that when a vowel deletes, the features which characterize the vowel also delete. Yet, for the epenthetic vowel to surface as a copy of the syncopated vowel in plural imperfectives, the stem's vocalism cannot delete. Of relevance to this point is the observation that in Maltese, Syncope need only be defined on the skeletal tier; reference to the specific quality of the vowel is unnecessary. Bearing this in mind, I would suggest that when Syncope applies, the vowel slot deletes, whereas the vocalic melody remains afloat until there is a melody-bearing unit for it to map onto. This is reminiscent of the notion of 'stability' in tonal phenomena. It has been observed that when a vowel is deleted, the tone that was previously associated with the vowel does not delete. Instead, it links up to the nearest tone-bearing unit. Given the common view

[8]The prefix vowel is systematically realized as [i] when followed by a stem-initial coronal obstruent (see Hume 1992).

that segmental features, like tones, are autosegments, it is not surprising that the features which comprise the vocalic melody behave in a manner similar to tones.

One might suppose that the reason the melody does not delete along with the V-slot is because it is a morpheme in and of itself which "belongs" to a given verb stem whether or not it is mapped onto a melody-bearing unit. The unassociated melody that remains after Syncope is thus assuming, in a certain sense, the same status that it had prior to the phonology. Let me be more explicit. Recall that in Maltese, triliteral verbs of the first measure are associated with a consonantism, e.g. √ʃrb 'drink', and a single vocalism, e.g. /o/. These elements map onto the prosodic template prior to the phonology, as illustrated in (40) below.

```
(40)  ʃrb, o
      ʃ    r    b
      :    :    :
      C  V C  V C
         :   /
         o
```

Without a template to map onto, the melodies remain unassociated, or floating. Thus, when the V-slot is deleted as a result of Syncope, we might suppose that the melody resumes the unassociated status that it had prior to the phonology[9].

Consider now the features that make up a stem's vocalism and thus, the ones which I claim are not deleted. Only the features that distinguish one vowel from others in the system crucially characterize the vocalism. These refer to place of articulation and height since all other features, e.g. [+sonorant, -consonantal, +continuant, +voice] are redundant. Following Clements (1989, 1991), I assume that a vowel's place and height features form a constituent dominated by the node VOCALIC, as illustrated in (41) for the vowel /o/.

```
(41) /o/        V
                :
             VOCALIC
              /     \
                     V-place
        Aperture        |
            |       [labial]
         [-high]
```

Given this representation, when Syncope applies it will be the VOCALIC node and the features that it dominates that

---

[9]One might also assume that there is a special principle in Maltese which overrules the more general convention which typically deletes a vocalic melody in syncope rules. For example, we might suppose that in Maltese conventions cannot totally delete morphemes.

remain afloat. I reformulate the rule of Syncope incorporating this point in (42) below (irrelevant structure is omitted).

(42) Syncope (final version):

```
 C     V     C    V         C         C    V
 |     ‡     |    |    ->   |         |    |
[ ]   VOC   [ ]  [ ]       [ ]  VOC' [ ]  [ ]
```

Informally stated, the V-slot and noncontrastive features of an unstressed vowel in a non-final open syllable delete. The VOCALIC node remains afloat and will be realized phonetically if, at some point in the derivation, there is an empty V-slot available for it to map onto. In imperfective plurals with a medial sonorant consonant, the rule of Epenthesis provides precisely this. Thus, by universal association conventions (Haraguchi 1977, Clements & Ford 1979, Pulleyblank 1986), the floating vocalic melody will map onto the epenthetic V-slot in a feature-filling manner. For concreteness, I refer to the association of the floating VOCALIC node to an empty V-slot as Vocalic Mapping as shown in (43).

(43) Vocalic Mapping:

```
  V
  ¦
  ¦
  ¦
 VOC'
```

A floating vocalic melody maps onto an unspecified V-slot (where VOC' indicates an unassociated vocalic melody and V̲ an empty V-slot).

In the full derivation given in section 6 below, it will be seen that by incorporating Syncope, Epenthesis and Vocalic Mapping into the analysis of plural imperfectives, we are able to account for the observation that it is the underlying quality of the stem vowel which surfaces in all verbs. Moreover, by applying these three operations within a single derivation, the product is metathesis. However, it is important to point out that this analysis also accounts for the realization of the imperfective prefix vowel, as I show just below.

## 5. The Realization of the Imperfective Prefix Vowel

In section 2.2 above, it was seen that the imperfective prefix vowel in verbs of the first measure is typically identical in quality to the underlying vocalism of the stem[10]. It is important to point out that it is only in the

[10]The only examples in which this is not the case is when the vocalism /i/ is subsequently changed to [a] by Guttural Assimilation.

first measure that the quality of the prefix vowel differs, i.e. it can be realized as [i], [e], [o] or [a]. In all other measures which contain a prefix vowel, the vowel always surfaces as [i], regardless of the quality of following vowels or consonants. This is illustrated in (44) below in which perfective and imperfective forms of representative fifth through tenth measure verbs are compared with [jaʔsam] 'he broke' of the first measure (the parenthesized [i] is epenthetic)[11].

(44)

| Measure | Perfective | Imperfective | |
|---|---|---|---|
| First | ʔasam | ja+ʔsam | to break |
| Fifth | tʔattel | ji+tʔattel | to destroy oneself |
| Sixth | tbierek | ji+tbierek | to be blessed |
| Seventh | (i)nʔabad | ji+nʔabad | to be caught |
| Eighth | (i)rtabat | ji+rtabat | to be bound |
| Ninth | ħdaar | ji+ħdaar | to grow green |
| Tenth | stenbaħ | ji+stenbaħ | to awaken |

Two properties of first measure verbs distinguish them from verbs of other measures. First, it is only in the first measure that the quality of the prefix vowel may differ, and second, it is only in the first measure that stem vowels undergo Syncope. These two observations are not unrelated. In my account of the realization of the metathesized vowel just above, it was claimed that the melody of a syncopated vowel remains afloat, mapping onto an empty V-slot if one is available. Consider how this proposal accounts for the differences between the realization of the prefix vowel in first measure verbs and those of other measures. Syncope of the first stem vowel in first measure verbs has been independently motivated in section 2.1 above. Now, if we assume, as shown in (45), that the prefix vowel enters into the derivation as an empty V-slot, the floating melody of the syncopated vowel will associate to this V-slot by Vocalic Mapping. For verbs of other measures, the structural description of Syncope is not met. Hence, there will be no floating melody to map onto the prefix vowel. In these cases, the prefix vowel surfaces as [i]. Recall from the discussion of Epenthesis in section 4.2 that the default values for vowels in Maltese are [coronal, +high]. Consequently, it is reasonable to conclude that these values are assigned to the prefix V-slot, thus providing the prefix vowel with its quality as [i].

[11]The fourth measure is obsolete in Maltese. In verbs of the second and third measures, there is no prefix vowel.

(45)

| | jV+ʔasam | jV+rtabat |
|---|---|---|
| Syncope | j V ʔ s a m<br>a' | n/a |
| Vocalic Mapping | j V ʔ s a m<br>a' | n/a |
| Default Assignment | n/a | jirtabat |
| | [jaʔsam]<br>'he breaks' | [jirtabat]<br>'he is bound' |

Independent evidence supports the claim that the prefix vowel enters into the derivation as an empty V-slot. Recall that the rule of Guttural Assimilation changes the vowel /i/ to [a] when adjacent to a guttural consonant. The rule of Guttural Assimilation may be considered a postcyclic lexical rule since it applies in both derived and non-derived environments. For example, in [laħaʔ] 'he reached' < /liħiʔ/, Guttural Assimilation applies within the stem. Conversely, in [ja+ħdem] 'he works' < /jV+ħidim/, the rule applies to the prefix vowel in the derived imperfective verb (I-lowering changes the last stem vowel to [e]). Since GA applies in both derived and non-derived environments, the rule is best viewed as postcyclic. I am not aware of any cases in which the rule applies across word boundaries, suggesting that it is a lexical rule.

Although Guttural Assimilation regularly affects the prefix vowel in verbs such as [jaħdem] 'he works', it fails to apply in verbs such as [jiħdaar] 'it grows green' (9th measure), despite the fact that the stem-initial consonant is guttural. The failure of GA to apply in the latter instance receives a straightforward account by assuming that the prefix vowel enters into the derivation as an empty V-slot.

This is illustrated in (46a,b) by comparing the derivations of [jiħdaar] and [jaħdem], where in both instances the prefix vowel starts out as a V-slot. Verbs of the ninth measure such as [jiħdaar] are derived from a stem of the form CCVVC, which again corresponds to the third person masculine singular perfective form of the verb. Syncope applies to delete the first stem vowel in (b) but is not applicable in (a). By Vocalic Mapping the floating melody links up to the unspecified prefix vowel in (b). Guttural Assimilation then applies to change the prefix vowel from /i/ to [a] in [jaħdem]. However, since the prefix vowel remains an empty V-slot at this point in the derivation for [jiħdaar] in (a), Guttural Assimilation is not applicable. Consequently, it will receive the default values [coronal, +high] and surface as [i]. Thus, by incorporating the view that the prefix vowel enters into the derivation as an empty V-slot, in conjunction with Syncope and Vocalic Mapping, we are able to account for the differences between these verbs with respect to the applicability of Guttural Assimilation.

(46)

| | a. | b. |
|---|---|---|
| | j V ħ d a a r | j V ħ i d i m |
| Cyclic | | |
| Syncope | n/a | j V ħ d i m<br>i' |
| Vocalic Mapping | n/a | j V ħ d i m<br>i' |
| Postcyclic | | |
| Guttural Assimilation | n/a | j a ħ d i m |
| I-lowering | n/a | j a ħ d e m |
| Default Assignment | j i ħ d a a r | n/a |
| | [jiħdaar] | [jaħdem] |

Accounting for the realization of the imperfective prefix vowel by Syncope and Vocalic Mapping is advantageous for a number of reasons. First, it accounts for the asymmetry observed between verbs of the first measure and those of other measures. Second, it obviates the need to posit that an additional rule, i.e. Prefix Vowel Assimilation, is responsible for deriving the quality of this vowel. Third, the quality of the imperfective prefix vowel and that of the imperfective plural stem vowel can be accounted for by the same operations, thus resulting in a more unified analysis. In the following section, I provide full derivations illustrating how the proposals in this and preceding sections allow for the realization of both the prefix and plural stem vowels.

## 6. A Nonlinear Account of Metathesis

In the preceding sections I have discussed Syncope, Epenthesis and Vocalic Mapping. The first two are independently motivated rules of Maltese, and the latter a universal association convention.

The test cases for my proposed analysis are verbs in which Guttural Assimilation also applies. Recall that accounting for the realization of the metathesized vowel in all plural imperfectives was shown to be problematic for an analysis in which metathesis is viewed as a one-step process. Within this approach, Guttural Assimilation would need to apply before metathesis in a form such as [jaħilbu], yet after metathesis in order to obtain the correct form for [jifilħu]. In (47) below, I provide the derivations of these two verbs within the view of metathesis as the product of more than one operation.

```
(47)
Lexical                jV́ + ħ i l i b      jV́ + f i l i ħ
   Syncope             jV ħ   l i b        jV f   l i ħ
                           i'                    i'
   Vocalic Mapping     jV ħ   l i b        jV f   l i ħ
                           i'                    i'
-----------------------------------------------------------
   Input               ji ħ l i b + u      ji f l i ħ + u
   Syncope             ji ħ l   b u        ji f l   ħ u
                              i'                  i'
-----------------------------------------------------------
Postcyclic
   Guttural Assim.     ja ħ l   b u        -n/a-
                            i'
-----------------------------------------------------------
Post-lexical
   Epenthesis          ja ħ V l  b u       ji f V l  ħ u
                               i'                  i'
   Vocalic Mapping     ja ħ V l  b u       ji f V l  ħ u
                               i'                  i'

Output                   [jaħilbu]            [jifilħu]
                        'they milk'       'they are strong'
```

As shown in this derivation, Syncope applies first to delink the vocalic melody from superordinate structure of the first stem vowel. By Vocalic Mapping, the floating melody maps leftward onto the empty V-slot of the prefix. With the addition of the plural suffix, Syncope applies to the second stem vowel. Yet, since there is no empty slot at this point in the derivation, the melody remains afloat. Guttural Assimilation applies noncyclically to change the prefix vowel of the first verb, its only target, from /i/ to [a]. Note that due to the second application of Syncope the medial sonorant consonant is in an unsyllabifiable position. Thus, in the post-lexical component an empty V-slot is inserted to the left of the sonorant consonant by the rule of Epenthesis. At this point, the floating melody is able to map onto the V-slot by Vocalic Mapping. Note that all rules are intrinsically ordered as a result of their stratal assignments.

By viewing metathesis as the product of more than one operation, we are able to account for the full range of plural imperfectives. Central to this account is the view that Syncope does not delete the vocalic constituent of the vowel. Rather, it remains afloat. Not only does this account for the failure of Guttural Assimilation to apply to the plural stem vowel, it also extends in a simple way to the realization of the prefix vowel.

## 7. Implications and Conclusion

### 7.1 Tier Conflation and Total Vowel Assimilation

In section 2.3 above, it was shown that Tier Conflation must apply prior to the application of Guttural Assimilation. Recall that if this were not the case, we would predict both vowels of verbs such as [ħadem] < /ħidim/ 'he worked' to surface as [a]. Invoking Tier Conflation prior to the application of Guttural Assimilation requires conflation to occur at least by the postcyclic lexical level.

The relevance of this point bears directly on the nonlinear representation of vowel movement. Recall that in the derivation of the verbs [jaħilbu] and [jifilħu] in (47), the vocalic melody of the vowel /i/ spreads across the medial consonant and links up to the epenthesized V-slot after the application of Guttural Assimilation. This was shown to be crucial in order to account for the correct quality of the vowel in all cases. Given that Tier Conflation must occur prior to Guttural Assimilation, and that Vocalic Mapping may apply after Guttural Assimilation, it follows that Vocalic Mapping may apply after Tier Conflation. This is significant since it means that total vowel movement across an intervening consonant does not imply entire planar segregation, as suggested in McCarthy (1989).

Moreover, given an enriched model of feature geometry such as that developed in the work of Clements (1989, 1991), Clements and Hume (forthcoming), Herzallah (1990), Hume (1992), planar segregation is not required as a means of representing total vowel movement across an intervening consonant. In this model, consonants and vowels are specified for the same set of articulator features, [labial, coronal, dorsal, pharyngeal]. As illustrated in (48), the place features of consonants link to a C-place node and vowel place features link to a V-place node. Vowel place and height features (dominated by an Aperture node) form a Vocalic constituent which is embedded under C-place (see Clements 1991, Clements & Hume forthcoming; Hume 1992 for evidence supporting this organization).

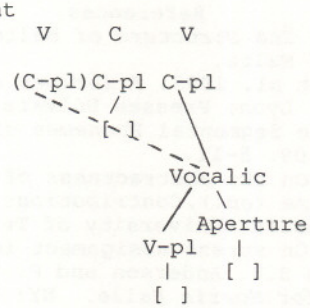
(48) Feature Organization

```
e.g.   t                  i
    C-place            C-place
       |                   \
       |                  Vocalic
       |                  /    \
       |                 /   Aperture
       |            V-place     |
       |               |     [+high]
   [coronal]       [coronal]12
```

[12]All values of a given feature are arrayed on the same tier although consonantal place features link to C-place, and vocoidal place features link to V-place.

This model makes a number of strong predictions. One is that consonants and vowels which are specified with a common place feature should pattern together as a natural class. A wide range of evidence supporting this claim can be found in works cited just above. This model also predicts that in the unmarked case, vowel movement should occur across an intervening consonant without crossing association lines. This is illustrated in (49). The Vocalic node of the vowel, dominating its place and height features, spreads across an intervening consonant. Spreading does not result in crossed association lines since consonants do not bear a Vocalic node (Only relevant structure is given. Interpolated nodes on the target are enclosed in parentheses.)

(49) Vowel Movement




Accounting for total vowel movement across an intervening consonant is thus represented in simple terms without invoking complete planar segregation.

7.2 Metathesis

Consonant/vowel metathesis has traditionally been treated as a one-step process in which the linear ordering of segments in a string switches. It is of particular interest that although great advancements have been made to eliminate linear notation in processes such as assimilation and dissimilation, the formal mechanisms used to represent metathesis in nonlinear phonology have changed little. Many current analyses of metathesis continue to make use of a linear transformational notation and treat it as a one-step operation. As I have shown for Maltese, this view of metathesis is unsatisfactory. Alternatively, I have suggested that C/V metathesis is the product of three elementary operations: delete (Syncope), insert (Epenthesis) and associate (Vocalic Mapping). Positing an additional rule of metathesis simply duplicates rules which are already independently motivated in the phonology.

This approach is advantageous for a number of reasons. First, it provides a straightforward account of the seemingly complex and poorly understood process of metathesis by drawing on elementary operations of nonlinear phonology. Moreover, under the assumption that metathesis involves more than one operation, it elucidates why this process is less common cross-linguistically than, for example, processes such as assimilation which could arguably by viewed as the result of one or at most two operations: spread, delink.

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## Cs and Vs or Moras: The case of Bukusu Prosodic Structure*

Nasiombe Mutonyi

### 0. Introduction.

One of the central issues dealt with in Hyman (1984; 1985) concerns the nature of the units which characterize the prosodic tier. Hyman (following Clements 1982, 1984; McCarthy 1979, 1982; Thráinsson 1978) pursues the question of whether it is theoretically viable to postulate both consonants (C's) and vowels (V's) as the elements which constitute the prosodic tier. Here's the basic question: Should Cs and Vs be given the same prosodic value?

Two subsequent studies -- Clements 1986 and Hayes 1989 -- respectively show the superiority of the CV and moraic theories over the classical SPE approach which failed to capture the relationship between processes like compensatory lengthening on the one hand, and glide formation, vowel contraction, and pre-nasal-consonant lengthening, on the other. These two theories share a number of features, but perhaps their most fundamental difference lies in their claims regarding the units which determine syllable weight, because where CV theory postulates Cs and Vs, the moraic theory adopts the *mora*. Evidence adduced across languages indicates that there are advantages and disadvantages to adopting either theory, because each theory has its strengths and weaknesses. Our task in this paper is not to try and resolve the dilemma faced by phonologists in this regard, but rather to examine a few prosodic structures in Bukusu which seem to favor the moraic theory over CV phonology.

I have divided my discussion into four parts. First, section 1 reviews the Bukusu system of prefixation with a view to highlighting the specific environments for the different phonological processes discussed later in the paper. It is shown, for instance, that each Bukusu noun (and adjective) contains two units in the prefix structure: a prefix and a preprefix. That the two be treated as separate units is essential for later arguments on haplology. Section 2 contains a brief background to the CV and moraic theories, especially their postulations regarding the units which constitute the prosodic structure. In section 3, I adduce evidence for the four processes which trigger compensatory lengthening (CL) as a preamble to the discussion of the problematic cases in section 4, where the predictive power of the CV and moraic theories is re-evaluated, especially with respect to syllable

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deleting processes. Finally, in section 5 we present a potential problem case -- y-epenthesis -- where the epenthesized glide seems to violate the prohibition against moraic glides.

## 1. Background

Bukusu, a Bantu language of Kenya, exhibits compensatory lengthening (henceforth, CL) caused by at least four phonological processes. Three of these processes -- glide formation (GF), vowel contraction (VC), and pre-nasal-consonant lengthening (PNC) -- are widely attested garden-variety rules which both CV and moraic theories handle quite satisfactorily. However, one phenomenon, syllable deletion, tips the balance in favor of moraic theory, especially following our demonstration that CV theory cannot account for such simple gliding as in **/u-ima/ ---> [wiima]** 'you sg.stand' without proposing an undesirable rule of C-epenthesis in the prosodic structure.

### 1.1 The Bukusu Prefix System

Nominal and adjectival prefixes will be examined simultaneously since there are no morphological or phonological differences between lexical noun prefixes and adjectival agreement prefixes. The survey will then examine verb structure.

#### 1.1.1 Nouns and Adjectives

In general, a Bukusu noun consists of two parts: a prefix structure and a stem. The prefix structure is assigned in accordance with the class of the noun, as illustrated in (1). Generally, preprefix vowels are always identical to the vowel of the prefix, except cl.9/10[1] which have no prefix vowel. [UR = Underlying; is PR = Phonetic Representation]

| (1) | UR | PR | Gloss | UR | PR | Gloss |
|---|---|---|---|---|---|---|
| | u-mu-ndu | omuundu | 'person cl.1'[2] | či-n-yofu | čiinjofu | 'elephants cl.10' |
| | ßa-ßa-ndu | ßaßaandu | 'persons cl.2' | lu-lu-ala | lúlwaala | 'finger cl.11' |
| | ku-mu-saala | kúmusaala | 'tree cl.3' | xa-xa-ala | xáxaala | 'small finger cl.12' |
| | ki-mi-saala | kímisaala | 'trees cl.4' | ßu-ßu-oßa | ßußwooßa | 'mushrooms cl.14' |
| | li-li-anda | lilyaanda | 'charcoal cl.5' | xu-xu-iča | xuxwiiča | 'to come cl.15' |
| | ka-ma-nda | kamaandu | 'charcoal cl.6' | a-a-ndu | á.aandu[3] | 'at place cl.16' |
| | si-si-ndu | sisiindu | 'thing cl.7' | mu-mu-ndu | mumuundu | 'in(side) place cl.17' |
| | ßi-ßi-ndu | ßißiindu | 'things cl.8' | xu-xu-ndu | xuxuundu | 'on place cl.18' |
| | e-n-yofu | eenjofu | 'elephant cl.9' | ku-ku-ala | kúkwaala | 'big finger cl.20' |
| | | | | e-_-Columbus | éColumbus | 'at Columbus cl.24' |

[1] These numbers were designed to capture the noun gender system where each noun prefix structure serves at least two functions: (i) it marks number, and (ii) it acts as a clue to the agreement structure that matches the noun class.

[2] The phonetic form shows a common process of vowel lengthening before nasal-consonant sequences, which we take up later in §3.3. Notice also that underlying /u/ surfaces as [o] word-initially. This is attributable to a rule that lowers underlying short nominal and subject prefixes word-initially (cf. fn 26).

[3] I use the period to show that adjacent vowels are heterosyllabic.

(1) contains two types of CVCV prefix structures: (i) those with identical syllables, and (ii) those with non-identical syllables. The first category is examined further in §3.4.

### 2.1.1 Prefixes and Preprefixes

For as start, let us consider the question of whether there is any justification in treating prefixes and preprefixes as separate units when, as the surface forms of the nouns in (1) indicate, the two components of the prefix structure always surface together. To answer this question, we must consider evidence from elsewhere in the grammar which shows that a prefix can occur on a lexical item without the corresponding preprefix, and vice versa. One such case involves the "Which X?" construction, as in (2), where "X" is a noun variable. Since preprefix omission does not yield bad forms, the conclusion is that the two syllables are autonomous units. Besides, the unacceptable forms in (3) show that the preprefix cannot replace the prefix, that is, they are not interchangeable components.

| | Citation | UR | PR | Gloss |
|---|---|---|---|---|
| (2) | ómuxaana | mu-xaana siina | muxaana sína | 'Which girl? cl.1' |
| | kúmusaala | mu-saala siina | musaala sína | 'Which tree? cl.3' |
| | kímirwe | mi-rwe siina | mirwe sína | 'Which heads cl.4' |
| | kámaru | ma-ru siina | maru sína | 'Which ears?cl.6' |
| | eenama | n-yama siina | ɲama sína | 'Which meat? cl.9'[4] |
| | číngo | n-ko siina | ŋgo sína | 'Which homes? cl.10' |
| (3) | | u-xaana siina | *oxaana sína | 'Which girl? cl.1' |
| | | ki-rwe siina | *kirwe sína | 'Which heads cl.4' |
| | | ka-ru siina | *karu sína | 'Which ears?cl.6' |
| | | e-yama siina | *eyama sína | 'Which meat? cl.9' |
| | | či-ko siina | *čiko sína | 'Which homes? cl.10' |

In contrast to (2), the preprefix appears without the prefix as a marker of agreement on verbs in certain syntactic constructions (cf.(4)). Moreover, just as preprefixes cannot replace the prefixes in (2) without yielding ill-formed structures, the unacceptable forms in (5) serve as confirmation that the prefix cannot be used in place of the preprefix in the other parts of the grammar.

| | | | |
|---|---|---|---|
| (4) | ku-mu-saal-a ku-ku-a | kúmusaalá kukwa | 'the tree falls cl.3'[5] |
| | ki-mi-saal-a ki-ku-a | kímisaalá kikwa | 'the trees fall cl.4' |
| | ka-ma-ru ka-ku-a | kámarú kakwa | 'the ears fall cl.6' |
| | e-n-yama e-ku-a | ééɲaméekwa | 'the meat falls cl.9' |
| | či-n-ko či-ku-a | číŋgó čikwa | 'the homes fall cl.10' |

---

[4] An underlying stem-initial glide deletes postnasally by regular Ganda Law, a pervasive rule which deletes a stem-initial postnasal consonant in case the following syllable has a nasal onset; apparently, this happens after homorganic nasal assimilation.

[5] Although it might be a leap of faith to assume that the preprefix marks agreement on verbs, the motivation is overwhelming, given that the agreement marker is identical to the preprefix in eighteen out of 19 classes, the only exception being cl.1 whose agreement marker is **a-**, not the preprefix **u-**. The burden of proof seems to fall on those who argue that the agreement marker in this case is not related to the preprefix.

| | | | |
|---|---|---|---|
| (5) | ku-mu-saal-a mu-ku-a | kúmusaalá *mukwa | 'the tree falls cl.3' |
| | ki-mi-saal-a mi-ku-a | kímisaalá *mikwa | 'the trees fall cl.4' |
| | ka-ma-ru ma-ku-a | kámarú *makwa | 'the ears fall cl.6' |
| | e-n-yama n-ku-a | ééɲamá *ŋgwa | 'the meat falls cl.9' |
| | či-n-ko n-ku-a | čííŋgó *ŋgwa | 'the homes fall cl.10' |

We get more evidence of prefix-preprefix autonomy from the "**Omweene**"-construction, which translates as "The owner of X", where "X" is a noun variable. As in the above cases, this structure (cf.(6)) shows that the noun is well-formed even when the preprefix is omitted. Data (7) are illustrative.

| | UR | PR | Gloss |
|---|---|---|---|
| (6) | u-mu-ene mu-an-a | ómweene mwáana | 'the owner of the child' |
| | u-mu-ene mu-saal-a | ómweene músaala | 'the owner of the tree' |
| | u-mu-ene mi-xono | ómweene míxono | 'the owner of the hands' |
| | u-mu-ene maru | ómweene máru | 'the owner of the ears' |
| | u-mu-ene n-yam-a | ómweene ɲama | 'the owner of the meat' |
| | u-mu-ene n-ko | ómweenééŋgo | 'the owner of the home' |
| (7) | u-mu-ene u-mu-an-a | *ómweene ómwaana | 'the owner of the child' |
| | u-mu-ene ku-mu-saal-a | *ómweene kúmusaala | 'the owner of the tree' |
| | u-mu-ene ki-mi-xono | *ómweene kímixono | 'the owner of the hands' |
| | u-mu-ene ka-ma-ru | *ómweene kámaru | 'the owner of the ears' |
| | u-mu-ene e-n-yam-a | *ómweene eeɲama | 'the owner of the meat' |
| | u-mu-ene e-n-ko | *ómweene ééŋgo | 'the owner of the home' |

Since prefixes and preprefixes have different distributional properties in the grammar, it follows that treating them as separate but closely bound units is well-motivated.

### 1.1.2 CVCV Prefix Structures

As already observed, some CVCV prefix structures comprise two identical syllables; such structures exhibit two allomorphs. The first appears when no other phonological process (e.g., GF, VC, PNC, etc.) applies first to modify the prefix so that it is no longer identical to the preprefix, in which case the prefix deletes by haplology. We follow Hayes (1989) in assuming that it is the prefix (and not the preprefix) that deletes, as it would be harder to explain the simultaneous lengthening of the surviving vowel if we assumed instead that the preprefix deleted, since CL across onsets is rare.[6]

The second allomorph appears when a phonological process alters the prefix, and as a result, removes the strict prefix-preprefix identity that must prevail for haplology to apply. In such cases, both the altered prefix and the preprefix surface, as the prefix can no longer haplologize. Example (8), which has two sets of data, illustrates, first outputs of prefix haplology, (8a); and the failure of haplology after it is bled by earlier rules.

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[6] Hayes's claim that this follows from Goldsmith's (1976) constraint on crossing lines does not hold since the moraic (= prosodic) tier is separate from the segmental tier. Therefore the rarity of cases of CL across onsets cannot be attributed to the blocking effect of the line linking the onset to the syllable node.

| | | | | | |
|---|---|---|---|---|---|
| (8)a. | **P1** | **P2** | **Stem** | **PR** | **Gloss** |
| | xu | xu | -lim-a | xuulima | 'to cultivate (cl.15)' |
| | xa | xa | -ßako | xaaßako | 'small hoe (cl.12)' |
| | ßa | ßa | -xasi | ßáaxasi | 'women (cl.2)' |
| b. | xu | xu | -iɲa-a | xúxwiiɲa.a | 'to play (cl.15)' |
| | xu | xu | -om-a | xúxwooma | 'to dry (intr.)' |
| | ßa | ßa | -ifu-i | ßáßeefwi | 'thieves (cl.2)' |

We examine the phenomenon in (8a) in more detail in §3.4, while the various phonological rul shown modifying the prefix in (8b) are dealt with under GF (§3.1), VC (§3.2), and PNC (§3.3 We shall now look at the verb structure.

## 1.2 Verb Structure

In its simplest form, a Bukusu verb takes a subject prefix (cf.(9a)), followed by an optional tense marker (cf.(9b)), which may in turn be followed by an object prefix (cf.(9c)), culminating in the lexical verb. All the verbal prefixes either end in a vowel or nasal.

| | | | | |
|---|---|---|---|---|
| (9)a. | **SP** | **Stem** | **PR** | **Gloss** |
| | n | ßona | mbona | 'I see' |
| | u | ßona | oßona | 'You sg. see' |
| | a | ßona | aßona | 'He sees' |
| | xu | ßona | xußona | 'We see' |
| | mu | ßona | mußona | 'You pl. see' |
| | ßa | ßona | ßaßona | 'They (cl.2) see' |

| | | | | | |
|---|---|---|---|---|---|
| b. | **SP** | **TM** | **Stem** | **PR** | **Gloss** |
| | n | la | ßona | ndáßona | 'I'll see' |
| | u | la | ßona | oláßona | 'You sg. will see' |
| | a | la | ßona | aláßona | 'He'll see' |
| | xu | la | ßona | xuláßona | 'We'll see' |
| | mu | la | ßona | muláßona | 'You pl. will see' |
| | ßa | la | ßona | ßaláßona | 'They (cl.2) will see' |

| | | | | | | |
|---|---|---|---|---|---|---|
| c. | **SP** | **TM** | **OP** | **Stem** | **PR** | **Gloss** |
| | n | la | mu | ßona | ndámußona | 'I'll see him' |
| | u | la | mu | ßona | olámußon | 'You sg. will see him' |
| | a | la | mu | ßona | alámußona | 'He'll see him' |
| | xu | la | mu | ßona | xulámußona | 'We'll see him' |
| | mu | la | mu | ßona | mulámußona | 'You pl. will see him' |
| | ßa | la | mu | ßona | ßalámußona | 'They (cl.2) will see him' |

Thus the underlying structure of a Bukusu verb is summarized in (10), where SP is the subject prefix, TM is the tense marker, and OP stands for the object prefix. The parentheses around TM and OP indicate that these units are optional.

---

[7] Given that the cl.1 subject agreement prefix is **a-** rather than **u-**, which we would expect if agreement was marked by preprefixes, it has been suggested that subject agreement markers constitute a separate set of prefixes from nominal preprefixes. However, when we consider that preprefixes and subject agreement markers are identical in eighteen out of nineteen classes, the similarity can hardly be considered accidental.

(10) *Bukusu Verb Structure*

**SP + (TM) + (OP) + STEM.**

The verb structure in (10) predicts that a high vowel of the SP, TM or OP will glide when affixed to a vowel-initial verb stem, as illustrated in (11a) below. But if the stem-initial vowel is non-high, vowel contraction applies, as in (11b). On the other hand, a prefix structure which ends in a nasal causes the SP vowel to lengthen when affixed to a C-initial stem, as illustrated by (11c). The trigger is the NC cluster created when affixation places the prefix nasal next to the following stem-initial consonant, in which case the lengthening results from regular PNC.

| (11)a. | **SP** | **Stem** | **PR** | **Gloss** |
|---|---|---|---|---|
| | n | iča | níîča | 'I come'[8] |
| | u | iča | wíîča | 'you sg. come' |
| | xu | iča | xwíîča | 'we come' |
| | mu | iča | mwíîča | 'you pl. come' |
| b. | a | iča | éěča | 'he comes' |
| | ßa | iča | ßéěča | 'they (cl.2) come' |
| | xa | iča | xéěča | 'you pl. will come' |

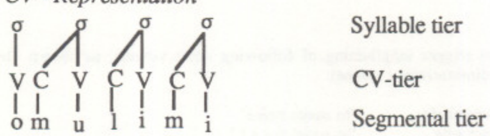
| c. | **SP** | **OP** | **Stem** | **PR** | **Gloss** |
|---|---|---|---|---|---|
| | u | n | čuxa | úúɲǰuxa | 'you sg. defeat me' |
| | ßa | n | čuxa | ßáá̧ɲǰuxa | 'they (cl.2) defeat me' |
| | mu | n | čuxa | múúɲǰuxa | 'you pl. defeat me' |

The three processes exhibited in (11) will be examined further in §3.

## 2. Theoretical Background

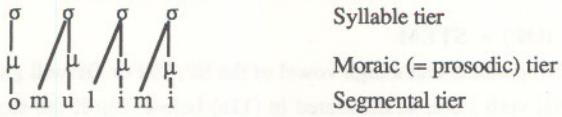
Although both the CV and moraic theories postulate multiple tiers for phonological representations, they differ in their claims regarding the elements which characterize the prosodic tier, because where the CV theory postulates Cs and Vs for the timing tier, the moraic theory proposes the mora, adding that non-vocalic segments are generally non-moraic. Thus while in the CV framework (see structure (12)) the array of Cs and Vs constitute the skeleton (= prosodic tier), moras constitute the prosodic structure in the moraic theory, as in (13).

(12) *CV - Representation*



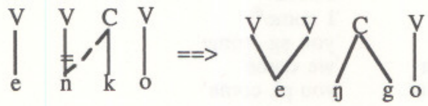

8 As we shall show in §5, the 1 sg. SP, /n/, causes a following stem-initial vowel to lengthen, indicating that the nasal prefix is underlyingly moraic.

(13) *Moraic Representation*




Thus both the CV and moraic theories postulate multiple tiers of phonological representation. This predicts that rules which target elements in one tier do not automatically affect other tiers, and that elements in one tier can be linked to multiple slots in another tier to yield Clements' (1986) "segmental analogues of Goldsmith's (1976) contour tones", as illustrated by the following derivation of **/e-n-ko/** ---> **[éeŋgo]** 'at home'.

(14)




However, the two theories differ in their claims about prosodic structure. We show in §4 that only moraic theory is equipped to deal with the two types of syllable deleting processes found in Bukusu. First, we turn to the three most common causes of CL.

## 3.0 Long Vowels in Bukusu

As the presence of derived long vowels imply existence of underlying long vowels in a language, we cite (15a,b) to show that vowel length is distinctive in Bukusu.

| | | | | | |
|---|---|---|---|---|---|
| (15)a. | xúu-roora | 'to dream' | b. | xúu-rora | 'to pluck' |
| | xúu-xaasa | 'to spit' | | xúu-xasya | 'to heat up' |
| | xuu-kuula | 'to roof' | | xuu-kula | 'to buy' |
| | xuu-siima | 'to thank' | | xúu-sima | 'to burn out (e.g., fire) |
| | xúu-tiima | 'to get lost' | | xuu-tima | 'to run' |
| | xúu-seesa | 'to winnow' | | xuu-sela | 'to boil' |
| | xuu-teena | 'to dry up' | | xuu-teßa | 'to seat |

Four phonological processes generate derived long vowels via CL. First, a vowel lengthens when the first of two adjacent vowels becomes a glide,[9] as illustrated in (16).

---

[9] Apparently, underlying glides do not trigger lengthening of following short vowels, as shown below. ((a) contains infinitives while (b) contains diminutivized nouns):

| | | | |
|---|---|---|---|
| a. | xu + xu + yokela | xuuyokela | 'to make noise' |
| | xu + xu + yama | xuuyama | 'to scout for s.t.' |
| b. | xa + xa + yama | xaayama | 'small piece of meat' |
| | xa + xa + yila | xaayila | 'small road' |

The case of underlying /w/ is dealt with later, it deletes obligatorily at the surface, except in the monosyllabic stems **-w-a** 'give' and **-wa** 'thorn' .

| (16) | SP | V-stem | PR | Gloss |
|---|---|---|---|---|
| | mu | -iča | mwííča | 'you (pl) come'[10] |
| | lu | -iβa | lwiiβa | 'it (cl.11) steals' |
| | βi | -asama | βyaasáma | 'they (cl.8) open mouths' |
| | li | -ola | lyóóla | 'it (cl.5) arrives' |

Secondly, a stem-initial vowel which is preceded by a non-high prefix vowel undergoes lengthening following the deletion of the preceding prefix vowel, as shown in (17). We refer to this change as vowel contraction (VC); see §3.2 for further discussion.[11]

| (17) | $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|---|
| | ka | ma | -ino | kámeeno | 'teeth cl.5' |
| | ka | ma | -olu | kámoolu | 'nose cl.5' |
| | βa | βa | -an-a | βáβaana | 'children cl.2' |
| | βa | βa | -ifu-i | βáβeefwi | 'thieves cl.2' |
| | βa | βa | -oni | βáβooni | 'sinners cl.2' |

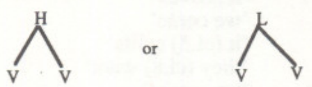
The third type of lengthening applies before nasal-consonant (NC) sequences. This process, which we refer to as PNC, is obligatory in Bukusu. Consider (18) for instance. Notice particularly the length difference between the vowels of the subject prefixes in (18a), and the same subject prefixes in the pre-NC positions in (18b). (Underlying stem-initial /w/ hardens to [b] postnasally.)

| (18)a. | SP | OP | V-Stem | PR | Gloss |
|---|---|---|---|---|---|
| | βa | xu | -wa | βaxúwa | 'they give you (sg.)' |
| | βa | mu | -wa | βamúwa | 'they give him' |
| | xu | βa | -wa | xuβáwa | 'we give them' |
| | xu | xu | -wa | xuxúwa | 'we give you (sg.)' |
| | βa | βa | -wa | βaβáwa | 'they give them' |

| b. | SP | OP | V-Stem | PR | Gloss |
|---|---|---|---|---|---|
| | βa | n | -wa | βáámba | 'they give me' |
| | mu | n | -wa | múúmba | 'you (sg.) give me' |
| | a | n | -wa | áámba | 'he gives me' |
| | u | n | -wa | úúmba | 'you sg.give me' |

---

[10] We know that the stem-initial vowel is underlyingly short because of the evidence from a rule that maps H tones as follows: (i) place H on the first stem mora of a low-toned verb when the SP is affixed; and (ii) place H on the second stem mora in case the verb is high-toned, as long as the second mora is not also the final vowel. This means that if the stem-initial vowel in [mwííča] 'you pl. come' had been long underlyingly, it would have surfaced with a falling tone since [xuxwiiča] 'to come' is long-toned. Conversely, [lwiiβa] 'it cl.11 steals' should have had a rising tone on the first syllable since [xúxwiiβa] 'to steal' is high-toned. The fact that both forms surface with level tones on the initial vowel confirms that these vowels were short underlyingly, but lengthened as a result of glide formation, in which case the resultant long vowels have a doubly linked tone, as depicted below:



[11] This phenomenon is treated as vowel coalescence in traditional accounts, but evidence from (17) and other examples suggests that besides the feature [-hi], which spreads from the deleting vowel, all the other properties of the lengthened vowel belong to the surviving vowel, which suggests that the process is more a deletion than coalescence. This also indicates that height spreading precedes vowel contraction. (cf. fn. 16 & 17.)

Although both the CV and moraic theories handle CL from GF, VC, and PNC satisfactorily, Bukusu also has a process which deletes a prefix after an identical preprefix, thereby causing the vowel of the surviving pre-prefix to lengthen. Apparently, this prefix haplology applies only when there is complete identity between the prefix and the preprefix. Thus if a prefix altering rule applies before haplology, it will bleed the latter. For instance, (19a) exhibit lengthened preprefix vowels attributable to CL after prefix haplology, while haplology fails in (19b) because an earlier rule has removed prefix-preprefix identity.

| (19) | $P_1$ | $P_2$ | Stem | PR | Gloss |
|---|---|---|---|---|---|
| a. | xu | xu | -lima | xuulima | 'to cultivate (cl.15)' |
| | ßa | ßa | -xasi | ßáaxasi | 'women (cl.2)' |
| | ßi | ßi | -tußi | ßiitußi | 'small baskets (cl.8)' |
| | li | li | -kulu | liikulu | 'sky (cl.5)' |
| | lu | lu | -kuulo | luukuulo | 'rafter (cl.11)' |
| | ku | ku | -nwa | kuunwa | 'big mouth (cl.20)' |
| b. | xu | xu | -ißa | xúxwiißa | 'to steal (cl.15)' |
| | ßa | ßa | -oni | ßáßooni | 'sinners (cl.2)' |
| | ßi | ßi | -ndu | ßißiindu | 'things (cl.8)' |
| | li | li | -ino | líliino | 'tooth (cl.5)' |
| | lu | lu | -ala | lúlwaala | 'finger (cl.11)' |
| | ku | ku | -uya | kúkuuya | 'draft of air (cl.20)' |

We discuss further the forms in (19a) in §3.4, where we argue that CL from prefix haplology is predictable, given the mora conservation principle (cf. Hayes 1989:285).

### 3.1 Glide Formation

We already saw in (17) that Bukusu high vowels become glides before other vowels. GF is a pervasive process in Bukusu which applies to subject and object prefixes within verb structure, lexical noun and adjectival prefixes, and stem-internal high vowels. (20)-(22) should suffice in this respect. Here we see that GF fails in the (a) examples before consonant-initial stems, but applies before the vowel-initial stems in (b).

(20) **Verbs**

| | SP | V-Stem | PR | Gloss | |
|---|---|---|---|---|---|
| a. | i | -tima | etíma | 'it runs' | (cl.9) |
| | xu | -lya | xulya | 'we eat' | |
| | ku | -čexa | kučéxa | 'it laughs' | (cl.3) |
| | ßi | -suta | ßisúta | 'they carry ' | (cl.8) |
| | u | -teexa | oteéxa | 'you (sg) cook' | |
| b. | i | -ola | yóóla | 'it arrives' | |
| | xu | -iča | xwííča | 'we come' | |
| | ku | -ara | kwáára | 'it (cl.3) splits' | |
| | ßi | -eɲa | ßyééɲa | 'they (cl.8) want' | |
| | u | -akama | waakáma | 'you cease' | |

(21) **Nouns**

| | **P₁** | **P₂** | **N-Stem** | **PR** | **Gloss**[12] |
|---|---|---|---|---|---|
| a. | u | mu | -xaana | ómuxaana | 'girl' (cl.1) |
| | ku | mu | -saala | kúmusaala | 'tree' (cl.3) |
| | li | li | -koxe | liikoxe | 'ash' (cl.5) |
| | ßi | ßi | -yeywe | ßiiyeywe | 'brooms'(cl.8) |
| | li | li | -wa | líiwa | 'thorn'(cl.5) |
| b. | u | mu | -ana | ómwaana | 'child' (cl.1) |
| | ku | mu | -ißa | kúmwiißa | 'sugarcane'(cl.3) |
| | li | li | -olu | líyoolu | 'nose' (cl.5) |
| | ßi | ßi | -uma | ßíßyuuma | 'beads'(cl.8) |
| | ki | mi | -asi | kímyaasi | 'shins'(cl.4) |

(22) **Adjectives**

| | **P₁** | **P₂** | **A-Stem** | **PR** | **Gloss** |
|---|---|---|---|---|---|
| a. | o | mu | -layi | ómulayi | 'good'(cl.1) |
| | ku | mu | -ßisi | kúmußisi | 'raw' (cl.3) |
| | li | li | -nefu | línefu | 'fat' (cl.5) |
| | ßi | ßi | -xulu | ßíxulu | 'elderly' (cl.8) |
| b. | o | mu | -imbi | ómwiimbi | 'short'(cl.1) |
| | ku | mu | -ana | kúmwaana | 'young'(cl.3) |
| | li | li | -asa | ílyaasa | 'gap' (cl.5) |
| | ßi | ßi | -omu | ßíßyoomu | 'dry' (cl.8) |

In SPE type phonology, GF is formalizable as (23). We return to this process later.

(23) *Glide Formation*:[13]

V ---> G / ______ V
[+hi]

### 3.2 **Vowel Contraction**

This section examines the rule that deletes a vowel (VC) in certain contexts. Two types of data are used for this purpose: where VC is a lexical process, and where it is postlexical.

#### 3.2.1 **VC at the Word-Level**

Briefly, a non-high prefix vowel deletes before a vowel-initial stem, as summarized in (24).

(24) Vowel Contraction

V -----> Ø / ______ V
[-hi]

---

12 Note here that stems starting with underlying glides (i.e., the last two examples of (21a)) behave like C-initial stems. We invoke this feature later on to argue for an abstract stem-initial consonant in apparent exceptions.

13 The rule is written in very general terms because there is no indication that it does not affect high vowels preceding other high vowels. In fact, a form like /u+ič-a/ ---> [wííča] 'you come' shows that high vowels glide before other high vowels. Therefore to account for alternations like /i+ix-a/ ---> [ííxa] ~ [yííxa] 'it (cl.9) descends', we propose optional glide deletion which applies to a glide before a corresponding high vowel.

Whether (24) captures vowel contraction correctly is determined by the effects of both C- and V-initial stems on the prefix vowel. In general, the prefix vowel remains short before intial C, as in (25a), and lengthens before initial V in (25b).

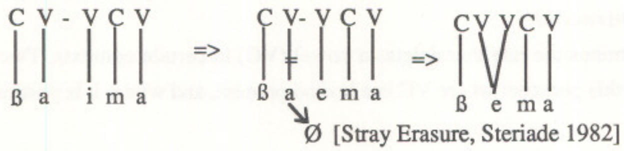
| | $P_1$ | $P_2$ | Stem | PR | Gloss |
|---|---|---|---|---|---|
| (25)a. | ka | ma | -loßa | kamaloßa | 'land' (cl.6) |
| | ka | ma | -ru | kámaru | 'ears' (cl.6) |
| | ka | ma | -ßi | kámaßi | 'bad ones' (cl.6) |
| b. | ßa | ßa | -oni | ßáßooni | 'sinners' |
| | ßa | ßa | -ene | ßáßeene | 'same ones' (cl.2) |
| | ka | ma | -omu | kámoomu | 'dry ones' (cl.6) |
| | xa | xa | -umu | xáxuumu | 'little sunshine' (cl.12) |

Further evidence of VC comes from verbs, where prefix vowels remain unchanged before consonant-initial stems (see (26a)), but delete before vowel-initial stems, as in (26b).

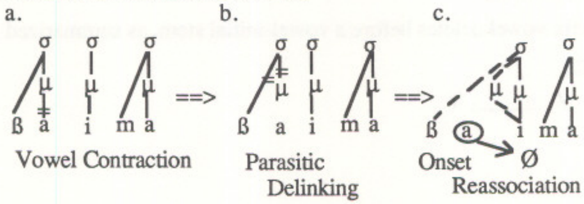
| | | | | |
|---|---|---|---|---|
| (26)a. | ßa | -ča | ßača | 'they (cl.2) go' |
| | xa | -lya | xalya | 'it (cl.12) eats' |
| | ka | -fwa | kafwa | 'they (cl.6) die' |
| b. | ßa | -iča | ßeéča | 'they (cl.2) come' |
| | xa | -ißa | xeeßa | 'it (cl.12) steals' |
| | ka | -ola | koóla | 'they (cl.6) arrive' |

Since non-linear phonology accounts for VC by postulating the deletion of association lines linking a vocalic segment to a slot in the prosodic tier, the change from underlying **/ßa-ima/** to surface [**ßeema**] 'they stand' can be assigned the two respective CV and moraic representations in (27) and (28).

(27) *Vowel Contraction CV version*




(28) *Vowel Contraction Moraic Version:*




In the moraic account, the prefix vowel first deletes by rule (24). This creates a syllable node without a nucleus, which undergoes Parasitic Delinking (see (65) below), a rule which deletes a syllable that does not dominate a nucleus. During the subsequent resyllabification, the now unassociated C and mora reattach to the next available syllable, as in (28c).

Apparently, a rule spreading the [hi] value of the first vowel to the second is ordered to apply before VC; see fn.16.

### 3.2.2 Post-lexical VC

Vowel contraction applies across word-boundaries as well. All that the rule requires is a sequence of vowels with the first being non-high. For instance, the final vowel of a noun or adjective will delete before the initial vowel of the following verb, as in (29) and (30).

(29)a. **Verbs**

| Imperative | SP | V-Stem | PR | Gloss |
|---|---|---|---|---|
| kwa! | i | -ku-a | ekwa | 'it (cl.9) falls' |
| tima! | a | -tim-a | atíma | 'he runs' |
| lila! | u | -lil-a | olíla | 'you (sg.) cry' |
| lwaála | a | -lwaal-a | alwaála | 's/he ails' |

b.

| noun | verb | PR | Gloss |
|---|---|---|---|
| éengoxo | ekwa | éengoxéekwa | 'the chicken falls' |
| omwaana | atíma | ómwaanáatíma | 'the dog runs' |
| wámweene | olíla | wámweenoolíla | 'you yourself cry' |
| omukooko | alwáála | ómúkóókáalwáála | 'the daughter ails' |
| éengurwê | exalála | éengurwéexalála | 'the pig gets annoyed' |

(30)

| Adjective | Verb | PR | Gloss |
|---|---|---|---|
| eembolo | ekwa | éémbóléekwa | 'the rotten (cl.9) falls' |
| éeŋana | ekwa | éeŋanéekwa | 'the young (cl.9) falls' |
| éexulu | ekwa | éexulíikwa | 'the elderly (cl.9) falls' |

The changes in (29) and (30) can be summarized as (31a,b) respectively.

(31)a.

| | | |
|---|---|---|
| o + e | ---> | ee[14] |
| a + e | ---> | ee |
| e + o | ---> | oo |
| o + a | ---> | aa |
| e + e | ---> | ee |

b.

| | | |
|---|---|---|
| o + e | ---> | ee |
| e + e | ---> | ee |
| a + e | ---> | ee |
| u + e | ---> | ii[15] |

Thus VC is both a lexical and a post-lexical rule in Bukusu.

The lst case of VC that we examine appears in the relative construction, which in Bukusu is formed by when a relative pronoun attaches to the verb. Like the infinitive prefix, the relative prefix comprises two identical syllables, which in turn are identical to the subject

---

[14] Since vowel lowering is a lexical rule, we assume that the verb-initial vowel that triggers VC has already lowered. Therefore the last example in (31b) is the only puzzling outcome, since the high vowel not only fails to trigger GF, but also triggers raising in the surviving vowel. (Also see (32c)). A possible explanation is that high vowels glide and then delete by rule, which seems to be supported by the following examples:

| | | |
|---|---|---|
| eɲǰuxi ekwa | ---> éeɲǰuxíikwa | 'the bee falls' |
| omuxasi akwa | ---> ómuxasyáakwa | 'the woman falls' |
| omuundu oyo | ---> ómuunduuyo | 'that person' |
| omuundu akwa | ---> ómúúndwáakwa | 'the person falls' |

The problem that remains unresolved is why the verb-initial vowel revert [+hi] in the first and third cases.

[15] If we assume that the [+hi] value of /u/ first spreads to convert the following mid vowel to [+hi], we can then posit GF by rule (23) prior to (optional) glide deletion, given that [**éexulwíikwa**] is an acceptable variant of the last example in (30).

prefix of the preceding (subject) noun or adjective. Thus the verb stem takes a relative prefix consisting of two identical vowels in case it is preceded by a class 1 or 9 subject, as in (32b). When this derived sequence of verb-initial vowels combines with the final vowel of the preceding subject, the output is an underlying sequence of three vowels, as in (32c). However, only two moras surface, presumably due to a mora trimming rule (Clements 1986:57) that limits the optimal syllable length to two moras. (RP = relative prefix.)

| (32)a. | **SP** | **V-Stem** | | **PR** | **Gloss** |
|---|---|---|---|---|---|
| | i | -li-a | | elya | 'it (cl.9) eats' |
| | a | -li-a | | alya | 's/he eats' |
| | i | -xol-a | | exola | 'it (cl.9) does' |
| | a | -č-a | | ača | 's/he goes' |
| b. | **$RP_1$** | **$RP_2$** | **V-Stem** | **PR** | **Gloss** |
| | i | i | -li-a | éelya | 'which eats' |
| | u | u | -li-a | óolya | 'who eats' |
| | u | u | -naany-a | óonaánya | 'who bothers' |
| | u | u | -č-a | óoča | 'who goes' |
| c. | **Noun** | | **Verb** | **PR** | **Gloss** |
| | éxaafu | | éelya | éxaaffilya | 'the cow which eats' |
| | éeŋgoxo | | éelya | éeŋgoxéelya | 'the chicken which eats' |
| | omuundu | | óoxola | ómuundúuxola | 'the person who does' |
| | ómwaana | | óonaánya | ómwaanóonaánya | 'the child who bothers' |
| | ómuxasi | | óoča | ómuxasúuča | 'the woman who goes' |

At least three observations can be made about (32): (i) VC is both lexical and postlexical; (ii) VC applies to any non-high vowel preceding another vowel; and (iii) the height of the deleting vowel determines the height of the surviving vowel.[16]

### 3.3 **Prenasal-Consonant Lengthening (PNC)**

As we saw in §3.0, PNC applies obligatorily to vowels preceding nasal-consonant sequences. Data (33) confirm this fact, because (33a) has verbs containing only a subject prefix (SP) and a stem. The length contrast between the short SP vowels in (33a) and their counterparts in (33b) is confirmation that the longer prefix vowels in (33b) is caused by the 1sg. object prefix (OP) nasal which was not present in (33a).

| (33)a. | **Infinitive** | **SP** | **V-Stem** | **PR** | **Gloss** |
|---|---|---|---|---|---|
| | xúura | u- | -ra | ora | 'you (sg) put' |
| | xuupiima | a- | -piima | apíima | 's/he weighs (tr.)' |
| | xúulasa | i- | -lasa | elasa | 'it (cl.9) shoots' |
| | xúuteexa | mu- | -teexa | muteéxa | 'you (pl.) cook' |
| | xúußukula | ßa- | -ßukula | ßaßukúla | 'they (cl.2)take' |
| | xuučexa | ku- | -čexa | kučéxa | 'it (cl.3) laughs' |

[16] As mentioned earlier, one could argue that first the height value of the first vowel spreads to the second vowel. This is followed by GF, then glide deletion; the last example in (32c) is especially important in this regard, and given fn.15.

| b. SP | OP | V-Stem | PR | Gloss |
|---|---|---|---|---|
| u | n | -ra | úúnda | 'you (sg.) put me'[17] |
| a | n | -piima | áámbiima | 's/he weighs me' |
| i | n | -lasa | ííndasa | 'it (cl.9) shoots me' |
| mu | n | -teexa | múúndééxa | 'you (pl.) cook me' |
| ßa | n | -ßukula | ßáámbukúla | 'they (pl.) take me' |
| ku | n | -čexa | kúúɲ̌jexa | 'it (cl.3) laughs at me' |

We also note that in the absence of the OP nasal, a word-initial short high vowel lowers to mid, as in the first example in (33a). This rule is blocked when the OP nasal causes the prefix vowel to lengthen, as in (33b).

Another case of PNC is exhibited by the class 9/10 prefixes, which consist of a nasal prefix preceded by a preprefix vowel. Since a NC sequence is created whenever these attach to a consonant-initial stem, our prediction is that the preprefix vowel will undergo lengthening, and that precisely is what we find in the following cl.9/10 forms.

| (34)a. $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| e | n | -tuuyu | ééndúuyu | 'a rabbit' |
| e | n | -kußo | eeŋgußo | 'clothe' |
| e | n | -yuxi | ééɲ̌juxi | 'a bee' |
| e | n | -yofu | eeɲ̌jofu | 'elephant' |
| e | n | -ßako | eembako | 'hoe' |
| e | n | -paaŋga | éémbaáŋga | 'large pot' |
| b. či | n | -tuuyu | čííndúuyu | 'rabbits' |
| či | n | -kußo | čiiŋgußo | 'clothes' |
| či | n | -yuxi | čííɲ̌juxi | 'bees' |
| či | n | -ßako | čiimbako | 'hoes' |
| či | n | -paaŋga | číímbaáŋga | 'large pots' |

But how do we know that the preprefix vowel in (34) is not underlyingly long? The crucial evidence comes from the following sets of nouns, which have no underlying nasal prefixes, although they act like cl.9/10 nouns, and therefore surface with short prefix vowels. Therefore their length in (34) must be caused by CL.

| (35)a $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| e | - | -tiimu | étíimu | 'a team cl.9' |
| e | - | -kalaamu | ékaláamu | 'a pen cl.9' |
| e | - | -ßarwa | éßarwâ | 'a letter cl.9' |
| e | - | -taraača | étaráača | 'a bridge cl.9' |
| e | - | -faraasi | éfaráasi | 'a horse cl.9' |
| e | - | -čoo.o | éčoo.ô | 'a toilet cl.9' |
| e | - | -sa.aani | ésa.áani | 'a plate cl.9' |
| e | - | -moosi | emoosi | 'a calf cl.9' |
| e | - | -maali | émáali | 'wealth cl.9' |

[17] Two processes apply simultaneously here: homorganic nasal assimilation (HNA), which applies vacuously before alveolar consonants, and the change of the liquid into a stop.

b.

| $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| či | - | -tiimu | čítíimu | 'teams cl.10' |
| či | - | -kalaamu | číkaláamu | 'pens cl.10' |
| či | - | -ßarwa | číßarwâ | 'letters cl.10' |
| či | - | -taraača | čítaráača | 'bridges cl.10' |
| či | - | -tiika | čítíika | 'giraffes cl.10' |
| či | - | -faraasi | čífaráasi | 'horses cl.10' |
| či | - | -čoo.o | číčoo.ô | 'toilets cl.10' |
| či | - | -sa.aani | čísa.áani | 'plates cl.10' |

There are two reasons why (35) is not just a case of nasal deletion. First, it is unlikely that the nasal only deletes before all the consonants in (35), but not those in (34). Secondly, since (36) show nasal deletion before fricatives as a regular process, we would expect a lengthened prefix vowel if (35) involved nasal deletion. The conclusion then is that there is no underlying nasal prefix in the words in (35).

(36)a.

| $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| e | n | -swa | éeswa | 'termite' |
| e | n | -xisi | éexisi | 'antelope' |
| e | n | -fula | éefula | 'rain' |
| e | n | -xaßi | eexaßi | 'luck' |
| e | n | -susi | éesusi | 'bedbug' |
| e | n | -xolo | éexolo | 'ethnic group' |

b.

| $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| či | n | -swa | číiswa | 'termite' |
| či | n | -xisi | číixisi | 'antelope' |
| či | n | -fula | číifula | 'rain' |
| či | n | -xaßi | čiixaßi | 'luck' |
| či | n | -susi | číisusi | 'bedbug' |
| či | n | -xolo | číixolo | 'ethnic group' |

The third case of PNC that we shall consider occurs stem-internally before NC sequences that do not derive from some morphological process. As PNC is obligatory before all NC sequences, we expect stem-internal NCs to act similarly. (37) confirms this.

(37)a. **Nouns**

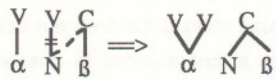
| $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| ku | mu | -kooŋgo | kúmúkóoŋgo | a back (cl.3) |
| ki | mi | -siiŋgi | kúmúsíiŋgi | a foundation (cl.4) |
| li | li | -ßoondo | liißoondo | a blister (cl.5) |
| e | n | -xooŋgo | eexooŋgo | a leader (cl.9) |
| lu | lu | -kooŋgo | luukooŋgo | a region (cl.11) |
| si | si | -piindi | síípíindi | a period (cl.8) |

b. **Verbs**

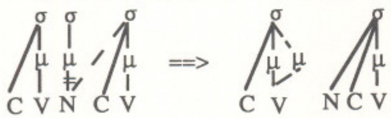
| SP | V-Stem | PR | Gloss |
|---|---|---|---|
| a | -loonda | alóonda | 'he follows' |
| ßa | -paaŋga | ßapaáŋga | 'they arrange' |
| n | -liinda | ndíinda | 'I wait' |
| xu | -suuŋga | xusuúŋga | 'we hang' |
| u | -fuuɲǰa | ofuúɲǰa | 'you (sg) break down (tr.)' |
| mu | -xeeŋga | muxéeŋga | 'you (pl.) sharpen' |

Using the CV framework, Clements (1986) treats PNC as desyllabification of the nasal before a C. This involves nasal delinking from a dominating V-slot in the CV tier, plus a subsequent reassociation to the following C-slot, which already dominates a consonant. In this account, the output is a complex segment. Another effect of the desyllabification is that a "floating" V-slot is created that later relinks to the preceding vowel, as shown below. (Apparently, this V-slot deletes by Stray Erasure in case there is no preceding vowel.)

(38) *PNC - CV Account:*



(39) *PNC - Moraic Account:*[18]



Thus PNC can be captured in CV terms, as in (38), and in moraic terms, as in (39). However, even though accounts involve the delinking of association lines joining melodic units to prosodic slots, they differ in their claims about the new locus for the resyllabified nasal. More specifically, while nasal resyllabification creates a "complex segment" in the CV account, the output is not necessarily a complex segment in the moraic account, since both the nasal and the following C project directly to the syllable. Thus the moraic theory avoids positing the controversial complex segment.[19]

### 3.4 **Syllable Deleting Processes**

There are two processes that delete an entire syllable in Bukusu to create desirable surface forms. The first of these is an optional process that applies to the first syllable of the verb **-xupa** 'hit' under the conditions spelled out in §3.4.1. The second process affects more than half of the class prefixes of the upward of eighteen noun classes in Bukusu, and is discussed in §3.4.2.

[18] There is a second way to do this in moraic theory, namely, we could assume that the nasal is not syllabic, but rather a regular coda consonant which undergoes weight by position prior to resyllabifying to give CL, as in the following derivation:

[19] One independent motivation for treating NCs as complex segments is the fact that Bukusu does not have any other cases of CC, except where the second C is a glide. However, given that Clements also treats consonant-glide combinations as sequences of segments which share the same prosodic slot in the CV tier, there would be no principled reason why consonant-glide sequences should not be considered complex segments. We shall leave the matter as it stands, pending further evidence to that effect.

### 3.4.1 The Verb *-xupa*

Although **-xupa** 'hit' is underlyingly a disyllabic stem, its surface forms show that the first stem syllable deletes optionally after a short prefix vowel.[20] To illustrate this, we shall consider four sets of data, three of which exhibit first syllable deletion (henceforth **xu-deletion**). The fourth set has been added to show that long vowels block this process.

First, as illustrated in (40), **xu-** deletes after a short subject prefix (SP) vowel to trigger compensatory lengthening in the subject prefix vowel. From the surface alternations, it is also apparent that the subject prefix vowel remains short if **xu** does not delete. The lengthening of one vowel after deletion of another is not unusual in autosegmental phonology, as segment deletion does not entail an automatic reduction of timing positions.

[20] This syllable deletion is an unique property of **-xupa**, since no other C-initial stem undergoes the rule. For instance, the initial syllables always surface in the following stems:

| SP | V-Stem | PR | Gloss |
|---|---|---|---|
| n | -kula | ŋgúla | 'I buy' |
| n | -xula | xula | 'I grow (intr)' |
| u | -kula | okúla | 'you buy' |
| u | -xula | oxula | 'you grow (intr.)' |
| xu | -kula | xukúla | 'we buy' |
| xu | -xula | xuxula | 'we grow (intr.)' |

In view of these, Hyman (p.c.) has suggested that we treat **-xupa** 'hit' as having the underlying form, **-Vpa**, where V is an underspecified vowel. But there are two arguments against this representation. First, the imperative for this stem is consonant-initial, which means that even if we posited an underspecified initial syllable vowel, we would still have to explain the loss of the initial consonant, and why only this consonant deletes, given that no other consonant-initial stem loses its initial consonant in a similar manner. The second argument is that postulating the structure **-Vpa** makes the wrong predictions about the surface forms of structures like the following where the 1 sg. OP is affixed between the SP and the stem:

| OP | SP | Stem | Predicted | PR | Gloss |
|---|---|---|---|---|---|
| u- | n- | -Vpa | *únipa | úúxupa | 'you sg. hit me' |
| mu- | n- | -Vpa | *múnipa | múúxupa | 'you pl. hit me' |
| ßa- | n- | -Vpa | *ßánipa | ßááxupa | 'they hit me' |
| a- | n- | -Vpa | *ánipa | ááxupa | 's/he'll hit me' |
| ni- | n- | -Vpa | *ninipa | niixupa | 'I hit myself' |

In short, the above examples confirm that the stem for 'hit' is **-xupa**.

(40)

| Imperative | SP | V-Stem | PR | Gloss |
|---|---|---|---|---|
| xupa! | u | -xupa | uupa ~oxupa | 'you sg. hit' |
| | a | -xupa | aapa ~axupa | 'he hits' |
| | xu | -xupa | xuupa ~xuxupa | 'we hit' |
| | mu | -xupa | muupa ~muxupa | 'you (pl.) hit' |
| | ßa | -xupa | ßaapa ~ßaxupa | 'they hit' |
| | n | -xupa | niipa ~xupa | 'I hit'[21] |

The second set of examples exhibit similar prosodic properties as the first, the only difference being the triggering vowel, which, as in (41), is the object prefix (OP).

(41)

| SP | OP | V-Stem | PR | Gloss |
|---|---|---|---|---|
| n | ßa | -xupa | mbáapa mbáxupa | I hit them |
| u | ßa | -xupa | oßáapa oßáxupa | you sg. hit them |
| a | ßa | -xupa | aßáapa aßáxupa | 's/he hits them |
| xu | ßa | -xupa | xußáapa xußáxupa | 'we hit them' |
| mu | ßa | -xupa | mußáapa mußáapa | 'you (pl) hit them' |
| ßa | ßa | -xupa | ßaßáapa ßaßáxupa | 'they hit them' |

The final motivation for **xu-deletion** derives from the behavior of **-xupa** when the infinitive prefix is attached. Consider (42).

(42)

| $P_1$ | $P_2$ | -Stem | PR | Gloss |
|---|---|---|---|---|
| xu | xu | -xupa | xúxuupa xúuxupa *xuxuxupa[22] | 'to hit' |

The surface alternations suggest that when faced with the choice between **xu-deletion** and **prefix haplology**, the speaker applies either of the two rules, the output of either rule being well-formed in the language. If the speaker applies **prefix haplology**, the preprefix

---

[21] The 1 sg. nasal prefix is underlyingly moraic, therefore a potential trigger for **-xu** deletion just like a short vowel, in which case it should become a geminate or syllabic nasal. But since Bukusu has no surface syllabic nasals, [i] epenthesis occurs in the formation of **niipa** 'I hit' to resolve the problem created by **xu**-deletion, as something has to lengthen compensatorily. The variant form shows the nasal as having deleted before the stem-initial fricative (cf. (36)). Apparently, most speakers delete **xu-**, although the variant forms are quite common since many speakers apply **xu-deletion** optionally.

[22] This forms should not be confused with the structure **xuxúxupa,** a variant of **xuxúupa** 'We hit you', where the first **xu** marks 1 pl. subject, the second marks 2 sg. object, and the third is the first stem syllable. Since this latter form is well-formed, it might not be premature to assume that only certain types of prefixes are subject to haplology and first syllable deletion. Further discussion follows in §3.4.2.

vowel lengthens and bleeds **xu-deletion**, since this latter rule requires a short triggering vowel. Conversely, haplology does not apply after **xu-deletion** because prefix-preprefix identity is removed by the lengthening prefix vowel.

That **xu-deletion** never occurs after long vowels gets support from the data in (43), where **xu-deletion** is blocked once the prefix vowel has lengthened by PNC. Thus unlike (40) and (41) which exhibit surface alternations, each example in (43) has only one surface form because PNC has bled **xu-deletion**.

| (43) | **SP** | **OP** | **V-Stem** | **PR** | **Gloss** |
|---|---|---|---|---|---|
| | a | n | -xupa | ááxupa | 's/he hits me' |
| | u | n | -xupa | úúxupa | 'you sg. hit me' |
| | mu | n | -xupa | múúxupa | 'you pl. hit me' |
| | ßa | n | -xupa | ßááxupa | 'they hit me' |
| | ku | n | -xupa | kúúxupa | 'it cl.3 hits me' |

To recapitulate, Bukusu has a rule of optional **xu-deletion** that applies to the first syllable of -**xupa** 'hit' after a short prefix vowel. This predicts that a process which lengthens prefix vowels would bleed **xu-deletion**. We shall keep this process in mind as we now turn to haplology, the second process that deletes syllables.

### 3.4.2 **Prefix Haplology**

Data (19), which we repeat as (44) for ease of reference, showed that certain Bukusu prefixes delete after identical preprefixes (cf.(44a); also compare (45) with (46)). Besides, it was observed that vowel changing processes can bleed haplology by removing prefix-preprefix identity, which includes prosodic structure identity, and is determined after the application of rules like GF, VC, and so on.

| (44)a. | **$P_1$** | **$P_2$** | **Stem** | **PR** | **Gloss** |
|---|---|---|---|---|---|
| | xu | xu | -lima | xuulima | to cultivate |
| | ßa | ßa | -xasi | ßáaxasi | women |
| | ßi | ßi | -tußi | ßiitußi | small baskets |
| | li | li | -kulu | liikulu | sky |
| | lu | lu | -kuulo | luukuulo | rafter |
| | ku | ku | -nwa | kuunwa | big mouth |
| b. | xu | xu | -ißa | xúxwiißa | to steal |
| | lu | lu | -ala | lúlwaala | finger |
| | ßa | ßa | -oni | ßáßooni | sinners |
| | li | li | -ino | líliino | tooth |
| | ku | ku | -uya | kúkuuya | draft of air |
| | ßi | ßi | -ndu | ßißiindu | things |

We note from (45) and (46) that three fairly common Bantu processes - GF, VC, and PNC - bleed haplology in case they apply first. GF and PNC account for the changes in the prefix in (45), while GF and VC yield the surface forms of (46). If, however, haplology is not bled, the prefix structures in (45) and (46) surface respectively as (47) and (48).

(45) **Nouns**

| $P_1$ | $P_2$ | N-Stem | PR | Gloss | |
|---|---|---|---|---|---|
| ßa | ßa | -ndu | ßaßaandu | 'persons (cl.2)' | - PNC |
| ßu | ßu | -oßa | ßußwooßa | 'mushroom (cl.14)' | - GF |
| li | li | -anda | lilyaanda | 'charcoal (cl.5)' | - GF |
| si | si | -ndu | sisiindu | 'thing (cl.7)' | - PNC |
| xa | xa | -ndu | xaxaandu | 'thing (cl.12)' | - PNC |
| xu | xu | -iča | xuxwiiča | 'to come (cl.15)' | - GF |

(46) **Adjectives**

| $P_1$ | $P_2$ | ADJ-Stem | PR | Gloss | |
|---|---|---|---|---|---|
| ßa | ßa | oki | ßáßooki | 'sharp (cl.2)' | - VC |
| ßu | ßu | oki | ßúßwooki | 'sharp (cl.14)' | - GF |
| ku | ku | oki | kúkwuuki | 'sharp (cl.20)' | - GF |
| li | li | oki | lílyooki | 'sharp (cl.5)' | - GF |
| mu | mu | oki | múmwooki | 'sharp (cl.18)' | - GF |
| si | si | oki | sísyooki | 'sharp (cl.7)' | - GF |
| xa | xa | oki | xáxooki | 'sharp (cl.12)' | - VC |
| xu | xu | oki | xúxwooki | 'sharp (cl.17)' | - GF |

(47) **Nouns**

| $P_1$ | $P_2$ | N-Stem | PR | Gloss |
|---|---|---|---|---|
| ßa | ßa | -xasi | ßáaxasi | 'women (cl.2)' |
| ßi | ßi | -taßu | ßíitaßu | 'books (cl.8)' |
| ßu | ßu | -suma | ßúusuma | 'cornbread (cl.14)' |
| ku | ku | -nani | kúunani | 'ogre (cl.19) |
| li | li | -rofu | líirofu | 'ripe banana (cl.5)' |
| lu | lu | -xu | lúuxu | 'firewood (cl.11)' |
| si | si | -ßala | síißala | 'the world (cl.7)' |
| xa | xa | -muka | xáamuka | 'gourd (cl.12)' |
| xu | xu | -čuxa | xuučuxa | 'to pour (cl.15)' |

(48) **Adjectives**

| $P_1$ | $P_2$ | ADJ-Stem | PR | Gloss |
|---|---|---|---|---|
| a | a | -layi | áalayi | 'good (cl.16) |
| ßa | ßa | -rafu | ßáarafu | 'hostile (cl.2)' |
| ßi | ßi | -xulu | ßíixulu | 'old (cl.8)' |
| ßu | ßu | -čou | ßúučou | 'big (cl.14)' |
| ku | ku | -kwaalaafu | kúukwaalaafu | 'clear liquid (cl.20)' |
| li | li | -líiwaaŋga | líiwaaŋga | 'rough (cl.5)' |
| lu | lu | -lulu | lúululu | 'bitter (cl.11)' |
| mu | mu | -ɲifu | múuɲifu | 'cold (cl.18)' |
| si | si | -ŋau | síiŋau | 'thin (cl.7)' |
| xa | xa | -raandaafu | xáaraandaafu | 'brown (cl.12)' |
| xu | xu | -ßalaayi | xúußaláayi | 'wide (cl.17)' |

Given that haplology applies to a prefix in case it is identical to the preceding preprefix, it is pertinent to investigate the other prefix structures targeted by this rule.

### 3.4.2.1 **Other Prefixes which Haplologize**

Besides the noun and adjective prefixes in (44)-(48), which haplologize after identical preprefixes, other targets of haplology include the infinitive of 'hit', which when contrasted with **xuxúxupa** 'we hit you' (see fn.24), and the examples in (49) and (50)), reveals that given a sequence of identical syllables, prefix haplology will target the prefix.

| | | | | | |
|---|---|---|---|---|---|
| (49) | **$P_1$** | **$P_2$** | **V-Stem** | **PR** | **Gloss** |
| | xu | xu | -xupa | xúxuupa<br>~xúuxupa | 'to hit' |
| (50) | **SP** | **OP** | **V-Stem** | **PR** | **Gloss** |
| | xu | xu | -xupa | xuxúxupa<br>~xuxúupa<br>*xuúxupa[23] | 'we hit you' |

But as the variants in (49) show, the speaker who applies haplology to the infinitive says **xúuxupa** 'to hit', with a falling tone on the lengthened preprefix vowel, but the speaker who applies **xu-deletion** says "**xúxuupa**" 'to hit', with a high tone on the short preprefix vowel. When **xu-deletion** applies, the prefix vowel lengthens. Otherwise haplology will cause CL in the preprefix vowel. Apparently, only **xu-deletion** can apply to a structure bearing a SP that is identical to the OP, as the SP-OP sequence does not provide the right environment for haplology. Now given that **xu-deletion** is optional, all the three identical syllables - the SP, OP, and initial syllable of -**xupa** - can surface without creating an ill-formed structure. From (49) and (50) we note that (i) not all cases of prefix-preprefix identity trigger haplology, and (ii), **xu-deletion** is optional. Notably, unlike (44)-(48) where the prefix and preprefix were co-referential, the SP's and OP's in (49) - (51) refer to different things, suggesting that for haplology to delete a prefix, the preceding preprefix must be co-referential.

| | | | | | |
|---|---|---|---|---|---|
| (51) | **SP** | **OP** | **V-Stem** | **PR** | **Gloss** |
| | ßa | ßa | -lima | ßaßálima<br>*ßaálima | 'they cultivate them' |
| | mu | mu | -suta | mumúsuta<br>*muúsuta | 'you pl. carry him' |
| | xu | xu | -saßa | xuxúsaßa<br>*xuúsaßa | 'we beg you sg.' |
| | ku | ku | -xila | kukúxila<br>*kuúxila | 'it (cl.3) overpowers it (cl.3)' |

Another set of identical prefixes worth considering occurs in relative constructions like those presented in (32b). Apparently, Bukusu forms relative constructions by affixing a relative prefix (RP) structure to the verb stem. (52a) whose simple verb structures comprise a SP and a V-Stem contrast well with their relativized counterparts in (52b).

---

[23]Both haplology and **xu-deletion** apply to the infinitive of **-xupa** which has a sequence of four identical syllables - the infinitive marker, 2 sg. OP, and the initial syllable. Thus **/xu-xu-xu-xupa/ ---> [xúuxuupa]** 'to hit you,' where the first two are the preprefix and prefix respectively, while the third is the OP.

(52)a.

| | SP | V-Stem | PR | Gloss |
|---|---|---|---|---|
| | ßa | -iča | ßééča | 'they come' |
| | mu | -ima | mwiima | 'you pl. stand' |
| | xu | -oma | xwooma | 'we dry' |

b.

| $RP_1$ | $RP_2$ | V-Stem | PR | Gloss |
|---|---|---|---|---|
| ßa | ßa | -iča | ßáßééča | 'those who come' |
| mu | mu | -ima | mumwiima | 'those of you who stand' |
| xu | xu | -oma | xuxwooma | 'those of us who dry' |
| u | u | -eɲa | óweeɲa | 'You who wants' |
| xa | xa | -ißa | xaxeeßa | 'that which steals' |

Notice that the prefix cannot undergo haplology in (52b) because VC has already applied to the vowel to yield a long vowel whose features combine the features of the prefix- and stem-initial vowels. The prediction then is that haplology will apply to a RP when it is attached to a C-initial stem. Indeed this is what we get in (53).

(53)a.

| | SP | V-Stem | PR | Gloss |
|---|---|---|---|---|
| | ßa | -xola | ßaxola | 'They do' |
| | mu | -lola | mulóla | 'you pl. look' |
| | xu | -ßira | xußira | 'we pass' |
| | u | -tima | otíma | 'you sg. run' |
| | xa | -yaßa | xayáßa | 'it (cl.12) digs' |
| | ku | -xola | kuxola | 'it (cl.3) does' |
| | si | -tora | sitóra | 'it (cl.7) gets wet' |
| | ßi | -lila | ßilíla | 'they (cl.8) cry' |

b.

| $RP_1$ | $RP_2$ | V-Stem | PR | Gloss |
|---|---|---|---|---|
| ßa | ßa | -xola | ßaaxola | 'those who do' |
| mu | mu | -lola | múúlóla | 'those of you pl. who look' |
| xu | xu | -ßira | xuußira | 'those of us who pass' |
| u | u | -tima | óotima | 'you sg. who runs'[24] |
| xa | xa | -yaßa | xááyáßa | 'that which digs' |
| ku | ku | -xola | kuuxola | 'one which does' |
| si | si | -tora | sítóra | 'one which gets wet' |
| ßi | ßi | -lila | ßílíla | 'those which cry' |

Therefore, from (50) and (53) we conclude that prefix haplology applies in (53) because the two syllables of the relative prefix are co-referential. Apparently, it is also requisite for haplology that the targeted prefix be co-referential with the preceding (identical) syllable.[25]

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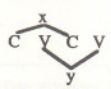
[24] This example is particularly interesting because besides showing haplology as applying to prefix structures whose prefix is identical to the preprefix, it also indicates that CL applies after initial short vowel lowering. But this creates an ordering paradox, given the first example in (33b). Therefore, we assume for now that the rule lowering the stem-initial vowel is sensitive to other aspects of the grammar.

[25] This might appear to support Hyman's suggestion (p.c.) that we treat the prefix structure targeted by haplology as a single unit, in which case the identical consonants and vowels can be treated as single segments linked to the skeleton as follows:




Here, *x* and *y* are segmental variables with *X* and *y* standing for consonants and vowels, respectively. Two reasons show that this representation is incorrect: first, given the short word-initial vowel lowering rule that applies in

To summarize, this section has examined two syllable-deleting processes. First, we reviewed **xu-deletion** in **-xupa** 'hit,' which was found to occur only after a short vowel. Secondly, we looked at haplology, which affects a prefix in case it is identical to, and co-referential with, the preceding preprefix. As both types of syllable deletion result in the compensatory lengthening of the preceding vowel, it would be interesting to examine the CV and moraic accounts for these processes. We pursue this in §4.3. Meanwhile, let us take a look at apparent exceptions to some of the processes discussed so far.

### 3.5 Apparent Counterexamples

We have made the following observations in the preceding discussion:

(54) i. *A high vowel becomes a glide before another vowel;*

ii. *A non-high vowel deletes before another vowel; and*

iii. *Vowel-initial stems trigger processes which alter the prefix, and as a result, block haplology.*

While (54i) summarizes the change triggered by vowel-initial stems to preceding high prefix vowels (cf.§3.1), (54ii) refers to VC, examples of which we saw in §3.2. (54iii), on the other hand, is a combination of (54i) and (54ii), since GF and VC are two of the three processes which may bleed haplology, the other being PNC (for which see §3.3). Because GF, VC, PNC, and syllable deletion are interrelated, counterexamples to one raises suspicions about the authenticity of the rest, hence the need to explain why Bukusu has vowel-initial stems which fail to trigger GF and VC.

#### 3.5.1 Apparent Counterexamples to GF

Despite the assertion in §3.1 that high vowels undergo GF before vowels, Bukusu has numerous cases of vowel-initial stems that seem to violate this generalization. To start with, let us consider (55) where high prefix vowels fail to glide before vowel-initial stems, and consequently provide the right conditions for prefix haplology. If, as treated in §3.1, GF was exceptionless, why would the prefix vowels fail to glide in (55), acting instead as though the stems were consonant-initial? Would VC also fail to apply if the same stems took prefixes with non-high vowels? Before attempting to answer these questions, we shall first consider exceptions to all the processes discussed to this point.

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words like /u-mu-ndu/ --> [omuundu] 'a person', it is hard to defend the view that the preprefix and prefix vowels are linked to the same slot, as that would predict lowering for the prefix vowel as well. Secondly, it would be hard to motivate this representation in relative constructions where the SP and RP are clearly autonomous.

(55)a. **Infinitives**

| $P_1$ | $P_2$ | V-Stem | PR | Gloss |
|---|---|---|---|---|
| xu | xu | -aaya | xuu.aaya | 'to hunt' |
| xu | xu | -andika | xúu.aandika | 'to write' |
| xu | xu | -ola | xúu.ola | 'to rest' |
| xu | xu | -oča | xuu.oča | 'to go on trial' |
| xu | xu | -ila | xúu.ila | 'to send' |
| xu | xu | -iŋga | xuu.iiŋga | 'to tighten' |
| xu | xu | -esya | xúu.esya | 'to conceive' |
| xu | xu | -eela | xuu.eela | 'to breathe' |
| xu | xu | -ula | xuu.ula | 'to overpower' |
| xu | xu | -uula | xúu.uula | 'to thresh' |

b. **Nouns**

| | | | | |
|---|---|---|---|---|
| ßu | ßu | -aani | ßúu.aani | 'generosity' |
| lu | lu | -eni | lúú.éni | 'lightning' |
| ku | ku | -embe | kúú.éembê | 'a big mango tree' |
| ßi | ßi | -ini | ßíi.ini | 'knife handles' |

c. **Adjective**

| | | | | |
|---|---|---|---|---|
| u | mu | -alaßa | ómu.alaßa | 'tough (cl.1)' |
| li | li | -olu | líi.olu | 'soft (cl.5)' |
| si | si | -alafu | síi.alafu | 'rough (cl.7)' |
| ßi | ßi | -aŋgafu | ßíi.aaŋgafu | 'mature (cl.8)' |

### 3.5.2 Apparent Counterexamples to VC and Haplology

As evidence for VC applying to any non-high vowel that precedes another vowel, we cited various sets of vowel-initial stems, and as with GF, we implied that VC was exceptionless. But then there are structures like those in (56) and (57) which force us to revise our rule to avoid creating the starred variants.[26]

(56)

| $P_1$ | $P_2$ | Stem | PR | Gloss |
|---|---|---|---|---|
| ßa | ßa | -aayi | ßaa.aayi<br>*ßaßaayi | 'hunters' |
| ßa | ßa | indi | ßáá.íindi<br>*ßáßéendi | 'Indians' |
| ku | ku | -uma | kúú.úma<br>*kúkúúma | 'fork (cl.20)' |
| xa | xa | -aani | xáa.aani<br>*xáxaani | 'giver (cl.12)' |
| ßi | ßi | -ini | ßíi.ini<br>*ßíßiini | 'knife handles' |
| si | si | -ilili | síi.ilili<br>*sísiilili | 'harp' |
| li | li | -aŋina | líi.aŋina<br>?lílyaaŋina[27] | 'queen bee' |

[26] We assume that mora-trimming would reduce input sequences of more than two moras to two.

[27] This form is rare but possible, suggesting that some speakers now analyze this as a true vowel-initial stem.

(57) **Adjectives**

| $P_1$ | $P_2$ | Stem | PR | Gloss |
|---|---|---|---|---|
| ßa | ßa | alafu | ßáa.alafu<br>*ßáßaalafu | 'rough (cl.2)' |
| ßi | ßi | aŋgafu | ßíi.aaŋgafu<br>*ßíßyaaŋgafu | 'ripe (cl.8)' |
| ßu | ßu | olu | ßúu.olu<br>*ßúßwoolu | 'easy/soft (cl.14)' |
| ku | ku | inda | kuu.iinda<br>*kukwiinda | 'rich (cl.20)' |
| li | li | alaßa | líi.alaßa<br>*lílyaalaßa | 'tough (cl.5)' |
| si | si | umbe | síi.uumbe<br>*sísyuumbe | 'round (cl.7)' |

Incidentally, haplology applies in (56) and (57) because the prefix vowels are unchanged, and so prefix-preprefix identity is present by the time haplology gets to apply. We now cite evidence to support the view that such stems are underlyingly consonant-initial.

### 3.6 'Ghost' Stem-Initial Consonants.

A number of studies have postulated "ghost" consonants (Archangeli 1984, 1988; Clements and Keyser 1983; and Marlett and Stemberger 1983) to account for stem-initial structures which surface with initial vowels but act as if they were consonant-initial. Before postulating the same for the stems in (56) and (57), let us consider some more sets of data.

#### 3.6.1 The Post-Nasal Evidence

As shown in (58a) below, the 1 sg. SP, **n-**, surfaces as [n] when affixed to a vowel-initial stem. Strangely, the same nasal becomes [mb] with stems where GF and VC fail.

(58)a.

| Infinitive | SP | V-Stem | "I-Verb" | Gloss |
|---|---|---|---|---|
| xuxwaaɲ̌ja | n | -aɲ̌ja | nááɲ̌ja | 'start'[28] |
| xuxwaala | n | -ala | náála | 'spread' |
| xuxwoola | n | -ola | nóóla | 'arrive' |
| xúxwooma | n | -oma | nooma | 'dry' |
| xúxwiira | n | -ira | niira | 'kill' |
| xúxwiima | n | -ima | niima | 'stand' |
| xuxweeɲa | n | -eɲa | nééɲa | 'want' |
| xúxweesa | n | -esa | neesa | 'pass time' |

[28] Ideally onset-insertion should not cause CL. Therefore the 1sg. prefix must be moraic since it triggers lengthening in the stem-initial vowel. Like GF, this is problematic for CV theory (cf.§4).

| b. Infinitive | SP | V-Stem | "I-Verb" | Gloss |
|---|---|---|---|---|
| xúu.axa | n | -axa | mbaxa | 'paint' |
| xuu.oona | n | -oona | mbóona | 'drive out' |
| xuu.uuna | n | -uuna | mbúuna | 'be punctual' |
| xuu.eela | n | -eela | mbéela | 'breathe' |
| xúu.iima | n | -iima | mbiíma | 'search for' |
| xuu.ina | n | -ina | mbína | 'tease' |

The difference in the behavior of the nasal before the stems in (58a) and (58b) suggests that (58b) might be underlyingly consonant-initial, given the general nasal place assimilation rule illustrated in (59).

| (59) Infinitive | SP | V-Stem | "I-Verb" | Gloss |
|---|---|---|---|---|
| xuukula | n | -kula | ŋgúla | 'buy' |
| xúuwa | n | -wa | mba | 'give' |
| xúußa | n | -ßa | mba | 'be' |
| xuupula | n | -pula | mbúla | 'ransack' |
| xuučexa | n | -čexa | ɲǰéxa | 'laugh' |
| xuulola | n | -lola | ndóla | 'look' |

Thus besides failing to trigger GF and VC, the stem-initials in (58b) a prefixal /n-/ to [m]. Even more surprising is the "mysterious" appearance of the voiced bilabial stop, [b], between the nasal and the stem-initial vowel. These developments resolve themselves if we posit an "invisible" initial consonant for the stems in (58b), since there would be no motivation for positing a rule which epenthesizes [b]. Therefore [b] must derive from an underlying stem initial labial consonant,[29] which might have been lost by a historical rule, but whose effects still show in structures like those in (58b). (Also see fn.9).

Any one of the three labial non-vocalic segments which surfaces as [b] post-nasally, **/p, ß, w/**,[30] could fit this slot. But since stems starting with /p/ and /ß/ retain their stem-initial consonants, /w/ would be a reasonable choice. This is supported by the rareness of stem-initial /w/, as it is found in only two stems, namely **-wa** 'to give/get finished'.[31]

If the stems in (58b) do not trigger GF and VC because they have an underlying initial consonant, it can be assumed that the apparent vowel-initial stems in (56) and (57) fail to trigger GF and VC for the same reason. Apparently, a number of "aberrant" adjectives derive from the same stems as corresponding irregular verbs. (60) is illustrative.

[29] The only other labial obstruent in the language, /f/, triggers nasal deletion like the other fricatives (cf.(36)).

[30] This post-nasal conversion to [b] does not apply to [w] derived from underlying /u/ due to ordering facts.

[31] As nothing depends crucially on this abstract segment being /w/, so we could assume that it is simply a C that is specified for [labial] as follows:

C
|
[Labial]

(60)

| Adjective | Infinitive | V-Stem | "I-Verb" | Gloss |
|---|---|---|---|---|
| ßáa.alafu | xuu.alala | -alala | mbálala | 'get rough' |
| ßíi.aaŋgafu | xuu.aaŋgala | -aŋgala | mbáaŋgala | 'get ripe' |
| ßúu.olu | xúu.ola | -ola | mbola | 'get soft/easy' |
| kuu.iinda | xúu.iindyaala | -indiala | mbiindyáala | 'get rich' |
| líi.alaßa | xuu.alala | -alala | mbálaßa | 'get tough' |
| síi.uumbe | xuu.uumba | -umba | mbúumba | 'mould' |

Similarly, the behavior of "aberrant" vowel-initial noun and adjective stems, can be explained by invoking 'ghost' consonants. Therefore the basic difference between "true" and "fake" vowel-initial stems is best captured by the respective underlying representations of **/n-axa/ ---> [naaxa]** 'I stink' and **/n-axa/ ---> [mbaxa]** 'I paint' in (61a,b) below. The square brackets in (61b) indicate the position occupied by the "ghost" consonant.

(61)a. b.

### 3.6.2 The Imperative Construction

Independent motivation for "ghost" consonants comes from comparing the imperatives formed from the two types of vowel-initial stems in (56), for which see (62). In short, speakers form the imperative of true vowel-initial stems by epenthesizing [y] before the initial vowel, as in (62a). On the other hand, apparent vowel-initial stems (cf. (62b)) do not allow [y] epenthesis. Instead, they begin with the stem-initial vowel in the same way that imperatives of consonant-initial stems start with the stem-initial consonant. (See (63).)

(62)a.

| Infinitive | V-Stem | Imperative | Gloss |
|---|---|---|---|
| xuxwaaɲǰa | -aɲǰa | yaaɲǰa | 'start!' |
| xuxwaala | -ala | yaala | 'spread!'[32] |
| xuxwoola | -ola | yoola | 'arrive!' |
| xúxwooma | -oma | yooma | 'dry!' |
| xúxwiira | -ira | (y)iira | 'kill!' |
| xúxwiima | -ima | (y)iima | 'stand!' |
| xuxweeɲa | -eɲa | yeeɲa | 'want!' |
| xúxweesa | -esa | yeesa | 'pass time!' |

[32] Oddly, epenthetic [y] triggers lengthening in the stem-initial vowel. This is problematic even for the moraic theory, because, if we assume like Hayes (1989) that glides are non-moraic, there is no reason why epenthetic [y] should trigger lengthening in the following vowel. Treating this as [i] insertion is untenable, as it seems strange for onset insertion to insert a vowel before another vowel [Itô 1989].

| b. **Infinitive** | **V-Stem** | **Imperative** | **Gloss** |
|---|---|---|---|
| xúu.axa | -axa | axa | 'paint!' |
| xuu.aaya | -aaya | aaya | 'hunt!' |
| xuu.oona | -oona | oona | 'drive out!' |
| xúu.ona | -ona | ona | 'heal (intr.)!' |
| xuu.uuna | -uuna | uuna | 'be punctual!' |
| xuu.una | -una | una | 'stab!' |
| xuu.eela | -eela | eela | 'breathe!' |
| xúu.ela | -ela | ela | 'perish!' |
| xúu.iima | -iima | iíma | 'search for!' |
| xuu.ina | -ina | ina | 'tease!' |

(63)

| **Infinitive** | **V-Stem** | **Imperative** | **Gloss** |
|---|---|---|---|
| xuukula | -kula | kula | 'buy!' |
| xúusila | -sila | sila | 'be silent!' |
| xuulaaŋga | -laŋga | laaŋga | 'call!' |
| xuuterema | -terema | terema | 'tremble!' |
| xuukukuma | -kukuma | kukuma | 'rumble!' |
| xuunyaala | -nyala | nyaala | 'dry up!' |

This further evidence from imperatives confirms that vowel-initial stems which fail to trigger GF and VC have "invisible" initial consonants. Therefore the earlier claim that vowel-initial stems cause preceding high vowels to glide and non-high vowels to delete remains valid. Let us now examine the implications of these facts for both the CV and moraic theories.

## 4.0 Evaluation of the Theories

This section examines the CV and moraic theories in view of the Bukusu facts presented so far, primarily because we want to determine which of the two theories is sufficiently constrained to make the right predictions regarding CL. Since both theories account for garden-variety GF, VC, and PNC, this section will focus on various problems. First, we shall consider the case of gliding word-initial prefixes, starting with the CV account and then the alternative moraic account. Secondly, we shall examine how the two theories handle syllable deletion as a trigger for CL. This should enable us to propose the theory that makes more general claims about the different sources of CL.

### 4.1 The Theories

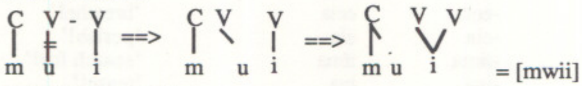
Since Clements (1986:40) treats both Cs and Vs as the units which characterize the timing tier, it is reasonable to consider the predictions that CV theory make regarding various sources of CL. Additionally, we need to contrast these predictions with those of the moraic theory, which differs from CV theory in its recognition of the basic difference between Cs and Vs, the latter of which assigns prosodic value, while treating the former as prosodically insignificant. Given this basic difference, we shall first show how each theory handles GF, VC, and PNC. Then the focus will turn to the problematic cases.

## 4.2 Derivations

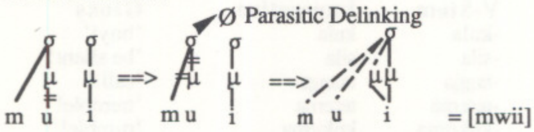
It has been claimed already that both CV and moraic theory can account for most cases of GF, VC and PNC. For instance, there is GF of the type depicted in (64).

(64). *GF and CL* - /mu-iča/ ---> [mwííča] 'you (pl.) come'

a. *CV Account*[33]




b. *Moraic account*




In both accounts, (64a) and (64b), GF triggers CL by delinking an underlying high vowel from its prosodic slot. Then follows resyllabification where the delinked element(s) attach to new positions, since the initial delinking would have produced a syllable that does not dominate a nucleus. As Hayes points out, such a syllable deletes by rule (65).

(65) *Parasitic Delinking* [Hayes 1989:268]

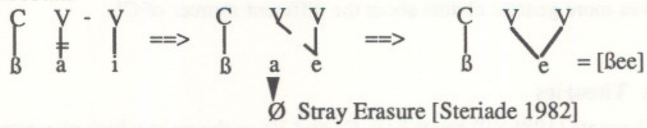
a. Syllable structure is deleted when the syllable contains no overt nuclear segment.

b.


The other process that the CV and moraic theories handle adequately well is vowel contraction, as illustrated in the following derivation of **/ßa-ißa/ ---> [ßeeßa]** 'they steal,' where /ßa/ is the SP. Apparently, a rule of [hi] spreading spreads the height value of the first vowel to the following vowel before the first vowel undergoes deletion.

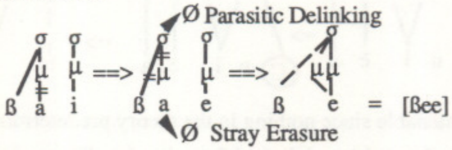
(66) *VC and CL* - /ßa-ißa/ ----> [ßeeßa] 'they steal'

a. *CV Account*




33 It might be argued that the output of CV derivation in (64a) could very well be interpreted as comprising a complex segment that is primarily a bilabial nasal, and secondarily a velar glide. Since no measurements have been carried out to establish the status of this sequence, we shall let the matter rest for now.

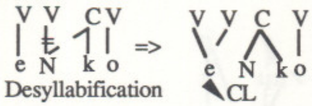
b. *Moraic Account*



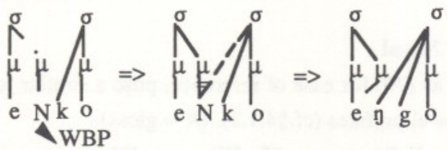

Lastly, PNC applies to any vowel occurring before a nasal-consonant sequence (cf.§3.3), as shown in the following derivation of /e-n-ko/ ---> [éeŋgo] 'at home' in (67).

(67). *PNC and CL*

a. *CV Account*




b. *Moraic Account*




Given (64)-(67) one would imagine that the two theories have equal predictive power regarding CL. However, further evidence reveals that CV theory is flawed in a way that moraic theory is not. We highlight this weakness in the next section.

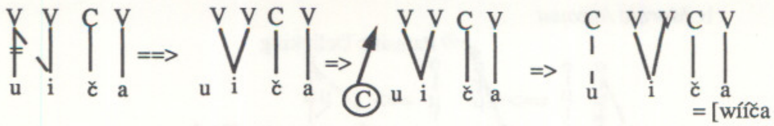
### 4.3 **Problematic Cases**

Three basic phenomena stand out as being problematic for CV . First, there is the problem posed by gliding syllable-initial vowels. Secondly, syllabic word-initial nasals produce effects that are quite similar to those of gliding syllable-initial vowels. Lastly, CV theory is not equipped to handle CL from syllable deleting processes with as much simplicity as it does in cases involving GF, VC, and PNC. We now turn to these processes.

#### 4.3.1 **Gliding Vowel Prefixes**

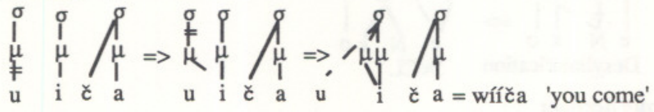
As observed before, Bukusu exhibits changes like **/u-iča/** ---> **[wííča]** 'you sg. come', where a prefix vowel glides before a stem-initial vowel. In the CV account in (68), C-epenthesis is postulated to provide a locus for the delinked vowel, which now becomes a glide.

(68)*CV Account* - /u-iča/ ----> [wííča] 'you (sg.) come'




However, this account is untenable since nothing in the theory predetermines that a C gets epenthesized, and not a V, after [u] has delinked from its slot. C-epenthesis violates the principle of "prosodic conservation", which says that rules targeting segments do not necessarily affect prosodic structure, and which both explains why segment deletion causes CL, and why we do not find spontaneous C and V lengthening. Contrast this with (69).

(69) *Moraic Account*



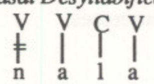

### 4.3.2 CL from 1 sg. SP Nasal

Data (58a), repeated below as (70) for ease of reference, pose a similar for CV theory as the one posed by gliding vowel prefixes (cf.§4.1.2). (X = gloss)

| (70) Infinitive | SP | V-Stem | "I X" | Gloss |
|---|---|---|---|---|
| xuxwaala | n | -ala | náála | 'spread' |
| xuxwoola | n | -ola | nóóla | 'arrive' |
| xúxwooma | n | -oma | nooma | 'dry' |
| xúxwiira | n | -ira | niira | 'kill' |
| xúxwiima | n | -ima | niima | 'stand' |
| xuxweeɲa | n | -eɲa | nééɲa | 'want' |
| xúxweesa | n | -esa | neesa | 'pass time' |

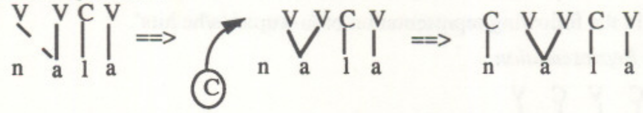
Stem-initial vowel lengthening after the 1sg. SP comes as a surprise because onsets do not generally cause the following nucleus to lengthen. However, following Clements (1986), we can assume that the nasal is underlyingly syllabic, in which case a form like [**náála**] 'I spread' starts out as (71), with the nasal linked to V.

(71) *Nasal Desyllabification*




Apparently, the nasal desyllabification results from a general prohibition against syllabic onsets (Hyman 1984). The "floating" V reassociates to the following nucleus to leave the nasal without a skeletal locus, as in (72). Thus a C-slot is epenthesized in the same fashion as the undesirable C-slot insertion encountered in (68) for the nasal to dock on.

(72) *CL & C-Epenthesis*



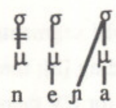
Notice here that if CL results from prosodic conservation, then slot insertion defeats the purpose of CL, which is to preserve the timing units found at the underlying level.

Moraic theory could treat postnasal lengthening as illustrated in the following representation of the change from **/n-ęɲa/** to **[néę́ɲa]** 'I want'. First, the nasal demoraifies and releases a mora that reassociates to the stem-initial vowel. Then the "floating" nasal attaches directly to the syllable, since onsets have no prosodic value; (73c) is illustrative.

(73)a.

Nasal Demoraification

b.



Parasitic Delinking

c.

Nasal Reassociation
&
Compensatory Lengthening

= néę́ɲa 'I want'

Crucially, the number of moras remains the same throughout the derivation in (73), which indicates that moraic theory conforms to the principle of prosodic conservation.

### 4.3.3 Syllable Deleting Processes

Two syllable-deleting processes were presented in §3.4, both of which caused a preceding vowel to lengthen compensatorily. For instance, it was shown that subject and infinitive prefix vowels lengthen because of the deletion of the first syllable of -**xupa** 'hit', to give forms like **[aapa]** 's/he hits' and **[xúxuupa]** 'to hit' from underlying **/a-xupa/** and **/xu-xu-xupa/**, respectively. Obviously, the deletion affects the entire syllable as the only trace of **xu** after the deletion is the lengthened vowel of the preceding syllable.

To appreciate fully the implication of syllable deletion for CV theory, recall that, despite Clements and Keyser's (1983) claim that only vowels function as loci for prosodic properties, CV theory considers Cs and Vs to be prosodically equal since both function as timing units, as in the following representation of **/a-xupa/** 's/he hits'.

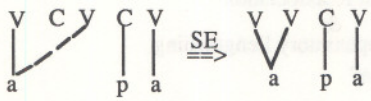
(74) *Underlying Representation*

Now given that **xu-deletion** eliminates the entire first syllable (cf. (40)), we can further assume that the process only targets the segments, leaving the CV tier intact, in which case **xu-deletion** yields (75), where the floating C and V lack segmental material. Potentially, the floating C can reassociate to the preceding nucleus, while the V can form a VC syllable with the following onset. However, this is blocked by the preferred syllable structure constraints of the language.

(75) *Xu - Deletion*

But assuming, like Marantz (1982), that only Vs attach to [+syll] segments, an argument could be made that only the V is capable of relinking to preceding [a]; then C deletes by Stray Erasure [Steriade 1982], as in (76). Does this rest the case for CV theory?

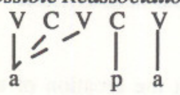
(76)



The irony of this elegant analysis, however, is that it provides a good argument in favor of a moraic approach, because it makes clear the fact that CV theory only recognizes Vs as having prosodic value, not Cs. If the purpose of postulating both Cs and Vs as prosodic units is to have them count as timing slots, then adding stipulations that prevent Cs from participating in prosodic processes is an admission that their inclusion in the prosodic structure was unfounded. In other words, placing Cs in the prosodic tier without assigning them any prosodic function defeats the purpose of having them there. Note also that if the prohibition against Cs associating to [+syll] slots were followed strictly, there would be no principled justification for syllabic nasals in the CV framework, since nasals are inherently [-syll]. Moraic theory does not need these extra stipulations, since it treats Cs as having no prosodic value, except that which is assigned by rule.

One suggestion is that perhaps both C and V reassociate to the preceding syllabic segment, as in (77). Then follows mora trimming (Clements (1986:57)),[34] as in (78).

(77) *Possible Reassociation*



(78) *V- Trimming (generalized)*

$V_Q \dashrightarrow Ø$ / ___ V V

*Subscript "Q" refers to any number of Vs in excess of the permissible two.*

However, (77) does not have the right configuration for (78), since the former has C in its configuration, while (78) trims any V followed by two Vs.

As our aim is to show that CL from syllable deletion is problematic for CV theory, which must make extra stipulations referring to the unique features of Cs and Vs to avoid generating wrong outputs, let us examine haplology, another type of syllable deletion.

Haplology operates like **xu-deletion**, since it also deletes an entire (prefix) syllable in case it is identical to the preprefix. The infinitive in (79) is illustrative.

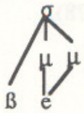
(79) *Prefix-Preprefix Identity*

But how can we tell that haplology does not just delete the onset C of the prefix? After all, this would put the two Vs adjacent to each other, as in the examples in §3.4.2. The motivation for postulating syllable-deletion comes from the fact that onset-deletion would not necessarily render the syllable ill-formed, since Bukusu phonology licences onsetless syllables. For instance, we see from (80) and the respective structures in (81) that Bukusu contrasts adjacent heterosyllabic moras with identical tautosyllabic moras. (The period is a syllable break.) Bukusu speakers treat the output of haplology as having structure (81a) rather than (81b).

| | | | |
|---|---|---|---|
| (80) | xu-xu-ßeela | xúu.ßee.la | 'to forgive' |
| | xu-xu-ßeela | xúu.ße.ela | 'to accuse falsely' |
| | xu-xu-ßuula | xúu.ßuu.la | 'to reveal' |
| | xu-xu-ßuula | xúu.ßu.ula | 'to overpower it (cl.14)' |
| | xu-xu-ßiila | xúu.ßii.la | 'to send them (cl.8)' |
| | xu-xu-ßiila | xúu.ßi.ila | 'to hate' |

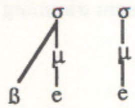
[34] This suggestion was made by a colleague during a seminar presentation of a portion of my data.

(81) a.



Contiguous tautosyllabic moras

b.



Contiguous heterosyllabic moras

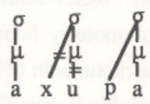
Therefore what is needed in the case of haplology is not just the creation of a CVV sequence; rather it is necessary that the rule eliminate the whole syllable so as to set free the prosodic slot needed for CL. The fact that the speaker-intuition is that haplology creates a single bimoraic syllable supports our analysis.

Therefore just as it was unable to account for the syllable deletion in -**xupa** without resorting to undesirable stipulations, CV theory fails to account for CL from haplology. Therefore we need to consider the alternative account offered by moraic theory.

#### 5.3.3.2 **The Moraic Account**

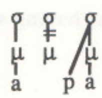
One of our strongest arguments in favor of a moraic analysis of Bukusu prosodic structures comes from its predictions regarding syllable deletion and the CL thereof. Since only coda Cs receive *weight by position* (WBP = Hayes 1989:258) in this framework, while onsets have no loci in the prosodic tier, the theory predicts that a rule like haplology which targets the second of two co-indexed syllables, culminates in CL since rules targeting the syllable tier do not necessarily affect prosodic structure. Thus the change from **/a-xupa/** to **[aapa]** 's/he hits', for instance, is derived in the following stages.

(82)a.



xu - deletion

b.



Parasitic Delinking

c.

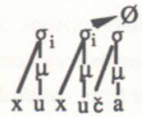
Compensatory Lengthening

= aapa 'he hits'

The lengthened SP vowel attests to Hayes' (1989:285) principle of mora conservation.

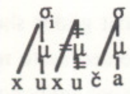
Similarly, prefix haplology can be illustrated by display (83), which captures the derivation of **[xúuča]** 'to go' from **/xu-xu-ča/**. (Subscript *i* marks identical syllables.) As indicated by (83b) unassociated segments delete by Stray Erasure.

(83)a.



Prefix Haplology

b.



Stray Erasure

c.

Mora Reassociation
= CL

= xúuča 'to go'

What is appealing about this account is its simplified, but intuitively correct, treatment of several processes which yield CL. This greater predictive power derives from its treating Cs as prosodically valueless, in contrast to Vs which attach to timing positions.

## 4.4 Summary and Conclusion

Our goal in this study has been to use the Bukusu facts to try and determine the theory that makes more accurate predictions about segment changing processes and CL. Although both theories account for basic GF, VC and PNC satisfactorily, the CV theory encounters problems with processes that moraic theory handles without difficulty. Apparently, these problems result from its failure to separate the skeleton from the prosodic tier. While the Bukusu evidence cannot be used as the sole premise for judging the adequacy of either theory, the evidence from the three problematic cases presented above has favored the moraic approach, hence the acceptance of Hyman's (1984) (also Hayes' 1989:254) claim about onsets being invisible to some phonological rules as a step in the right direction.

While it is true that recent work on Hungarian and Moroccan Arabic, to name just two, shows that moraic theory does not answer satisfactorily the perennial question concerning the elements which constitute the timing tier, the Bukusu facts presented above show that any theory which fails to recognize that consonants are prosodically valueless is too powerful. Perhaps what we need is a theory that treats the skeleton as separate from the moraic tier, but includes both in phonological representations. As of now, the predictions made by the moraic theory in a language like Bukusu cannot be ignored.

## 5.0 [y] - epenthesis - A Case for Further Research

The preceding sections have shown that moraic theory distinguishes consonants and vowels by treating the later as inherently moraic, and the former as non-moraic. CV theory, on the other hand, does not recognize a separate prosodic tier from the skeletal tier. In the moraic theory, all non-vocalic sonorants behave like regular consonants unless otherwise stipulated by particular languages. The prediction then is that glides should not cause adjacent vowels to lengthen. However, just as data (58a) forced us to revise a similar assump-tion about nasals, evidence can be adduced to disprove our prediction about glides.

This evidence is seen in the imperative constructions in (62a), repeated below as (84), where the epenthetic [y] causes lengthening in the stem initial vowel.

| (84) | **Infinitive** | **V-Stem** | **Imperative** | **Gloss** |
|---|---|---|---|---|
| | xuxwaaɲǰa | -aɲǰa | yaaɲǰa | 'start!' |
| | xuxwaala | -ala | yaala | 'spread!' |
| | xuxwoola | -ola | yoola | 'arrive!' |
| | xúxwooma | -oma | yooma | 'dry!' |
| | xúxwiira | -ira | (y)iira | 'kill!' |
| | xúxwiima | -ima | (y)iima | 'stand!' |
| | xuxweeɲa | -eɲa | yeeɲa | 'want!' |
| | xúxweesa | -esa | yeesa | 'pass time!' |

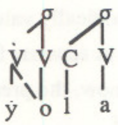
Clearly, (84) is problematic because, while it is possible to speak of moraic nasals within autosegmental phonology, one cannot argue convincingly that epenthetic [y] is syllabic (= moraic), since syllabic glides automatically change to corresponding high vowels. The question here then is how to account for the lengthening that follows [y]-epenthesis, since syllabicity cannot be invoked as the trigger. But if we assumed, for lack of a better explanation, that the glide was underlyingly /i/, the epenthesis would violate Itô's (1989) Onset Principle (see (85)). How then does one account for lengthening from [y]-epenthesis?

(85) *Onset Principle*

**Avoid $_{\sigma}$[V**

CV phonology would probably handle the change from **/y-ola/** to **[yoola]** 'arrive!' as involving V-insertion such that the inserted V functions as both the onset and the initial mora of the syllable to which it belongs, as in configuration (86):

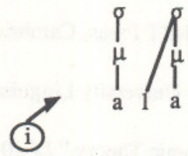
(86)




But we lack motivation for this sort of representation.

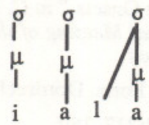
The problem is equally hard for the moraic theory because it treats glides differently than high vowels by assuming that they are non-moraic. This means that (84) cannot be explained unless we accept that the epenthesis involves [i] which later glides before the stem-initial vowel. Thus if we ignore the onsetless principle and assume that imperative construction involves [i] insertion, the change from **/i-ola/** to **[yoola]** 'arrive!' will proceed as in (87). But why insert a vowel when the structure needs an onset?

(87)a.



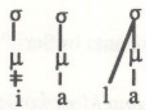
Epenthesis

b.



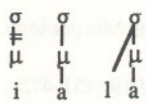
Mora Assignment

c.



Glide Formation

d.



Parasitic Delinking

e.

CL and Onset Insertion

= yaala 'spread!'

Although the moraic theory seems to have greater predictive power than the CV theory with respect to CL, the proposed treatment of CL from glide epenthesis cannot be defended on any principled grounds as it violates the onsetless principle without proper justification. Thus in trying to answer one question, we have raised another problem: How should we modify the current non-linear theories so as to account for CL from epenthesized glides?

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# Simplicity of Underlying Representation as Motivation for Underspecification

David Odden

A fundamental assumption underlying research in generative phonology has been that grammatical descriptions should contain the minimum number of symbols. This view is enforced through three principles. First, it is held that the number of rules in a grammar should be minimized. Second, each rule should be formalized with as few feature specifications as possible. Third, underlying representations should contain the minimum number of feature specifications. This paper reports the results of computational experiments in underspecification which raise questions about the legitimacy of this last assumption. It is shown that the goal of reducing the number of underlying feature specifications leads to intractable problems in computing the optimal grammar for a language. For any phonemic inventory there are vast numbers of underspecified representations, and the principle of representational simplicity does not provide an effective method for selecting between competing analyses. This leads to postulating a principle restricting the use of underspecification to cases where there is direct evidence in a language for deleting certain feature values from underlying representations: the mere possibility of doing so does not per se justify underspecification. Furthermore, the fact that underspecification of feature values will result in a grammar using fewer symbols will not be taken to be sufficient motivation for underspecification.

The outline of the paper is as follows. Section 1 establishes the significance of simplicity as a motivating force in the literature of underspecification. Section 2 discusses certain technical issues in underspecification theory, focusing in particular on the consequences of the fact that there are many ways to underspecify a phonemic inventory. Section 3 presents results from computational experiments in generating underspecification systems from surface segmental inventories.

## 1. The role of simplicity arguments in underspecification

Arguments for underspecifying feature values which one encounters in the literature can be divided into four classes.

(1) Line crossing
Behavioral asymmetry
Linking and markedness
Simplicity

The first two types of arguments may motivate eliminating certain feature values from underlying representations; the last two do not, and the focus of this paper is on the very last of these arguments.

The first argument, the line crossing reason, is clearly the strongest. An exemplar of this argument is the underspecification analysis of neutral vowels in vowel harmony. The vowels [i] and [e] in Finnish are transparent to the spreading of the feature [back], despite being [-back] on the surface. Given the fundamental principle that association lines cannot cross, it is inescapable that these vowels must be underspecified for the feature [back].[1]

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[1]A terminological distinction will be adopted here between underspecification and nonspecification of features. The term "nonspecification" will be employed when a segment lacks a given feature at every stage in a derivation. The term "underspecification" will refer

Asymmetry arguments, such as those given in Pulleyblank (1988) regarding the vowel [i] in Yoruba (where only [i] triggers certain rules, and all vowels but [i] seem to trigger other rules) or those in Pulleyblank (1986) for mid tone in Yoruba could also provide evidence for feature underspecification, especially if it is impossible to directly exclude the segment in question from the class of triggers or targets. Although Clements and Sonaiye (1989) argue that the Yoruba vowel argument is not as compelling as appears, the questions which they raise cast doubt on a specific analysis, and do not show that asymmetry is in principle an unacceptable argument.

The linking and markedness argument, also known as the epenthetic vowel argument, is often given to support the claim that certain features are unspecified in underlying representations. For example, if a language has a number of vowel epenthesis rules, all of which insert the same vowel, it is widely assumed that one only needs to insert a timing slot and allow redundancy rules to fill in the relevant features. However, Mohanan (1991) shows that a theory with structure preserving constraints (which may include something analogous to default rules) can account for such phenomena; underspecification in underlying representations is not necessary to explain why rules of vowel epenthesis generally insert a single vowel in a given languge. While studying the results of epenthesis rules may provide some information about the form of redundancy rules in a language, the existence of such rules does not per se show that a given segment must have an underlying blank in positions where the feature specification could be supplied by redundancy rule.

The weakest reason for underspecifying segments, the one to be investigated here, is that eliminating redundant features results in simpler underlying representations. This paper argues that considerations of simplicity have no validity. Yet the simplicity argument plays a central role in underspecification literature. For example, Halle (1959:29-30) sets forth as one of the fundamental axioms of phonological analysis the following condition:

> Condition (5): In phonological representations the number of specified features is consistently reduced to a minimum...

Later, commenting on two competing methods for specifying the Russian phonemes /t,s,c,n/, it is noted (p. 36)

> The freedom in ordering feature-questions may result in several branching diagrams compatible with the above requirements. In such cases the choice may be dictated by Condition (5)... It is evident that the second ordering is the more economical since it yields a greater number of zeros.

Halle (1962: 60) states "In general, we must omit features in all dictionary representations, whenever these can be introduced by a rule that is less costly than the savings it effects". In a similar vein, Stanley (1967: 434) states:

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more narrowly to the situation where a segment is specified for a feature in the output of the phonology, but is not so specified in some earlier stage. Feature geometry makes this distinction important. Rules of front ~ back vowel harmony are generally blind to intervening consonants, so for example labial consonants never intrinsically trigger or block backness harmony. In pre-geometric autosegmental theories, this would entail that [p] (which would be [–back]) is underspecified for the feature [back], since it neither causes fronting of vowels nor interferes with [back] spreading from other vowels. Adopting certain theories of feature geometry such as those proposed in Sagey (1986) or Steriade (1987), [back] is a feature under the dorsal (or velar) node, and labials have no dorsal node either in underlying or surface representations. In such a case, the lack of a [back] specification for labial consonants is not underspecification, as defined here.

> ...we have an evaluation measure which tells us what the best set of MS conditions is; it is, essentially, the shortest set of MS conditions that allows us to leave the greatest number of blanks in dictionary matrices...[2]

In the contemporary literature on underspecification, formal simplicity continues to play a major role. According to Archangeli (1984:36),

> In this theory, certain values for all features are supplied by redundancy rules, rather than being present in underlying representation. In this way, underlying representations are simplified.

Similarly, it is stated that (p. 41-2)

> The underlying representation of our hypothetical language is considerably streamlined if underspecification is assumed. This means that the language learner has less to learn and less to memorize.

Elsewhere, it is claimed that elimination of whole features or elimination of feature values, takes priority over considerations of rule simplicity (p. 48):

> There are various assumptions possible about what constitutes the most highly valued minimally specified matrix. These break into three categories, algorithms based on:
> (2.25)
> a. the rules necessary to supply the missing feature values.
> b. the number of feature values (i.e. the number of pluses and minuses) in underlying representation.
> c. the number of features in underlying representation.
>
> Consideration of these options ranks the third above the other two, and the second above the first.

The Feature Minimization Principle is established, to elevate these sentiments to the level of theoretical principle (p. 50):

> FEATURE MINIMIZATION PRINCIPLE:
> A grammar is most highly valued when underlying representations include the minimal number of features necessary to make different the phonemes of the language.

Finally, it is stated (p. 65) that

> The procedure includes principles like those noted above: Minimize the number of features and minimize the number of marks.

Archangeli (1988: 183) echos these sentiments.

> An evaluation metric in Universal Grammar provides a means of selecting between possible grammars for a particular language. The evaluation metric as conceived in Chomsky and Halle (1968; henceforth SPE) prefers the

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[2] For the most part, Stanley (1967) presumes that "dictionary" entries contains zeros for all redundant features, but appears to reject all forms of underspecification on p. 435.

> grammar in which only the idiosyncratic properties are lexically listed and predictable properties are derived. The essence of underspecification theory is to supply such predictable distinctive features or feature specifications by rule.

More recently, Archangeli and Pulleyblank (1992) have reaffirmed the methodological principle of selecting the simplest underlying representation, setting forth the principle of Representational Simplicity which holds that the value of a representation is the inverse of the number of terminal F-elements (features) and associations to features.

Thus the question of simplicity, in terms of counting feature specifications and in terms of counting features having specifications, has been a significant motivating factor for underspecification. Virtually no attention has been paid to addressing the question of why it should be intrinsically desirable to require that the underlying representation be "simple" in this sense. One view, expressed in the earlier generative literature, was that on the assumption that storage space in the brain is limited, underlying representations containing fewer elements could be stored in less space than would be required for fully specified representations. This kind of reasoning cannot be given much credence: our understanding of the mechanisms of information storage in the human brain is not sufficiently refined that we can seriously compare the consequences of full specification versus underspecification for a psychologically realistic model of phonology. A related argument is that under-specification gives the child "less to learn" about a language. In fact, underspecification gives a child more to learn — the child must learn what the rules are in the language which fill in missing feature values. Moreover, given that the surface feature values are phonetic features, it is not necessary for the child to "learn" that, for example, [a] is [+voice]. That fact can be provided by simple observation. What does require learning is that in some language, certain [+voice] segments are not specified as [+voice] in underlying representations. Such an inference requires reasoning beyond simple observation of the phonetic segments in a language.

## 2. Technical questions

There are two widely accepted theories of underspecification, often referred to as Contrastive Underspecification (CU) and Radical Underspecification (RU), which differ on whether contrastive feature specifications may be eliminated from underlying representations. The problem considered here regarding simplicity is largely independent of the CU/RU debate. We will start from the simpler set of assumptions made within CU, discover the consequences of pursuing simplicity considerations, and then extend the investigation to the RU framework.

### 2.1 Eliminating redundant features in Contrastive Underspecification

In order to investigate the interaction between underspecification and simplicity, it is necessary to state explicitly how an underspecified representation is arrived at. With prior knowledge of the underspecified representation and the rules which fill in redundant values, one can mechanically apply the rules to the representation and verify that correct surface segments result. Inferring a set of rules and an underlying representation from a surface inventory, as a child learning a language might do, is much more difficult. The first step is therefore to consider techniques for removing all and only non-contrastive feature values from a surface inventory and arriving at an underlying inventory.[3]

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[3]The term "contrastive" is defined as follows (this assumes the standard definition of feature value distinctness which is that only the values + and – are distinct):

It is important to recognize that feature values must be arranged into a hierarchy in order to resolve conflicting redundancy relations. A consideration of the 3 vowel system [iau] shows why this is so. There is a well-known redundancy relation between the features [back], [low] and [round] in such vowels systems. Since all [+back,–low] vowels are [+round], all [+low] vowels are [–round], and all [–back] vowels are [–round] it is possible to predict all values of [round] on the basis of values of [back] and [low], and no segment needs to be specified for a value of [round]. But it is also possible to predict all values of [back] on the basis of [round] and [low]: all [+low] vowels are [+back], all [–round,-low] vowels are [–back] and all [+round] vowels are [+back].

It is not possible to simultaneously eliminate specifications of both [round] and [back], since doing so renders the contrasting vowel pairs {i,u} indistinct.[4] There are at least two ways to underspecify the system [iau], one in which [back] is eliminated and [round] is retained, and one in which [round] is eliminated and [back] is retained. Each such hierarchy of features represents a potentially distinct underspecified underlying representation. Stanley (1967: 400) recognizes this problem, and in commenting on the method of feature underspecification in Halle (1959) observes that

> there may be considerable freedom in the way this branching diagram is constructed for a given set of systematic phonemes; a different choice of redundant feature values in this set will lead to a different branching diagram and thus to a different hierarchy of features.

A simple algorithm can be devised which deletes features from a surface inventory of a language and arrives at an underspecified representation as follows:

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DEFINITION: The value of feature $F_i$ is contrastive in segment X iff there exists a segment Y such that the value for $F_i$ of X is not identical to the value for $F_i$ of Y, and there is no other feature $F_j$ where the value for $F_j$ of X is distinct from the value for $F_j$ of Y.

[4]Archangeli (1988: 192) presents the following algorithm for establishing a contrastively underspecified representation:

a. fully specify all segments
b. isolate all pair of segments
c. determine which segment pairs differ by a single feature specification
d. designate such feature specifications as 'contrastive' on the members of that pair
e. once all pairs have been examined and appropriate feature specifications have been marked 'contrastive', delete all unmarked feature specifications on each segment.

From this she concludes that only a single underlying representation is possible for a given system. It is then argued (p. 201-2) that CU cannot distinguish the vowels in the system [iaəæʊ], on the grounds that following the above algorithm, [i] and [æ] have the same representation, namely [–back], since the features [low] and [high] will be unspecified for both vowels on the grounds that they are not (surface) contrastive.

The problem which Archangeli points to is not strictly a consequence of the theory of CU. Rather, it is the result of a specific algorithm for underspecifying an inventory in CU theory. As will be seen here — and as hinted by Archangeli — deletion of redundant features cannot be performed simultaneously on all features, but rather must be performed with respect to an assumed preference among features for deletability.

(2) Select some feature value of some segment. If that value is noncontrastive, delete it.
Repeat until all feature values of all segments have been evaluated.

This procedure avoids the paradox of incorrectly eliminating values of both [round] and [back]. One may start with the value of [round] for [i]. That value is noncontrastive ([i] differs from [u] and [a] in [back]), so the value of [round] for [i] is deleted. Proceding to [round] in [u], the value is noncontrastive ([u] differs from [i] in [back], and from [a] in [high]), so [round] is deleted. Finally coming to [round] in [a], that value is also noncontrastive ([a] differs from [i] and [u] in [high]), so it too is deleted. This gives the following partial result.

(3)

| | high | low | back | round |
|---|---|---|---|---|
| i | + | − | − | 0 |
| u | + | − | + | 0 |
| a | − | + | + | 0 |

Now, coming to the value of [back] for [i], [i] and [u] contrast only in the feature [back], so [back] cannot be eliminated from [i] (nor can it be eliminated from [u]).

On the other hand, one might instead start with the value of [back] for [i], which is noncontrastive, and eliminate it. By a similar procedure one arrives at a system where all values of [back] are eliminated, predicted primarily on the basis of the value of [round]. Other hierarchies are possible: one could start with the value of [round] for [i], proceed to the value of [back] for [u], and so on, and arrive at a different system. The number of distinct hierarchies to consider is K! (i.e. $1 \times 2 \times 3 \ldots \times k$ ) where $k$ is the number of feature values in a given inventory (which is the number of segments multiplied by the number of features). To specify the three vowel system [iua] using the four relevant vowel features, there are 12 feature values, so there are 479,001,600 (=12!) different ways in which to approach the underspecification task. For the 5 vowel system [ieaou] which requires 20 feature specifications, there are 2,432,902,008,176,640,000 (=20!) arrangments of the four relevant features, and for the phonemic inventory of English which uses 528 feature specifications (based on 33 segments and 16 surface features to represent those segments) there are $1.5 \times 10^{2146}$ (=528!) feature arrangements.[5]

Given the requirement that redundant features must be removed from underlying representations, there are many competing hypotheses which must be considered regarding which system of underspecification is selected over all of its competitors. Simplicity plays a crucial role in grammar selection (cf. especially Halle (1959), Stanley (1967)): it acts as the final arbitrar in picking an underlying representation for a phonemic inventory, since one will select the system which gives an underlying representation with the fewest feature values remaining specified.

[5]There are obviously many more paths for getting at underspecified systems under this algorithm than there are underspecified systems. If any feature value were freely deleted independent of any other value and with no regard for whether the resulting system is a well formed underspecification system, then given a total of $k$ feature values there are at most $2^k$ underlying representations. So for a 5 vowel system there could be no more than 1,048,576 distinct underlying representations.

### 2.2 Redundant features in Radical Underspecification

The difference between RU and CU is the additional principle of RU that no feature may be specified with both minus and plus values. RU requires context sensitive rules filling in values of features on the basis of values for other features (as does CU), and unlike CU it also requires context free rules which insert plus or minus values of each feature without reference to other feature specifications. It is clearly the practice in RU to include context sensitive rules of segment redundancy as well as context free rules. For instance, in de Haas's (1988:238) analysis of the vowel system [ieaou] in Kasem, [+low] is eliminated from /a/ by a rule filling in [+low] on all [+back,–round] vowels, and yet there is also a context free rule assigning the value [-low] to all vowels. Similarly, in Hyman (1988: 261) [+low] vowels in Esimbi are specified [–hi], but there is also a context free rule assigning [+high] to all remaining vowels. In Ringen (1988: 332) the context free value of [back] in Hungarian is [+back], but [– rd,–low] vowels are by a context sensitive rule given the value [–back], allowing [i,e] to be unspecified for backness. Finally, Vago (1988: 354) assigns [–back] vowels in Pasiego the value [–low], and [+back,–low] vowels receive the value [+round]; in addition, [-round] and [+back] are assigned by context free rules.

The addition of context free redundancy rules gives RU a greater degree of freedom in establishing an underspecified inventory: the possibilities for underspecification in RU are a product of the context sensitive rules plus the context free rules. Systems of radical underspecification can be generated on the basis of systems of CU underspecification in the following manner: beginning with any CU system, create two new systems, one where all plus values of the first feature are deleted, and one where all minus values of the first feature are deleted. Repeat this procedure on the resulting systems with the second feature and so on until no feature has both plus and minus values. Given any CU system of specification with *k* features having both plus and minus values, there are $2^k$ corresponding RU systems.

## 3. Computing underspecification systems

This section describes the results of a series of computational experiments in underspecification, whose goal is determining how the simplest underlying representation can be found. One algorithm for underspecification, (2) above, has been considered, where feature values may be considered in any order. This procedure was implemented as a computer program which reads in a phonemic system and eliminates feature specifications from that phonemic system according to the algorithm, given an order in which features are eliminated. With this procedure one could in principle search all possibilities looking for the simplest underlying representation. However since there are 479,001,600 ways to delete features in the vowel system [iau], an exhaustive search is not feasible.

### 3.1 Improving the algorithm

One way to reduce the size of the task is to adopt a more restrictive algorithm for underspecification. The search procedure was therefore constrained so that all values of a particular feature are underspecified simultaneously. This assumes a linear ordering of features, such that all possible eliminations of values of $F_1$ will take place, followed by elimination of values of $F_2$, and so on. Schematically, the procedure operates as follows:

(4) Start with the first feature $F_1$ and the first segment A. Locate the next segment B which has a distinct value of $F_1$.

Scan the features of segments A and B: if there is no other feature such that A and B have distinct values of that feature, then the values which A and B have for feature $F_1$ is contrastive.

If the values which A and B have for $F_1$ is not contrastive, continue the comparison by determining whether A and the next segment C have contrastive values for $F_1$ (and so on until A has been compared with all segments in the language).

If there is no segment which has a contrastive value for feature $F_1$, then the value which A has for $F_1$ is noncontrastive. When all segments have been scanned for $F_1$, noncontrastive values of $F_1$ are deleted. Proceed to the next feature.

This algorithm still requires an ordering among features, but the number of orderings is reduced to K!, where *k* is the number of features present. Consequently the number of cases to search does not grow as a function of the number of segments in the language. Under this approach, there are 24 feature orders to consider in an exhaustive search of all underspecification systems for a vowel system using the features [high], [back], [low] and [round]. For 16 features, there are 20,922,789,888,000 orders. In comparison to the $1.5 \times 10^{2146}$ possibilities for the vowel system [ieaou] under the "any feature in any segment" algorithm, this is a considerable reduction in the size of the problem. It must be kept in mind, though, that the restricted algorithm is incapable of discovering underspecification systems which the unrestricted algorithm can uncover.[6] While this gives fewer orders to consider, it remains impossible on practical grounds to evaluate the set of underlying representations arising from each of these orders for anything but the simplest tasks. An exhaustive search of an entire phonemic inventory, or of a consonantal system, is still out of the question.

An alternative is to select a large random sample of orders of feature evaluation, and generate the underspecification systems resulting from those orders. Given a sufficiently large sample, one can reasonably extrapolate from the properties of the sample to the properties of the whole set. This task can be performed by a computer program which eliminates feature specifications following the revised algorithm.

A search was conducted for representations of the vowel system [ieaou] using the features [high], [low], [back] and [round], employing 900,000 randomly selected orders. This search resulted in 50 distinct ways of underspecifying this vowel system. These same 50 systems can also be reached by a less extensive search of 500 orders. It is therefore quite likely that an exhaustive search would not yield many more ways of underspecifying the vowel system [ieaou].

### 3.2 Underspecifying English

The language selected for this part of the study was a dialect of English.[7] This inventory was specified with standard SPE-style surface feature assignments, using 16

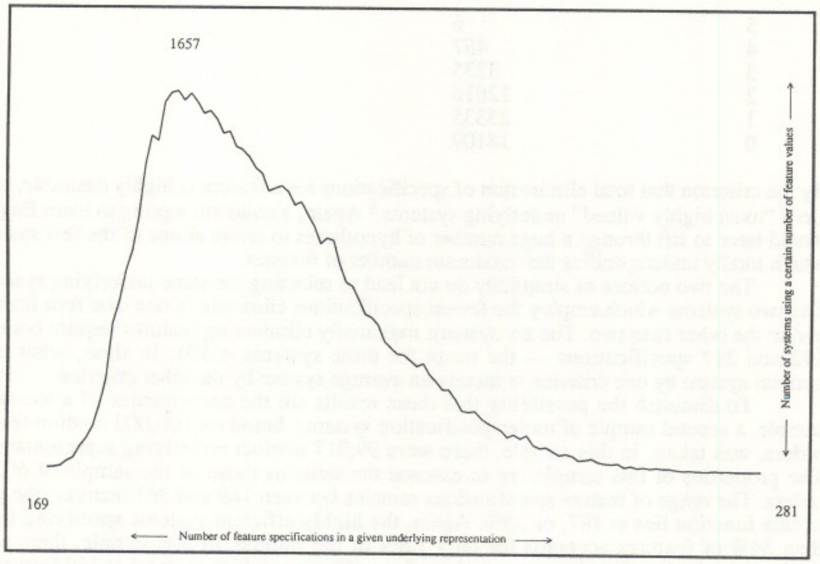
[6]Since this algorithm allows 24 ways of ordering the features [high], [low], [back] and [round] there could never be more than 24 ways of underspecifying a vowel system using just those features. In fact, there are 12 ways of underspecifying the system [ieaou] under this algorithm. The previously discussed algorithm allows at least 50 ways of specifying this system: the 12 allowed by the current algorithm, plus 38 others.

[7]In this dialect — that of the author — there is no contrast between [a] and [ɔ]. Furthermore, as a simplifying assumption, syllabic sonorants are phonemicized as

features. Certain features such as [constricted glottis] and [spread] were not entered into the database, given that all segments of English have the same value for those features. A sample of underlying systems based on 60,000 distinct random orders was generated; obviously this is a miniscule fraction of the entire population of underspecification possibilities. This sampling resulted in 59,958 distinct underlying representations. In short, only 0.07% of the systems in the sample turned out to be identical to other systems in the sample.

Different underlying systems may have different numbers of underlying feature specifications. (5) provides a plot of the feature elimination function for this sample. The vertical axis indicates the number of underlying systems which exhibit a particular degree of feature elimination, ranging from a low of 1 system to a high of 1657 systems. The horizontal axis indicates the total number of surface plus and minus values which remain in a given underspecified representation, ranging from a low of 169 to a high of 281. Expressed as a percentage of feature values remaining specified, there is a range from 32% to 53%; the mean number of specified features is 201, or 38%. However, the peak of the graph actually lies at 188 features, or 35%.

(5) ELIMINATION OF FEATURES IN ENGLISH — SPE FEATURE REPRESENTATIONS




As inspection of the graph reveals, this is a result of a relatively larger number of less efficient systems, in contrast to the relatively smaller number of more efficient systems. The mean will therefore be disregarded in favor of reporting where the peak of the function appears. 33% of the cases in the sample have between 34% and 36% of their features specified, and 46% of the sample specifies between 33% and 37% of the features. Only 1.9% are in the efficient range of less than 34% specification.

In this sample, there are two systems which result in the minimum number of feature specifications. Given the assumption that the least costly underlying representation is to be selected, one of these two systems would be the underlying system which a child acquiring English strives to uncover. But in order to arrive at one of these two solutions in the first place, a huge number of hypotheses must be considered and rejected — there is a 0.003% chance of finding one of these two underspecification systems. Moreover, if the drive to find a maximally underspecified inventory is so strong, there is no reason to end the search at this point, since it is possible that continuing the search will result in a system which has an even greater degree of underspecification, and is therefore even more desirable.

It is also interesting to consider two competing metatheories of what constitutes a "simple" underlying representation. On the one hand, there is the classical notion that the system requiring the fewest underlying feature values is simplest. On the other hand, Archangeli (1984) holds as most highly valued those systems which "include the minimal number of features" — that is, systems maximizing the number of features having no specifications at all. In this sample, we find that the degree of total underspecification of features is as follows:

(6)

| features eliminated | number of underspecification systems |
|---|---|
| 5 | 6 |
| 4 | 457 |
| 3 | 3235 |
| 2 | 12816 |
| 1 | 25335 |
| 0 | 18109 |

By the criterion that total elimination of specifications for a feature is highly desirable, there are 6 "most highly valued" underlying systems.[8] Again, a child attempting to learn English would have to sift through a huge number of hypotheses to arrive at one of the few systems which totally underspecifies the maximum number of features.

The two notions of simplicity do not lead to selecting the same underlying systems. The two systems which employ the fewest specifications eliminate in one case four features and in the other case two. The six systems maximally eliminating features require between 192 and 217 specifications — the mean for these systems is 201. In short, what is an optimal system by one criterion is merely an average system by the other criterion.

To diminish the possibility that these results are the consequence of a too-small sample, a second sample of underspecification systems, based on 100,000 random feature orders, was taken. In this sample, there were 99,917 distinct underlying representations. The properties of this sample are in essence the same as those of the sample of 60,000 orders. The range of feature specifications remains between 169 and 281 features: the peak of this function lies at 187, or 35%. Again, the highly efficient systems specifying fewer than 34% of features accounts for only 1.8% of the sample. In this sample, there are 4 systems employing the minimum number of specifications which remains at 169 features.

In terms of the number of features totally eliminated, we find the following.

[8]A feature may not be eliminated if there exists any segment pairs which contrast only in specification for that feature. For English, six features can be eliminated, namely [round], [consonantal], [lateral], [nasal], [sonorant] and [delayed release]. The features which are eliminated in the 6 systems using the fewest features are these features except for [sonorant].

(7)

| features eliminated | number of underspecification systems |
|---|---|
| 5 | 919 |
| 4 | 6975 |
| 3 | 22080 |
| 2 | 36626 |
| 1 | 29493 |
| 0 | 3824 |

Again, in each of the systems allowing maximal feature elimination, the features eliminated are [round], [consonantal], [lateral], [nasal], and [delayed release]. In that set of 919 systems the range of feature specifications is from 170 to 233, with the mean at 188. Note that this coincides with the peak of the feature elimination function for the entire sample, indicating that the systems maximally eliminating features are neither significantly less efficient nor more efficient at reducing the total number of feature values.

An additional sample of 300,000 orders resulted in 299,264 distinct underlying systems: the range remains from 169 to 281 features specified, with the peak still at 187 features. 1.9% of this sample use fewer than 34% of the features. In this sample, there are 11 systems specifying the minimum number of specifications — again, there is a .003% chance of encountering one of these maximally efficient systems. There are 2,557 systems in this sample which use the minimum number of features. The average number of specifications within this subset of the sample is 188, which is the average for the entire sample. Two systems in this sample employ the minimum number of features and 169 feature specifications, which is the minimum in the whole sample. These two systems maximally satisfy both simplicity criteria, so if formal simplicity is to be taken seriously, one of these two systems would be the underlying representation selected by a child. However, these systems can be identified only after a very extensive search.

One final search of possible underspecification systems was undertaken, this time using 2,000,000 orders.[9] This resulted in 1,973,479 distinct ways to underspecify the English phonemic inventory, and again the vast majority of these underlying systems use 188 feature specifications. There were 66 systems using the minimum number of feature specifications, which remains at 169. There are also 14,799 systems which require the minimum number of features, which is 11, and in that group, there are 5 systems which also require the minimum number of feature specifications. Presumably criteria other than simplicity would be required to select the best underlying system out of this group of 5.

The conclusion to be drawn from these four exercises in underspecification are the following. First, there are vast numbers of underspecification systems possible for English — if the trend continues, it is not unreasonable to expect that there are nearly 16! distinct ways of underspecifying the phonemic inventory of English. Second, the overwhelming majority of underspecification systems for English require about 188 features, give or take about a dozen features. The probability of encountering a highly efficient system using the fewest features and specifications is very small — one chance in 150,000. A vast number of underspecification systems must be searched in order to arrive at one which is minimalist. Finally, the number of feature values saved by seeking a highly parsimonious underlying systems as opposed to taking one of the less parsimonious but more frequent systems in the middle, is around 17 feature values. Very little is saved in reward for seeking a simpler system.

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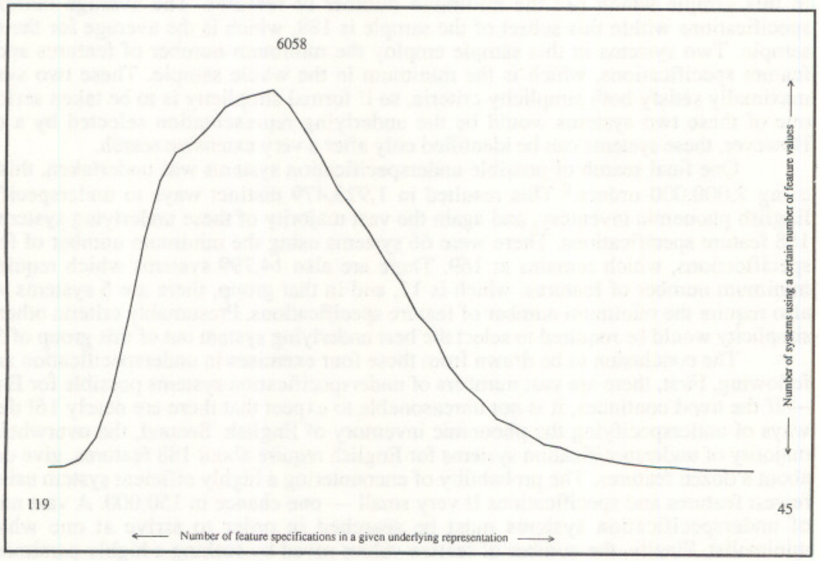
[9]This search was conducted on a Cray YMP-64: I would like to thank the Ohio Supercomputer Center for a grant of computer time which enabled this portion of the study to be conducted. Over 65 hours of CPU time were required to complete this search: it would require approximately 11,000 years to complete an exhaustive search.

### 3.3 Underspecification and Feature Geometry

It might reasonably — but incorrectly — be suspected that the proliferation in underspecification systems is an artifact of the SPE model of features for place of articulation, where vowels are redundantly specified [–coronal] and consonants are redundantly [–back]. Therefore, a sample of English segmental underspecification systems was taken, based on a feature geometric approach where vowels (but not consonants) are specified with the features [hi], [low], [back], [round] and [ATR]; and consonants (but not vowels) are specified with the privative features [coronal], [labial] and [dorsal]. In such a system, there is no underspecification of coronality for vowels — rather, vowels are non-specified for [coronal]. This will eliminate artificially inflated degrees of underspecification arising from the SPE model of place features.

However, it turns out that the same problem arises even adopting a geometric view of features. A sample of 99,989 distinct orderings of features was taken, and from this sample, 99,450 resulting systems proved to be unique, again showing that there are vast numbers of competing hypotheses to consider in arriving at an optimal underlying representation, and the feature-elimination function is graphed in (8).

(8) ELIMINATION OF FEATURES IN ENGLISH — GEOMETRIC REPRESENTATIONS




In this sample, the number of features remaining specified ranged from a low of 119 to a high of 162, out of 374 features specified on the surface. While this is lower than what was encountered in underspecifying English based on SPE-style feature analysis, this is entirely due to the fact that surface representations have fewer features specified, in comparison to the SPE approach. Expressed as a percentage of the total number of specifications, between 32% and 43% of surface features remain specified underlyingly (compare this to the range 32% to 53% for the SPE-based analysis). The mean count of specifications for this sample was 133, or 35% (compare this to 38% with SPE features): the peak of the graph and the mean coincide in this case. In the 34%–36% specification range we find 50% of cases; in the 33%–37% range find 79% of the systems. Again, 1.8% of the sample lies at the most efficient value of 32% specification. In comparison to a SPE-style feature analysis, there is a slight improvement in the mean efficiency of underspecification with a geometric analysis of features. For the most part, there is little change from the earlier finding, that there are many schemes which result in similar degrees of underspecification, and only a few highly efficient systems.

The degree of total underspecification of features is as follows:

(9)

| features eliminated | number of underspecification systems |
|---|---|
| 3 | 2768 |
| 2 | 16485 |
| 1 | 43968 |
| 0 | 36229 |

In other words, 2.7% of the sample eliminates the maximum number of features. One out of every 36 systems sampled eliminates the greatest number of features, in contrast to one out of every 9993 systems using an SPE-style specification of features.

### 3.4 Separating vowels and consonants

The size of the search can be further reduced by restricting possible redundancy relations which could result in deletion of features. This can be done by splitting the task of underspecifying the inventory of a language into two independent subtasks, namely underspecifying consonants and underspecifying vowels. As a further simplifying assumption, the glides [w] and [y] are not included in either subsystem: this has the benefit of not introducing otherwise unnecessary vocalic features into the consonantal system, and also eliminates the need to consider the property of syllabicity in the search of the vocalic subsystem. Two additional searches of underspecification systems were undertaken. The first was an exhaustive search of the 120 possible systems[10] for representing vowels, and the second was a search of 300,000 possible underspecification systems for consonants (where consonants are given a articulator-based analysis).

This search of vowel systems resulted in 54 distinct ways to specify the vowel system. The amount of underspecification is very restricted: underlying systems for vowels require between 34 and 38 values to represent English vowels.[11]

(10)

| N values | number of systems with N features |
|---|---|
| 34 | 17 |
| 35 | 8 |
| 36 | 15 |
| 37 | 12 |
| 38 | 2 |

[10]This represents 5!, which is the number of feature orders possible with the five features required to specify English vowels, namely [high], [low], [back], [round],and [tense].

[11]Again it must be remembered that this algorithm only identifies a subset of the underspecification systems which are found by the "any feature of any segment" algorithm. A sample of 90,000 feature orders using that method of searching resulted in 4,291 distinct ways to underspecify the English vowel system. Expanding the search to 900,000 orders uncovered 4,723 systems.

The search of consonants resulted in 81,639 unique underlying systems out of 300,000 searched. The range of feature specifications lies between 70 to 102. Given 193 surface feature specifications, this gives a range of 37% to 53%, with the mean at 42%. There were 28 highly efficient systems uncovered which employ only 70 features. Increasing the size of the search to 600,000 cases resulted in 105,361 distinct ways of underspecifying English consonants. These systems require between 70 and 103 feature specifications; in this set there are 34 systems employing the minimum number of feature values. This means that there are 578 distinct underlying systems of representation which have the same degree of minimal specification of features — any one of the 34 most efficient consonantal systems combined with any of the 17 most efficient vocalic systems.

### 3.5 Simplicity in Radical Underspecification

Underspecifying an inventory within the tenets of RU requires an additional layer of rules, namely context free rules supplying contrastive feature specifications. A system lacking only contrastive feature values can be mapped onto a set of RU-style representations by deleting the plus or the minus value for any feature. If there are $k$ features containing both plus and minus values under context sensitive underspecification, there are $2^k$ RU-style representations. Thus, the 12 context sensitive ways of underspecifying the vowel system [ieaou] can be transformed into 96 RU representations. Those systems would not all necessarily be distinct: in fact, 76 of those representations turn out to be distinct.[12]

The first substantial problem considered here is what the simplest RU specification is for the English phonemic inventory (adopting a geometric representation of consonant and vowel place features). Previous sections have noted that an exhaustive search of context sensitive underspecification systems for English is impractical since there are huge numbers of possibilities to consider. It is even less practical to perform an exhaustive search of possible RU systems, since there are approximately 32,000 times more RU representations.[13] So while there are around $1.2\times 10^{16}$ possibilities to consider using only context sensitive rules, there are about $3.8\times10^{20}$ possibilities with context free rules added.

One can approximate the properties of the entire set of RU systems by taking a large randomly selected set of systems which are subjected to context sensitive rules of underspecification, and subject them to a large random selection of patterns of context free underspecification. A computer program therefore randomly selected 1,000 context sensitive underspecified systems and for each of them searched 300 of the roughly 32,000 possible RU transformations. This resulted in 293,533 unique RU systems. The feature-elimination function for this sample is shown below.

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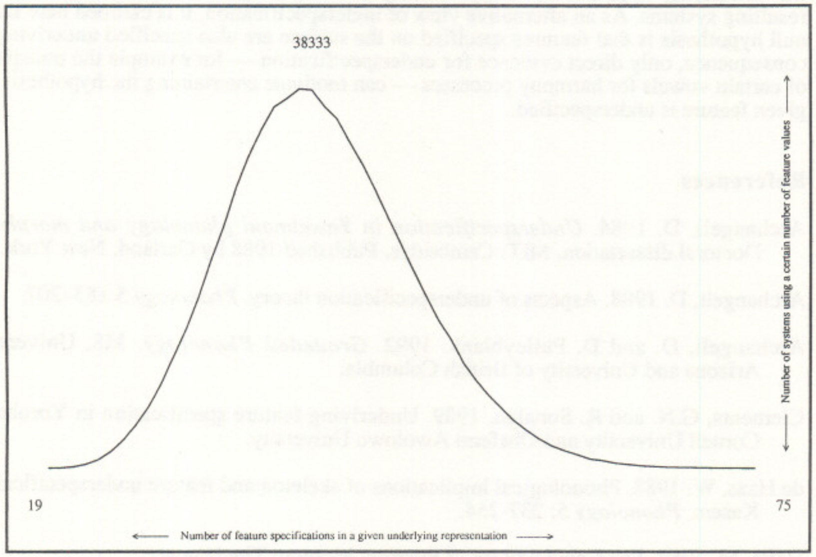
[12]Building on the less restrictive "any feature of any segment" algorithm which yields 50 underspecified systems, there is an upper limit of 672 RU-style representations for [ieaou], and of these 478 are distinct.

[13]On the average, 18 features are required to specify the segments of English. The three privative features [coronal], [labial] and [dorsal] are intrinsically "radically" underspecified. In effect, then, there are about 15 features subject to context free underspecification, hence the factor of 32,000.

(11) ELIMINATION OF FEATURES IN ENGLISH — RADICAL UNDERSPECIFICATION




It is obvious that this graph is essentially identical to previous graphs. The average number of features specified ranges from 51 to 120, with the mean at 74; 4 systems employ the minimum number of feature specifications. In other words, there is less than 1 chance in 70,000 of discovering one of these highly efficient systems.

This task was further broken down into separate searches of consonants and vowels. An exhaustive search of the 1,728 ways to specify the English vowel inventory was conducted,[14] and resulted in 1,060 distinct underlying systems of respresentation. These systems required between 13 and 25 feature specifications, with the average being 18. There were 4 systems which employed the minimum number of feature specifications.

An exhaustive search of RU-style representations of English consonants is impractical, so an approximation of this set was made by randomly selecting 1,000 CU systems and subjecting each to 900 randomly selected patterns of context free underspecification. This sample yielded 689,275 distinct systems using between 19 and 75 feature specifications, with an average of 41. There was one system employing 19 features: the probability of finding that system is obviously quite small.

## 4. Conclusions

A metaphor often applied to the task of learning a language is that the child constructs competing hypotheses and applies the simplicity metric to each, keeping only the most parsimonious grammar. The results of this study provide a reason to reject such a view of language acquisition, insofar as it applies to underspecification of a phonemic inventory. In order for the child scientist to be reasonably convinced of having discovered

[14]This is based on 32 RU transformations of the 54 CU-style representations for English vowels.

the most parsimonious system, the child would need to spend decades simply enumerating the competing hypotheses, to say nothing of comparing the formal simplicity of the resulting systems. As an alternative view of underspecification, it is claimed here that the null hypothesis is that features specified on the surface are also specified underlyingly. In consequence, only direct evidence for underspecification — for example the transparency of certain vowels for harmony processes — can motivate entertaining the hypothesis that a given feature is underspecified.

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# The Feature Pharyngeal in Rwaili Arabic: A Case for Long Distance Multiple Linking*

## 0. Introduction.

Rwaili is a Bedouin dialect of Arabic spoken in Northern Saudi Arabia (Prochazka 1988) similar to those described by Al-Mozainy (1981) and Irsheid (1984). This dialect has a rule of Raising which raises the first of a sequence of two *a*'s provided it is in an open syllable. This accounts for underlying /katab/ surfacing as [kitab] 'he wrote.' But this rule has a number of exceptions which may be divided into two groups, those like [gaʕad] 'he sat' and [ḥafar] 'he dug' in which the target vowel precedes or follows a guttural consonant, and those similar to [nzalan] 'she got down' where the following consonant is a coronal sonorant.

In this paper I will demonstrate that these forms are not exceptions, but are not predicted to undergo the dissimilatory process of Raising in accordance with the Linking Constraint as proposed by Hayes (1986). This analysis is dependent upon the specification of the vowel *a* as well as the group of consonants known as "gutturals" (McCarthy 1991) for the feature [pharyngeal]. In the [gaʕad] group of 'exceptions,' this feature is multiply linked by a language specific rule to both the potential target vowel and the neighboring guttural. For the [nzalan] group, the two vowels are multiply linked to each other. This analysis depends crucially upon the proposal of coronal transparency discussed by Paradis and Prunet (1989, and elsewhere). I will show, however, that in Rwaili not all coronal consonants show transparency, only the sonorants are afforded this special status.

The organization of the paper is as follows: in §1 the phonology and morphology are described with particular attention paid to the processes accounting for vowel alternations. Discussion of the forms not undergoing Raising is provided in §2 as well as an outline of the Linking Constraint and coronal transparency. In §3 Paradis and Prunet's proposal of coronal transparency is reevaluated and some modifications suggested. Semitic root cooccurrence restrictions are outlined in §4 with discussion of their apparent incompatability to coronal transparency.

## 1. Phonology of Rwaili Arabic.

The phonemic inventory of Rwaili contains six guttural consonants *x*, *ġ*, *ḥ*, *ʕ*, *h*, and *ʔ*, three emphatics *ṭ*, *ð̣*, and *ṣ*, as well as more common segments listed in (1) below. The

* I would like to thank the many people whose comments generously contributed to this paper including Mary Beckman, Beth Hume, Nasiombe Mutonyi, David Odden, Lisa Selkirk, Jennifer Venditti, and Dieter Wanner. However, any errors are my own.

only consonants which are both sonorant and coronal are *n*, *r*, and *l*. Rwaili also has the vowels *a*, *i*, and *u* and the glides *y* and *w*.

1. Consonants of Rwaili Arabic.

| | labial | interdental | dental | alveolar | velar | uvular | pharyngeal | laryngeal |
|---|---|---|---|---|---|---|---|---|
| stops | b | | ṭ t d | | k g | | | ʔ |
| fricatives | f v | ð ð̣ | ṣ s z | | | x ġ | ḥ ʕ | h |
| nasals | m | | n | | | | | |
| liquids | | | l | r | | | | |

## 1.1 The Morphology of Rwaili.

The morphology of Rwaili is comprised of both affixes and nonconcatenative vowel alternations. Verbs consist of a consonantal root, a vocalic melody, and an optional affix depending on the binyan and the grammatical person. The third person masculine singular (3ms) form of 'to write' in the Active Perfective tense is [kitab] from the consonantal root of *ktb*, an underlying vocalism of /a/[1], and no affixes. The 3fs form of the same verb is [ktibat] from the same consonantal root and vocalism and the suffix *-at*. The deletion of the vowels as well as their alternation in quality are predictable by rules which will be discussed below.

2. Active Perfective of *k t b* 'to write'

| | singular | plural |
|---|---|---|
| 3m | kitab | ktibam |
| 3f | ktibat | ktiban |
| 2m | kitabt | kitabtam |
| 2f | kitabtay | kitabtan |
| 1 | kitabt | kitabna |

From the forms in (2) the endings in (3) can be discerned. Those suffixes which are vowel initial pattern together and are called vocalic endings while those which are consonant initial or null, as the 3ms, are called consonantal endings. This distinction becomes important to rules which are sensitive to syllable structure as the vocalic endings will cause the stem final syllable to be 'open' while the consonantal endings will not affect the syllabification of the stem.

[1] An underlying vocalism of /a/ will appear on the surface as *a C a* in accordance to McCarthy's (1981) analysis of Classical Arabic.

3. Endings for the Active Perfective.

| | singular | plural |
|---|---|---|
| 3m | -ø | -am |
| 3f | -at | -an |
| 2m | -t | -tam |
| 2f | -tay | -tan |
| 1 | -t | -na |

There is some variation in these endings, most of which is phonological. For example, the final consonant in the 3mp suffix varies with *w* so that *ktibam* alternates with *ktibaw*. However, these variations are not within the scope of this paper. Within the active perfective, there is variation in the vocalism which is of interest. All verbs fall into one of two categories with respect to the active perfective, those which take *a a* as their underlying vocalic melody, and those which take *a i*. This distinction has traditionally been denoted with the terms *faʕala* and *faʕila*, respectively. The verb 'to write,' *ktb* is of the *faʕala* class while *smʕ*, 'to hear,' is a *faʕila* verb as illustrated in (4).

4.

| | faʕala 'to write' | faʕila 'to hear' |
|---|---|---|
| 3ms | kitab | simiʕ |
| 3fs | ktibat | samʕat |
| 3mp | ktibam | samʕam |
| 3fp | ktiban | samʕan |
| 2ms | kitabt | simiʕt |
| 2fs | kitabtay | simiʕtay |
| 2mp | kitabtam | simiʕtam |
| 2fp | kitabtan | simiʕtan |
| 1s | kitabt | simiʕt |
| 1p | kitabna | simiʕna |

## 1.2. *i* Deletion.

The *faʕala* vs *faʕila* distinction is most important for the process of *i* Deletion which is sensative to syllable structure and vocalic quality. This process is motivated by the *i* ~ ø alternation seen in (4) and will be discussed later. The *faʕala* vs *faʕila* distinction does not exist in the passive as shown in (5) below.

5. The Passive Perfective.

| *ḥ m l* 'to carry' | *š r b* 'to tie' | *ʕ z m* 'to invite' | *l b s* 'to wear' |
|---|---|---|---|
| ḥmil | šrib | ʕzim | lbis |
| ḥimlat | širbat | ʕizmat | libsat |
| ḥimlaw | širbaw | | |
| ḥimlan | širban | ʕizman | libsan |

The forms in (5) of the passive show no alternation in vowel quality; where the stem vowel surfaces, it is always *i*. It can be assumed, then, that the underlying vocalism is /i/. The distinction between forms like [ḥmil] in which the first stem vowel is deleted and those like [ḥimlat] where it is the second stem vowel that deletes, is that the former has a consonantal ending added where the latter has a vocalic ending added. This suggests that deletion is sensitive to syllable structure such that the vowel is lost in an open syllable.

It is not true that all vowels are lost in an open syllable as evidenced by the forms [kitab] and [simiʕ], in the active perfective. This can be explained if deletion is limited to the underlying vowel *i* since in both [ḥmil] and [ḥimlat] the deleted vowel is *i* underlyingly. If the deletion is restricted to the vowel *i*, then the initial vowel in [kitab] and [simiʕ] must be *a* underlyingly. This process, which will be called *i* Deletion, deletes the vowel *i* when it appears in an open syllable. This process applies from right to left since it is the rightmost *i* in an open syllable which is lost where two *i*'s appear in open syllables in the same word. This is shown in the derivation of the passive /ḥimilat/ --> [ḥimlat]. Similar alternations are seen in (6).

6. *i* Deletion and the Passive Perfective.

| stem | 3ms | 2ms | 3fs | gloss |
|---|---|---|---|---|
| | -ø | -t | -at | |
| /ḥimil-/ | ḥmil | ḥmilt | ḥimlat | 'was carried' |
| /ḥizim-/ | ḥzim | ḥzimt | ḥizmat | 'was tied' |
| /širib-/ | šrib | šribt | širbat | 'was drunk' |
| /ʕizim-/ | ʕzim | ʕzimt | ʕizmat | 'was invited' |
| /ḥifir-/ | ḥfir | | ḥifrat | 'was dug' |
| /xizin-/ | xzin | | xiznat | 'was stored' |
| /libis-/ | lbis | | libsat | 'was worn' |

Since the second stem vowel is lost in active forms like [samʕat] and [samʕan] in (4 & 7) where a vocalic ending is added to the stem *smʕ*, it must be *i* in the underlying representation. This is supported by the fact that where the second stem vowel does surface for this verb, it is *i*. The first stem vowel alternates from *a* to *i*, but is never deleted. This indicates that the vowel cannot be *i* underlyingly since this vowel would be lost in open syllables as in [simiʕ]. Instead, the first stem vowel must be an *a* underlyingly, and the alternation of *a* to *i* is accounted for by another process which will be discussed below.

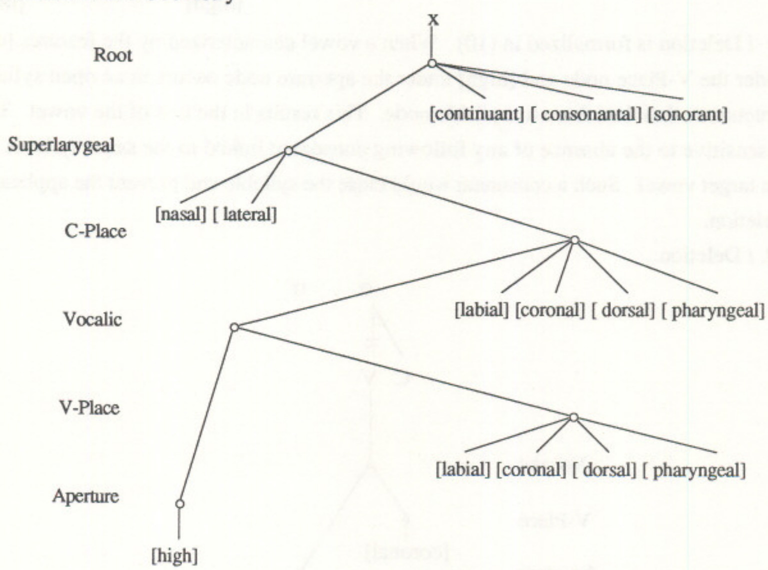
7. The Active Perfective of *faʕila* Verbs.

| stem | 3ms | 2ms | 3fs | gloss |
|---|---|---|---|---|
| | -ø | -t | -at | |
| /samiʕ-/ | simiʕ | simiʕt | samʕat | 'heard' |
| /šarib-/ | širib | širibt | šarbat | 'drank' |
| /labis-/ | libis | libist | labsat | 'wore' |
| /zaʕil-/ | ziʕil | ziʕilt | zaʕlat | 'became upset' |
| /gadir-/ | gidir | gidirt | | 'was able to' |
| /cabir-/ | cibir | | cabrat | 'became big' |

For each form in (7), the first stem vowel is not lost because it is not /i/ underlyingly. In those cases where a vocalic ending is added to the root, the second stem syllable is opened. Since the second stem vowel is /i/, it is deleted in these instances. Otherwise, the second stem syllable remains closed so that deletion does not occur.

I assume a model of feature organization similar to that developed in the work of Clements (1989, 1991), Herzallah (1990), and Hume (1992). Within this framework, vowels are exclusively characterized by the Vocalic node. This node dominates both V-Place and Aperture which designate the place of articulation and height of the vowel, respectively. Here, [high] coresponds to [-open] in the Clements framework.

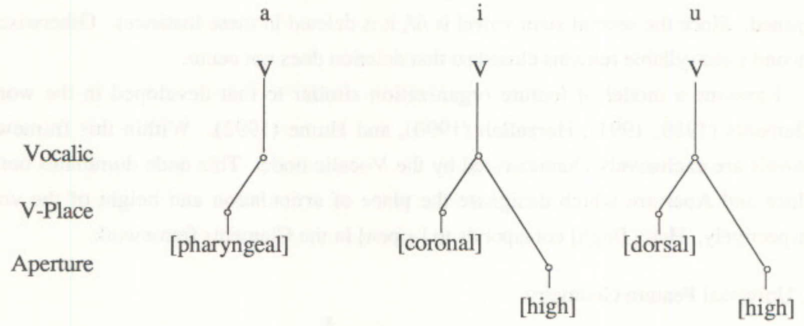
8. Universal Feature Geometry




The vowels *a*, *i*, and *u* are represented in (9) where the vowel *a* is characterized by the feature [pharyngeal] beneath the V-Place node and is not specified by the feature [high]. The remaining vowels are both characterized by [high] beneath the Aperture node, and are distinguished by their place of articulation under V-Place.

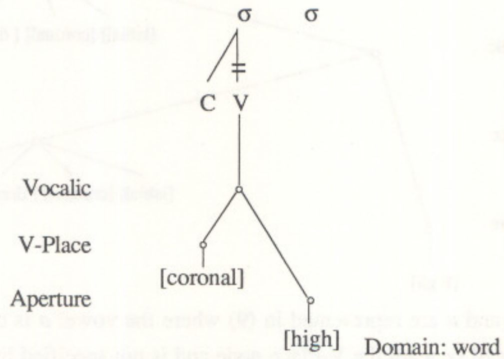
There are language specific redundancy rules which ensure that all dorsal vowels also have a labial (i.e. round) articulation, and that all pharyngeal vowels have a secondary coronal articulation so that they are actually pronounced [æ]. These secondary articulations do not play a role in the phonology, and are beyond the scope of this paper.

9.




*i* Deletion is formalized in (10). When a vowel characterized by the features [coronal] under the V-Place node and [high] under the aperture node occurs in an open syllable, the structure is delinked from its syllable node. This results in the loss of the vowel. This rule is sensitive to the absence of any following consonant linked to the same syllable node as the target vowel. Such a consonant would close the syllable and prevent the application of *i* Deletion.

10. *i* Deletion.




The inclusion of the following syllable within the same word in (10) is crucial to correctly deriving forms like [nisi] 'he forgot' and [diri] 'he knew' from /nasi/ and /dari/ respectively. These forms lack a final consonant so that the final syllable, headed by *i*, is open but does not undergo *i* Deletion.

Underlying *a* in forms like /samiʕ/ does not undergo *i* Deletion since it is specified for [pharyngeal] rather than [coronal] beneath the V-Place node. The stipulation of [coronal] in (10) restricts its application to *i*.

| 11. Derivations. | a. | b. | c. | d. |
|---|---|---|---|---|
| UR | /samiʕ/ | /samiʕ-at/ | /ḥimil/ | /ḥimilat/ |
| *i* Deletion | --- | samʕat | ḥmil | ḥimlat |
| *a* to *i* | simiʕ | --- | --- | --- |
| | 'he heard' | 'she heard' | 'he was carried' | 'she was carried' |

Some derivations are provided in (11) where *i* Deletion fails to apply to underlying /samiʕ/ (11a) since the *i* occurs in an closed syllable in contrast to underlying (11b) /samiʕ-at/ where the *i* appears in an open syllable and is lost. The process which changes *a* to *i* will be discussed below. The process of *i* Deletion applies in each of the two passive forms (11c, d), each time to the rightmost open syllable.

### 1.3. Coronal Spread.

In deriving /samiʕ/ --> [simiʕ] (11.a) an additional process is required which changes *a* to *i*. This process does not occur in forms like [samʕat] in which *i* Deletion has taken place. This pattern is seen in (12) below.

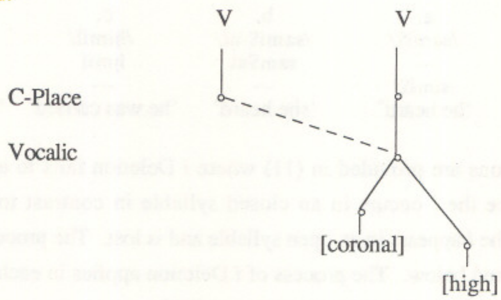
12. *a* Changes to *i* — No Change Takes Place

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3ms | /samiʕ/ | --> | simiʕ | 3fs | /samiʕ-at/ | --> | samʕat | 'hear' |
| 2ms | /samiʕt/ | --> | simiʕt | 3mp | /samiʕ-am/ | --> | samʕam | " |
| 3ms | /ʕarif/ | --> | ʕirif | 3fs | /ʕarif-at/ | --> | ʕarfat | 'know' |
| 3ms | /racib/ | --> | rićib | 3fs | /racib-at/ | --> | racbat | 'ride' |
| 3ms | /šarib/ | --> | širib | 3fs | /šarib-at/ | --> | šarbat | 'drink' |

This might lead one to suspect that the process involves syllable structure such that the process does not apply in closed syllables. This would explain its application in [simiʕ] and non-application in [samʕat]. However, this fails to explain the occurrence of the stem initial *i* in the form 'he heard him' in which the suffix *-ih* is added to the stem, /samiʕ-ih/ --> [simʕih]. In this case, a vocalic ending is added so that the second stem vowel is lost, closing the first syllable, but the process applies anyway.

The crucial generalization is that the process applies whenever an *i* occurs to the right of the target *a*. This suggests an assimilation which spreads [coronal] from *i* leftward to *a*. This rule is not sensitive to syllable structure as it applies both in an open syllable, [simiʕ], and a closed syllable, [simʕih]. The process of [coronal] Spread is formalized in (13) below.

13.Coronal Spread.




The derivations in (13) demonstrate that Coronal Spread must be ordered after *i* Deletion since the deleted coronal vowel in [samʕat] does not trigger the process, establishing a bleeding relationship.

13. Derivations.

| | | | |
|---|---|---|---|
| UR | /samiʕ/ | /samiʕ-at/ | /samiʕ-ih/ |
| *i* Deletion | --- | samʕat | samʕih |
| Coronal Spread | simiʕ | --- | simʕih |

So far, the vocalism for the passive has been established as /i/ and the deletion of the stem vowel for these forms has been accounted for by the process of *i* Deletion in which the coronal vowel is deleted in a non-final, open syllable. Similarly, the vocalic melody for *faʕila* verbs was shown to be *a i* and the second stem vowel is again succeptable to *i* Deletion. The change of the inital stem vowel to *i* is accounted for by the process of Coronal Spread which raises an *a* when followed by an *i*.

## 1.4. Syncope.

In forms like [kitab] 'he wrote,' the underlying vocalic melody cannot be /i/ since the second stem vowel is not deleted in forms containing a vocalic ending such as [ktibat] 'she wrote.' In this case, the first stem vowel is lost. If the vocalism were the same as in *faʕila* verbs, then the same pattern of alternations would be expected and the 3fs form would be *[katbat] which does not occur.

Nor could the first stem vowel be *i* since this vowel is not lost in the 3ms form [kitab]. If this vowel were *i* in the underlying representation, it would be lost due to *i* Deletion yielding *[ktab] which is also incorrect. This leaves only the vocalism *a a* for *faʕala* verbs. Positing this underlying vocalism makes the prediciton that neither vowel will be lost to *i* Deletion. However, since the first stem vowel is lost in forms to which vocalic endings are added, there must be another process which deletes that vowel to derive /katab-at/ --> [ktibat].

In (15) it appears that this process, Syncope, applies when a vocalic ending is suffixed to the root. For each form in (15.a) the vowel initial suffix opens the second stem syllable creating a sequence of two open syllables. In this environment, the nucleus of the first open syllable is lost. In (15.b), the ending is consonantal, so the syllable structure of the root is unaffected and no deletion takes place.

15.a. Syncope Applies

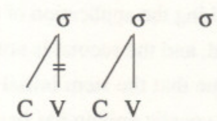
| | | | |
|---|---|---|---|
| /katab-at/ | --> | ktibat | 3fs |
| /katab-an/ | --> | ktiban | 3fp |
| /katab-am/ | --> | ktibam | 3mp |

15.b. Syncope Fails

| | | | |
|---|---|---|---|
| /katab-ø/ | --> | kitab | 3ms |
| /katab-t/ | --> | kitabt | 2ms |
| /katab-na/ | --> | kitabna | 1p |

Syncope is formalized in (16) below where in a sequence of two consecutive open syllables the first vowel is delinked from its syllable and thus lost to stray erasure. This rule is insensitive to the vowel quality of either syllable.

16. Syncope.




The third syllable stipulated in (16) to prevent the application of Syncope on forms such as [nisi] 'he knew' and [miša] 'he went' which are bisyllabic. Since both syllables are open in these forms, Syncope would apply if the third syllable were not mentioned in the structural description of the rule.

Syncope must apply after *i* Deletion to correctly derive forms like [simʕat] 'she heard.' The underlying repersentation meets the structural description of both rules since there is both a sequence of two, non-final open syllables, and an *i* in an open syllable /samiʕ-at/. Since it is the *i* which is lost and not the *a*, it is clear that *i* Deletion applies.

17. a.

| | |
|---|---|
| UR | /samiʕ-at/ |
| Syncope | smiʕat |
| *i* Deletion | --- |
| Coronal Spread | --- |
| | *[smiʕat] |

b.

| | |
|---|---|
| UR | /samiʕ-at/ |
| *i* Deletion | samʕat |
| Syncope | --- |
| Coronal Spread | --- |
| | [simʕat] |

The two possible orders are given in (17) above. Where Syncope precedes *i* Deletion (17.a), the incorrect form *[smiʕat] is derived. The derivation in (17.b) illustrates that the proper ordering correctly derives the surface form [simʕat].

## 1.5 Raising.

The form [kitab] which is derived from /katab/ demonstrates that there is another rule of Raising which changes underlying *a* to *i* . The process applies in each form in (18) as well as /ðabaḥ/ --> [ðibaḥ] 'he killed' and /sakatat/ --> [skitat] 'she stopped talking' showing this process to be pervasive. This change cannot be attributed to Coronal Spread since there is no coronal vowel in the underlying representation to which the stem initial *a* may assimilate.

18.

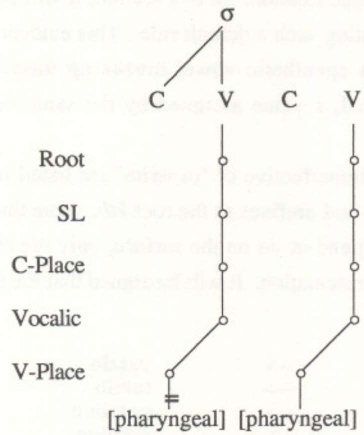
| | singular | | | plural | | |
|---|---|---|---|---|---|---|
| 3m | /katab/ | --> | kitab | /katab-am/ | --> | ktibam |
| 3f | /katab-at/ | --> | ktibat | /katab-an/ | --> | ktiban |
| 2m | /katab-t/ | --> | kitabt | /katab-tam/ | --> | kitabtam |
| 2f | /katab-tay/ | --> | kitabtay | /katab-tan/ | --> | kitabtan |
| 1 | /katab-t/ | --> | kitabt | /katab-na/ | --> | kitabna |

In the form [kitabtan] which is derived from /katab-tan/, it is observed that neither stem vowel is deleted. *i* Deletion cannot apply as there are no coronal vowels in the stem underlyingly, and Syncope cannot apply since a consonantal ending is added, rendering the stem final syllable closed and blocking the application of (16). Of interest here is that of the two stem vowels, the first is raised, and the second is not.

It would be incorrect to assume that the stem initial vowel is always raised since it is deleted in those forms to which a vocalic ending has been added, and in those same forms it is the second root vowel which is raised. Instead, the generalization is that the pharyngeal vowel is raised in an open syllable, when followed by another *a*. This explains why the first, but not the second *a* raises in /katab-tan/ --> [kitabtan] as well as why the final vowel in [kitabna] does not raise in spite of appearing in an open syllable.

While the process of Coronal Spread is assimilatory, Raising (19) is a process of dissimilation. Here, the occurrence of two pharyngeal vowels triggers the raising of the first. This is accomplished by the delinking of the feature [pharyngeal] from the first vowel which is later filled in by default with the value [coronal]. This default rule is independently motivated below in §1.6.

19. Raising.




The two processes also differ in sensitivity to syllable structure such that Coronal Spread raises a vowel in an open or closed syllable as the derivations in (20) demonstrate. In /samiʕ/ -> [simiʕ] the target vowel is in an open syllable and in /samiʕ-ih/ -> [simʕih] it appears in a closed syllable, yet undergoes the rule. In the forms [kitabtay] and [kitabtan], there appear two adjacent syllables headed by *a*, yet there is no dissimilation as the target vowel appears in a closed syllable.

20.

| | | | |
|---|---|---|---|
| UR | /samiʕ-ih/ | /katab-tan/ | katab-at |
| *i* Deletion | samʕih | --- | --- |
| Syncope | --- | --- | ktabat |
| Coronal Spread | simʕih | --- | --- |
| Raising | --- | kitabtan | ktibat |

So while the two processes of Coronal Spread and Raising have the same effect of changing an *a* to an *i*, they are distinct in their implementation. This is clear from the environments in which they may apply since Coronal Spread is insensitive to the syllable structure of the target while Raising applies only to open syllables. The two also differ in that Coronal Spread (13) is assimilatory, spreading the Vocalic node of *i* to a vowel to its left. The formalization makes no mention of the quality of the target vowel. In Raising, which is a process of dissimilation, the occurrence of identical, adjacent Vocalic nodes is avoided by delinking the first if it appears in an open syllable. Raising requires the stipulation in the formalism, (19), that both target and trigger be [pharyngeal].

### 1.6. Epenthesis and Default [coronal].

In the previous section, a default rule was assumed which fills in the value [coronal] for a vowel with no V-Place specification. In this section, it will be shown that independent evidence exists for postulating such a default rule. This evidence comes from the Active Imperfective in which an epenthetic vowel breaks up unsyllabifiable clusters. The epenthetic vowel is coronal, a value assigned by the same default rule necessary for Raising.

Forms for the Active Imperfective of 'to write' are listed in (21). This paradigm is formed by adding suffixes and prefixes to the root *ktb*. Note that while both the 3fs from [taktíbin] and 2fs [taktbín] end in *-in* on the surface, only the latter contains the suffixal vowel in its underlying representation. It will be argued that the presence of *i* in the former is the result of epenthesis.

| | | | | |
|---|---|---|---|---|
| 21. | 3ms | /ya-ktib/ | --> | yaktíb |
| | 3fs | /ta-ktib/ | --> | taktíb |
| | 3fp | /ya-ktib-n/ | --> | yaktíbin |
| | 2fp | /ta-ktib-n/ | --> | taktíbin |
| | 2fs | /ta-ktib-in/ | --> | taktbín |

In the 2fp form [taktíbin] the presence of the stem vowel indicates that no deletion has applied, whereas the absence of a stem vowel in 2fs [taktbín] is due to the application of *i* Deletion. In order for *i* Deletion not to apply in the case of [taktíbin], the stem vowel must not appear in a non-final open syllable. Since syllabification of the surface form is such that the stem vowel appears to meet the structural description of *i* Deletion: *tak.tí.bin*, an underlying representation in which the stem vowel is not in an open syllable must be assumed. The derivations in (22) make this point clear.

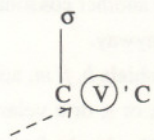
| 22. | | 3fs | 2fp | 2fs |
|---|---|---|---|---|
| | | ta-ktib | ta-ktib-n | ta-ktib-in |
| | *i* Deletion | --- | --- | taktbin |
| | Syncope | --- | --- | --- |
| | Stress | taktíb | taktíbn | taktbín |
| | Epenthesis | --- | taktíbin | --- |

In the derivation of [taktbín], the stem vowel is deleted since the structural description of *i* Deletion is met. The different surface forms of the two verbs, [taktbín] and [taktíbin], results from the absence and presence of the suffixal *i*. This is predicted since the vocalic ending *-in* will make the stem syllable while the affixation of the consonantal ending *-n* allows the stem syllable to remain closed. This suggests that the second *i* in [taktíbin]was inserted by epenthesis after *i* Deletion would have applied.

Confirmation of this analysis is found in stress assignment for these forms. Stress is predictable in Rwaili, falling on the rightmost closed syllable. In this way, 'he wrote' will have stress on its final syllable, [kitáb], and similarly in 'she wrote,' [ktibát]. The stess in the word [taktíbin] appears to violate this generalization since the rightmost, closed syllable is unstressed with stress falling on the second from last syllable. If we assume that stress is assigned after *i* Deletion and Syncope but before Epenthesis as in (22), then the stress pattern of [taktíbin] is accounted for. In this case, the *i* of the final syllable is not present when stress is assigned, and therefore leaves the stem vowel as the rightmost vowel and receives stress.

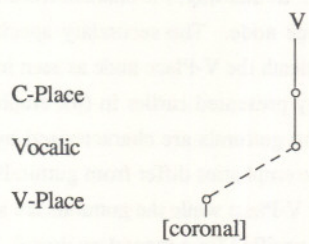
The process of Epenthesis (23) is triggered by the presence of an unsyllabified element. In forms like /ya-ktib-n/, the final *n* cannot be syllabified to the syllable *tib* since the coda *-bn* would violate a stipulation that the more sonorous *n* be nearer the nucleus than the obstruent *b*. Since this renders the *n* unsyllabified, an epenthetic vowel is inserted to resolve the conflict.

23. Epenthesis.




The quality of the epenthetic vowel is determined by Default which ensures that the inserted vowel is *i*. This rule, (24), instantiates the value [coronal] to a Vocalic node which lacks a specification for V-Place. An additional redundancy rule states that all coronal[2] vowels also be specified for [high] beneath the Aperture node.

24. Default Coronal.




In deriving a verb like [yaktíbin] 'they (f) write' from /ya-ktib-n/, syllabification would license the syllables *ya* and *ktib*, but would render the final *n* extrasyllabic. In this case, Epenthesis would provide a V-slot which would serve as a syllabic nucleus to which *n*

---

[2] Since the vowel /a/ surfaces with a coronal specification (c.f. §1.2), we must assume that this redundancy rule applies before /a/ -> [æ], or that it applies to vowels specified *only* for coronal beneath V-Place.

could syllabified yeilding /yakatíbVn/. The rule of Default Coronal would then fill in a value for the empty V-slot so that *i* will surface in [yaktíbin].

### 1.7. Backing.

The surface form [ṣumal] contains an *u* while neither the *faʕala* nor *faʕila* paradigms contain this vowel. It is incorrect to assume that the *u* exists in the underlying representations of forms like [ṣumal] since it can be predicted from neighboring consonants.

| | | | | |
|---|---|---|---|---|
| 25.a. | wugaf | 'he stopped' | ṭubax | 'he cooked' |
| | ṣubar | 'he waited' | | |
| | ṣumal | 'he was steadfast' | wuṣil | 'he arrived' |
| b. | rubaṭ | 'he tied' | wgufat | 'she stopped' |
| | rubṭat | 'she was tied' | ð̣rubat | 'she hit' |

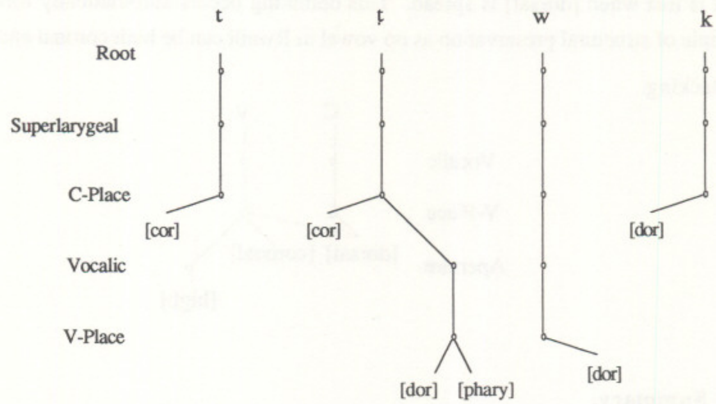
In each form in (25.a) the *u* surfaces adjacent to an emphatic or *w*. However, this is not true for the forms in (25.b) where another consonant intervenes between the emphatics and the target vowel, yet *u* surfaces anyway.

Prochazka (1988:20) states that labials *b*, *f*, *m*, and the liquids *l* and *r* are phonetically emphatic when a true emphatic, *ṭ*, *ð̣*, or *ṣ*, or a velar consonant occurs in the same root. This predicts the pronunciation of [ṣubar] to be [ṣuḅaṛ] when more narrowly transcribed. The forms [rubaṭ] and [rubṭat] indicate that these 'derived' emphatics may also trigger the occurrence of *u* since there are no 'true' emphatics adjacent to the target vowel.

The structure of an emphatic consonant is such that it has both primary and secondary specifications. The primary specification is dominated by C-Place and is determined by the primary place of articulation. In this way, *ṭ* is characterized by a primary specification of [coronal] beneath the C-Place node. The secondary specification for all emphatics is [dorsal] and [pharyngeal] beneath the V-Place node as seen in (26).

In the universal geometry presented earlier in (8), emphatics are characterized as in (26). Both the emphatics and gutturals are characterized by the feature [pharyngeal] as discussed in §2.1 below. The emphatics differ from gutturals in that their specification of [pharyngeal] is dominated by V-Place while the gutturals are so specified under the C-Place node. The dorsal glide *w* is specified for a secondary dorsal.

26.




The emphatics are also specified for secondary dorsal. Velars are also specified for dorsal, but under the C-Place node. Since the emphatics and *w* act as a natural class in triggering the occurrence of *u*, they must share some structure. The structure they share is the specification of [dorsal] beneath V-Place. For this reason, this process, which we shall call Backing, must involve the feature dorsal under V-Place.

In addition to occurring only near a consonant with a secondary dorsal specification, Backing affects only the vowel *i*. The data in (28) illustrate this as in each of these forms, the *u* appears where *i* is expected as the product of Raising. Additonally, the form [waṣlat] from /waṣilat/ indicates that where the underlying *a* remains, Backing does not apply.

| 28. | UR | deletions | Raising | Backing | |
|---|---|---|---|---|---|
| | ṣamal | --- | ṣimal | ṣumal | 'he was steadfast' |
| | ð̣arabat | ð̣rabat | ð̣ribat | ð̣rubat | 'she hit' |
| | wazan | --- | wizan | wuzan | 'he weighed' |
| | rabaṭ | --- | ribaṭ | rubaṭ | 'he tied' |
| | rabaṭat | rbaṭat | rbiṭat | rbuṭat | 'she tied' |

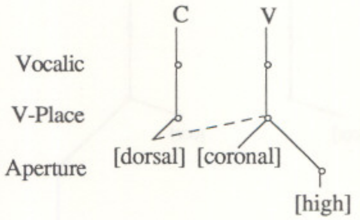
It is a coincidence that there does not exist a form in which Backing occurs which does not also contain a labial. This might lead to the conclusion that it is the feature [labial] which is being spread to derive *u*. This cannot be correct as the data below demonstrate. Here, labials occur without the appearance of *u*.

| 27. | simiʕ | 'he heard' | * sumiʕ |
|---|---|---|---|
| | širib | 'he drank' | * šurib |
| | šrib | 'it (m) was drunk' | * šrub |
| | libis | 'he wore' | * lubis |

Backing is formalized in (29) where a V-Place specification for [dorsal] is spread to a vowel, if specified for [high] under the Aperture node. The existing specification for V-

Place is lost when [dorsal] is spread. This delinking occurs automatically following the principle of structural preservation as no vowel in Rwaili can be both coronal and dorsal.

29. Backing.




### 1.8. Summary.

To this point, the processes of *i* Deletion, Syncope, Coronal Spread, Epenthesis, Default Coronal, Raising, and Backing have been described and motivated. Crucial ordering stipulations require *i* Deletion to apply before Syncope, and that *i* Deletion applies before Coronal Spread. It is also necessary that Raising apply before Backing. Some sample derivations are provided in (30).

30.

| | katab<br>he wrote | katabat<br>she wrote | samiʕ<br>he heard | samiʕat<br>she heard | ðarab<br>he hit | ðarabat<br>she hit |
|---|---|---|---|---|---|---|
| *i* Deletion | --- | --- | --- | samʕat | --- | --- |
| Syncope | --- | ktabat | --- | --- | --- | ðrabat |
| C-Spread | --- | --- | simiʕ | --- | --- | --- |
| Raising | kitab | ktibat | --- | --- | ðirab | ðribat |
| Backing | --- | --- | --- | --- | ðurab | ðrubat |

## 2. Exceptions to Raising.

There are a large number of forms in which an *a* appears in a non-final open syllable. The forms included in the representative list in (31) would seem to be exceptions to Raising, but are in fact accountable by appealing to established phonological principles.

31. Apparent Execptions to Raising.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a. | gʕadat | 3fs | 'sit' | b. | ḥalab | 3ms | 'kill' |
| | gaʕad | 3ms | 'sit' | | ġsalat | 3fs | 'catch' |
| | ðbaḥat | 3fs | 'kill | | nxalat | 3fs | 'sift'' |
| | ṭbaxat | 3fs | 'cook' | | nzalan | 3fp | 'get down' |
| | naxal | 3ms | 'sift' | | ḥfarat | 3fs | 'dig' |
| | ġasal | 3ms | 'catch' | | ðarab | 3ms | 'hit' |
| | hadaf | 3ms | 'return' | | ṣbarat | 3fs | 'wait' |
| | ḥazam | 3ms | 'milk' | | wzanat | 3fs | 'weigh' |
| | ḥafar | 3ms | 'dig' | | | | |

These forms can be divided into two groups, one (31.a) in which a consonant adjacent to the target vowel is a guttural, like [naxal], and one (31.b) where the consonant between the two vowels is a coronal sonorant like [nzalan]. The basis for this grouping will be shown to provide an account for the failure of these forms to undergo Raising.

### 2.1. The Gutturals and the Feature [pharyngeal].

The first stem vowel in the forms in (31.a) is *a* where *i* is expected. In this group, each *a* which fails to undergo Raising is adjacent to a uvular consonant as in [naxal] 'he sifted' and [ġasal] 'he caught,' a pharyngeal as in [gʕadat] 'she sat' and [ħamal] 'he carried,' or a laryngeal as in [hadaf] 'he returned in the evening.' When the target vowel is not adjacent to a guttural, the same verb will undergo Raising as the form [hdifat] 'she returned in the evening' indicates.

McCarthy (1991) motivates the grouping of uvular, pharyngeal, and laryngeal consonants into a natural class, which he calls gutturals. He demonstrates that the segments *x, ġ, ħ, ʕ, ʔ, h,* and *a* function as phonological class in Semitic languages as well as showing that they share some phonetic properties. The SPE system of distinctive features (Chomsky and Halle 1968) and many models of feature geometry such as the model proposed by Sagey (1986) cannot characterize all and only these segments into a natural class. For this reason, McCarthy proposes the feature [pharyngeal] be used to denote the natural class of gutturals.

Others have also recognized the need to group the gutturals into a natural class. Clements (1989) does so by specifying these segments with the feature [radical]. Clements includes this feature under both the C-Place and V-Place nodes so that the feature [radical] (i.e. pharyngeal) may characterize both consonants and vowels. In this approach, the vowel *a* would be included in the natural class of gutturals.

Herzallah (1990) also provides X-Ray evidence which suggests that the gutturals and *a* share the place of articulation, rather than an articulator. She also argues against the feature [+low] for *a* since the tongue body is actually raised and backed in producing this vowel. Instead, she posits the feature [pharyngeal] to characterize both *a* and the guttural consonants in her account of Palestinian Arabic.

Hume (1992) groups the gutturals and *a* into a natural class denoted by the feature [pharyngeal] in her account of Maltese Arabic. The guttural consonants act as a phonological class in the process of Guttural Assimilation where *i* becomes *a* in the vicinity of a guttural. In her account, this is accomplished by spreading the feature [pharyngeal] from the consonant to the vowel so that /liħiʔ/ becomes [laħaʔ] 'he reached' (1992:224-26).

In Rwaili, the guttural consonants also act as a natural class in blocking Raising. This is accomplished by a language specific rule which fuses the feature [pharyngeal] between a guttural consonant and a neighboring *a*. The resulting structure contains a single occurrence of [pharyngeal] which is multiply linked to both the vowel and the consonant.

This structure becomes resistant to certain types of processes as predicted by the Linking Constraint.

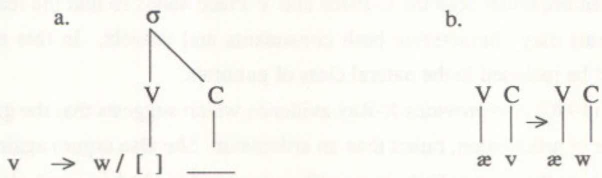
**2.2. Inalterability and the Linking Constraint.**

Hayes (1986a and 1986b), as well as others (e.g. Schein and Steriade (1896)), recognize geminates as special structures. Generally, two segments which share some or all of their features are called geminates. These pairs of segments then behave differently than a single segment bearing the same features in that geminates resist several types of processes such as epenthesis. Hayes accounts for this by proposing the Linking Constraint by which a given phonological process is restricted in its application to apply only to structures which share the number of association lines specified in the rule.

32. The Linking Constraint.
Association lines in structural descriptions are interpreted as exhaustive. (Hayes 1986b:331)

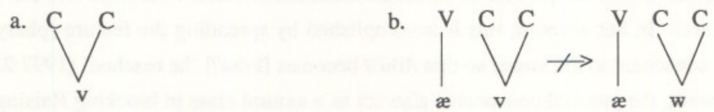
Hayes (1986b) provides an example of this phenomenon where the Linking Constraint blocks the application of *v* Weakening (33.a) in Persian. This process will change *v* to *w* when preceded by a vowel. The application of *v* Weakening, illustrated in (33.b), accounts for the consonant alternation in the derivation of /boræv/ to [borow] 'go.'

33.



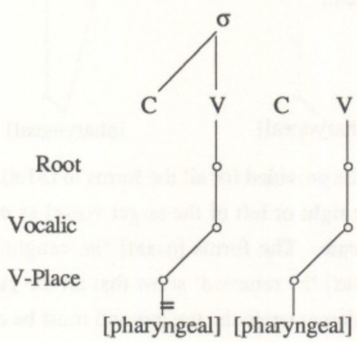

This rule does not apply to structures in which the target *v* is a geminate as in [marovvæt] 'generosity'. Here, a single specification for *v* is multiply linked to two C slots as in (34.a) Since the structural description of the rule (33.a) mentions only a single association line, *v* Weakening can not apply to this form (34.b)

34.




The Rwaili words like [naxal] listed in (31.a) where an adjacent guttural blocks Raising are examples of the Linking Constraint restricting the application of a process to structures identical to those mentioned in the rule. The rule of Raising (repeated in 35) shows the feature [pharyngeal] linked to a single vowel. The structure of the forms in (31.a) do not meet the structural description for Raising as will be explained below.

35. Raising (cf.18).

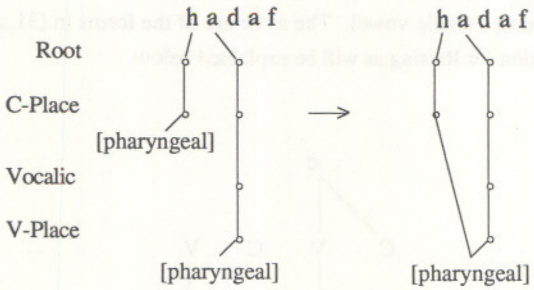



**2.3. Adjacent Gutturals and the Linking Constraint.**

The grammar of Rwaili contains a language specific process which creates a structure which would render the feature [pharyngeal] multiply linked and having the effect of blocking Raising as shown in (31). This process fuses the C-Place [pharyngeal] specification of a consonant to the same specification under V-Place in a vowel when the two are adjacent. This forms a partial geminate in a guttural *-a* sequence which resists the process of Raising in accordance with the Linking Constraint.

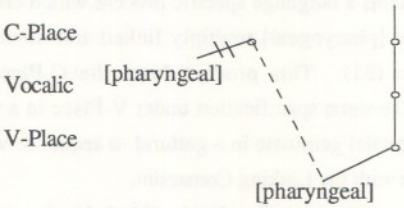
This process of fusion takes a structure like that in (36.a) for the word [hadaf] 'he returned' where a guttural consonant is adjacent to *a*, and fuses them so that the structure in (36.b) results. The partial geminate consisting of *h* and *a* resists the process of Raising so that the first *a* does not raise to *i* in spite of appearing in an open syllable before another pharyngeal vowel.

36. a. b.




A similar account can be provided for all the forms in (31.a). It is unimportant whether the guttural appears to the right or left of the target vowel as the forms [gʕadat] 'she sat' and [gaʕad] 'he sat' indicate. The forms [ġasal] 'he caught,' [ṭbaxat] 'she cooked,' [ḥafar] 'he dug,' and [hadaf] 'he returned' show that all the gutturals trigger CV Fusion. Finally, the forms in (38) demonstrate the the guttural must be adjacent to the target vowel for CV Fusion to take place.

37. CV Fusion.




CV Fusion is formalized in (37). If a pharyngeal vowel is adjacent to a consonant specified for pharyngeal under C-Place, the specifications of [pharyngeal] fuse. The result is a structure in which the guttural consonant and *a* are both linked to a single specification of [pharyngeal].

38.

| a. CV Fusion Applies. | | | b. Raising Applies. | |
|---|---|---|---|---|
| ʕazam | 3ms | 'invited' | ʕzimat | 3fs |
| ḥalab | 3ms | 'milked' | ḥlibat | 3fs |
| ðbaḥat | 3fs | 'killed' | ðibaḥ | 3ms |

It is also clear that in order to block Raising, Fusion must take place before *a* dissimilates to *i*. Where Fusion applies, Raising cannot. The 'exceptions' in (31.a) are actually structures which have been altered by CV Fusion so that they may not undergo Raising. So too may the forms in (31.b) be accounted for as obeying the Linking Constraint and therefore not raising the first vowel.

## 2.4. Vowel Raising in Kera.

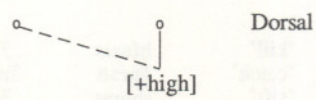
Kera, a Chadic language, also has two rules of raising as discussed by Ebert (1979) and Odden (1989). A comparison can be drawn between the two rules which change *a* to *i* in Rwaili to the raising rules in Kera. There is a height harmony rule in Kera which raises a non high vowel to a high vowel when followed by another high vowel as the forms in (39) illustrate.

39. Height Harmony in Kera.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| hool-on | --> | hool-on | 'warms me' | seen-n | --> | séen-ń | 'my brother' |
| hool-i | --> | huul-i | 'warms you' | seen-a | --> | séen-á | 'her brother' |
| hool-u | --> | húul-u | 'warms him' | seen-i | --> | siin-i | 'your (f) broth. |
| kass-n | --> | káas-ń | 'my hand' | korm-on | --> | korm-on | 'my son' |
| kass-i | --> | kəəs-i | 'your (f) hand' | korm-iyi | --> | kurm-iyi | 'your (f) son' |
| kass-u | --> | kəəs-u | 'his friend' | kormuyu | --> | kurm-uyu | 'his son' |

Odden (1989) accounts for this as the result of spreading [+high] from the following high vowel. Note that in Ebert's (as well as in Odden's) account, ə is a high, back, unrounded vowel so that *a* will change to ə as a result of this harmony, but *o* will raise to *u*. It should be noted that this spreading will apply in a closed syllable as /korm-iyi/ changes to [kurmiyi]. It is also noteworthy that this process will also apply when *a* is preceded by a [+low][3] consonant as seen in /hool-i/ --> [huuli]. Odden formulates Height Harmony as in (40).

40.




In addition, Kera contains a rule of dissimilation in which *a* in an open syllable will raise ə when followed by another *a* provided that the first vowel is not preceded by the low consonants *h* or *ʔ*. This accounts for the alternations in (41) in which we see the application of Dissimilation and its nonapplication when preceded by a [+low] consonant.

41.

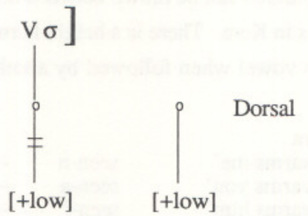
| | | | |
|---|---|---|---|
| bàl-àn | --> | bə̀l-an | 'loves me' |
| fal-am | --> | fəl-am | 'finds you' |
| nar-am | --> | nər-am | 'your (m) aunt' |
| hàm-àm | * | hə̀m-àm | 'eats you' |

Odden formulates this rule as in (41) where the feature [+low] (which could be reanalyzed as [pharyngeal]) is delinked from a low vowel in an open syllable which is also followed by an *a*. This process does not apply to /hàm-àm/ since the vowel preceding the

[3] I would like to note, as does Odden, that the feature [pharyngeal], and not [+low] is a better specification for the segments *ʔ*, *h*, and *a*, but I use [+low] here to be consistant with Ebert's analysis.

target vowel is adjacent to another [+low] consonant. Odden attributes this to the multiple linking of [+low] to both the *h* and the *a*.

41.




The two rules of raising in Kera have a similar distribution to their counterparts in Rwaili. The assimilatory rule of spreading is insensitive to multiple linking while the dissimilatory rule of delinking is prohibited by the Linking Constraint to apply to geminates.

### 2.5.1. Intervening Coronal Sonorants

The forms in (43 (repeated from 31.b)) do not necessarily contain gutturals, but do resist Raising. These examples have in common only a coronal sonorant which separates the two pharyngeal vowels. The account for these forms must make reference to a coronal sonorant in this position.

| | | | | | | |
|---|---|---|---|---|---|---|
| 43. | ḥalab | 3ms | 'kill' | ḥfarat | 3fs | 'dig' |
| | ǵsalat | 3fs | 'catch' | ð̣arab | 3ms | 'hit' |
| | nxalat | 3fs | 'sift' | ṣbarat | 3fs | 'wait' |
| | nzalan | 3fp | 'get down' | wzanat | 3fs | 'weigh' |

The forms in (44.a) demonstrate that a coronal sonorant which precedes the vowel targeted by Raising will not block the process. From this, it can be concluded that the blocking effect does not involve multiple linking between the coronal sonorant and *a*. If this were the case, fusion would be expected to occur on either side of the vowel as it does for the adjacent pharyngeals.

| | | | | | |
|---|---|---|---|---|---|
| 44.a. | ð̣rubat | 'she hit | b. | nizal | 'he got down' |
| | ḥlibat | 'she milked' | | wuzan | 'he weighed' |
| | rubaṭ | 'he tied' | | kitab | 'he wrote' |
| | xrubat | 'she became ruin' | | wuṣaf | 'he described' |
| | | | | gidar | 'he was able' |

The forms in (44.b) show that intervening coronal obstruents do not block the process of Raising so that the analysis which explains the exceptional forms in (40) must refer only to coronal sonorants. Forms like [ṣumal] 'he was steadfast' indicate that an intervening labial sonorant also allows Raising to apply.

## 2.6. Coronal Transparency

Paradis and Prunet (1989) propose that coronal consonants are special in that they lack a place node in their underlying representations which makes them 'transparent' to certain phonological processes. Paradis and Prunet (1989) cite evidence from Guere which illustrates this special behavior of coronal consonants. Guere has a height constraint that prevents two non high vowels from appearing in the same stem. This correctly predicts that forms like *[beo], *[kẽ̆mẽ], *[kɔ̃mẽ], and *[kɛbo] cannot occur in this language.

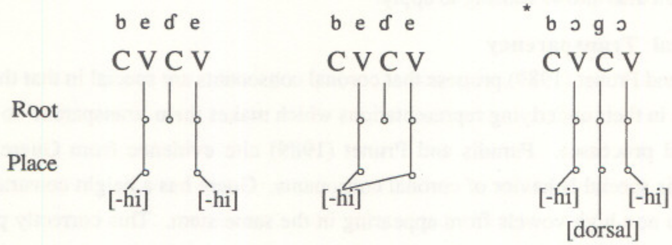
While it is true that no bare stems exist with two non high vowels, suffixation may create forms which are in violation of the height constraint. For example, the stem /ɓlē/ meaning 'sing' has a single mid vowel, and is not in violation of the height constraint. If the object pronoun /-ɔ/ is added, the resulting structure of /ɓlē-ɔ/ is in violation of the height constraint. Guere has a rule which corrects such illformed structures by raising the stem vowel so that the surface form of /ɓlē-ɔ/ is [ɓlīɔ].

Paradis and Prunet also note that in forms in which two identical, adjacent vowels occur in a stem, they may be non high. Since these forms are not excluded by the height constraint, it can be assumed that the two vowels share a single specification for [-high]. In this way, words such as [sɔɔ] 'lose weight!' are permitted since there is only a single occurrence of the feature [-high].

But a there are forms in Guere which do seem to violate the height constraint as they contain two non high, non adjacent vowels. These include [beɗe] 'to hang,' and [wɔlɔ] 'wash!.' What makes these forms permissible in Guere is that the two non high vowels are separated only by a coronal consonant. Paradis and Prunet propose that all unmarked coronals will be unspecified for place in their underlying representation and later in the derivation, a redundancy rule will fill in the value coronal to the empty place node.

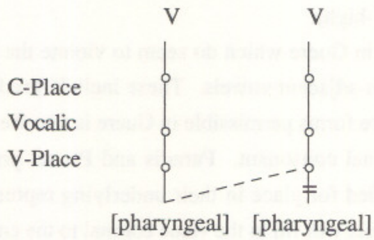
In this way, /beɗe/ has the underlying structure in (45.a). Paradis and Prunet argue that this structure is then altered to that in (45.b) in which there is a single specification of [-high] shared by both vowels. This is possible in words like [beɗe] in which the intervening consonant is a coronal and lacks a place node. In a word like *[bɔgɔ] (45.c), the intervening consonant is specified as velar in its underlying representation, and therefore, the two vowels may not fuse their [-high] specification into one, and so are ruled out by the height constraint.

45. a. b. c.



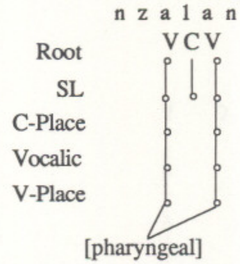

The proposal of Paradis and Prunet accounts for the forms in (43) since coronal transparency allows the two *a* s in forms like [nzalan] to share their specification of [pharyngeal] over the intervening *l*. This is accomplished by a second rule of fusion which fuses vowels that are identical at the C-Place node. VV Fusion is formalized in (46) where pharyngeal vowels which have identical structures beneath their C-Place nodes fuse their specifications for [pharyngeal]. Since only coronal sonorants lack a place node, all other consonants will not meet the structural description for VV Fusion. Since only coronal sonorants will permit fusion, no other consonants will show the inalterability effects discussed above.

46. VV Fusion.




The forms in (43) have a structure similar to that in (47) in which the coronal lacks a C-Place node and [pharyngeal] is multiply linked to both vowels. This structure is impermeable to Raising as the Linking Constraint prevents the rule from applying to multiply linked sturctures.

47.



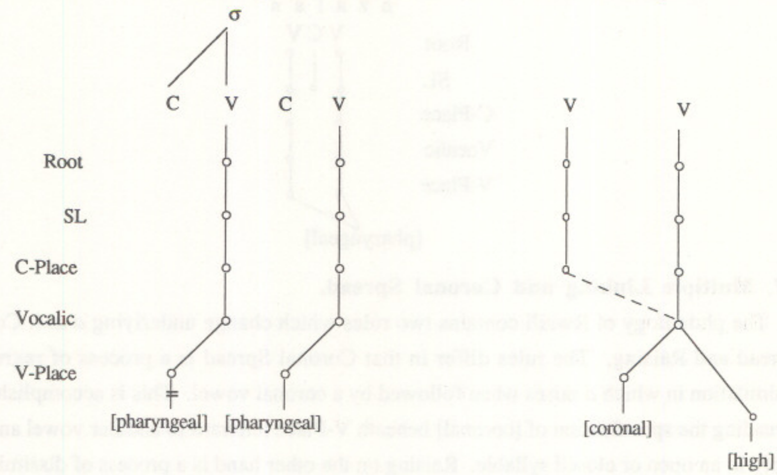

**2.7. Multiple Linking and Coronal Spread.**

The phonology of Rwaili contains two rules which change underlying *a* to *i*: Coronal Spread and Raising. The rules differ in that Coronal Spread is a process of regressive assimilation in which *a* raises when followed by a coronal vowel. This is accomplished by spreading the specification of [coronal] beneath V-Place leftward to another vowel and will apply in an open or closed syllable. Raising on the other hand is a process of dissimilation in which an *a* in an open syllable dissimilates to *i* when followed by another pharyngeal vowel. This is accomplished by delinking the specification of *a* from the supralaryngeal node when the above conditions are met, and filling in the value of *i* by Default.

It was shown that a large number of apparent exceptions exist to Raising which are accounted for by appealing to the Linking Convention which prevents the process from applying as it would require two association lines to delink where the rule specifies only one. In this way, the exceptional forms were shown to be exceptions which do not require extra stipulations to be placed on the grammar, but rather fall out naturally from the behavior of geminates and the nature of the rule of Raising.

The existence of forms similar to /ʕarif/ --> [ʕirif] suggests that neither adjacent gutturals nor intervening coronal sonorants will block the application of Coronal Spread. Some explanation is required to account for the Linking Constraint affecting the application of Raising but not of Coronal Spread. An examination of the two rules makes clear that while Raising is subject to the Linking Constraint, Coronal Spread is not within the domain in which inalterabilty effects are predicted to exist.

48. a.Raising b.Coronal Spread




The process of Raising, (repeated in 44.a) involves delinking an association line to affect the change of *a* to *i* as the value of coronal is filled in by default. Since the structural change of the rule involves the delinking of an association line, it is predicted that the linking constraint be in effect and prevent the application of this process on geminates.

Coronal Spread (repeated in 44.b) spreads the value the vowel on the right leftwards. The delinking of the existing specification comes from a structural preservation stipulation that prohibits the specification of [pharyngeal] for a vowel that is also specified as [high] under Aperture. Since Coronal Spread is a rule of spreading and does not delink an association line, the Linking Constraint is not predicted to affect the application of this process. The Linking Constraint, then, provides an elegant account for both the existence of 'exceptions' to Raising and for the absence of such forms for Coronal Spread[4].

## 2.8. Long Distance Geminates.

Hayes (1986b) includes many examples from a variety of languages which show the effects of the Linking Constraint, but all involve geminates which are adjacent on the timing tier. In a footnote, Hayes (1986b:328) states that long-distance geminates which show inalterability effects can exist, but cites no examples.

[4] It is also true that the Linking Constraint would not play a role in the application of Coronal Spread if CV Fusion is ordered after Coronal Spread but before Raising. No other part of the analysis depends upon this ordering, nor is there any evidence suggesting that CV Fusion applies before Coronal Spread.

The analysis provided here of the forms in (43) makes crucial reference to the number of association lines attached to a pharyngeal vowel *a*. This makes the forms in which the two occurrences of *a* are separated by a coronal sonorant an example of long distance geminates. The multiple linking which blocks Raising exists between two segments which are not adjacent on the timing tier but has the same effect as multiple linking among adjacent segments as is the case with the adjacent gutturals discussed in §2.4.

## 3. Obstruents and Coronal Transparency Reevaluated.

In addition to providing an example of a long distance geminate, the 'placeless coronal' account for the [nzalan] type exceptions to Raising also challenges certain aspects of Paradis and Prunet's (1989) proposal for coronal transparency. Paradis and Prunet propose that all unmarked coronals will show transparency effects which include obstruents as well as sonorants. It will be argued here that the general principle of coronal transparency is limited to sonorants.

To illustrate their proposal for coronal transparency, Paradis and Pruent provide evidence from Fula, Guere, and Mau in which coronals exhibit transparency effects. Yet Paradis and Prunet note in their analyses of Guere and Mau that only the sonorants show transparency in these languages (1989:340, 1990; 1989:341). Coronal obstruents are only considered in the analysis of Fula, and it will be shown that this analysis does not adequately demonstrate that obstruents should be included in the special class.

There are three processes which are said to exhibit transparency in Paradis and Prunet's analysis of Fula: vowel spreading in verbal inflection, vowel spreading in nominal markers, and spreading of epenthetic vowels. In the case of vowel spreading in nominal markers, the spreading takes place only over *r* for morphological reasons, and therefore does not demonstrate that obstruents are transparent. Spreading of epenthetic vowels is also limited to the implosive [ɗ] since only a single form is provided in which the spreading may take place (1989:335). In this form [ɓuttiɗit] 'become fat again' an epenthetic vowel is inserted to break up the consonant cluster /ttɗt/ so that underlying /ɓuttɗt/ becomes /ɓuttiɗt/.

A second epenthesis is required to break up the /ɗt/ cluster so that /ɓuttiɗt/ becomes /ɓuttiɗit/. In this second epenthesis, an empty V slot is said to be inserted to which the quality of the first epenthetic vowel is spread to the second. It is not clear how the first epenthesis obtains its value when the second must receive its quality from the first. Moreover, the single form provided by Paradis and Prunet may surface as the alternate form [ɓuttiɗtu] (1989:335). In the latter form, which Paradis and Prunet note is less prefered than the former, the second epenthetic vowel receives a different quality than the first without appealing to spreading in spite of the intervening consonant's transparency as coronals. Even if we accept the spreading analysis, it fails to provide evidence of obstruent transparency since Paradis and Prunet consider implosives, such as [ɗ], to be sonorants.[5]

The strongest argument for the transparency of coronal obstruents is in the analysis of vowel spreading in verbal inflection. Paradis and Prunet argue that in the suffixes listed in (49) the identity of the vowels on both sides of *t* in suffixes like *otoo* is due to spreading of one vowel quality to empty V slots to its right. This is possible if *t* lacks a place node and is therefore transparent. The Passive 4 suffix *-etee* is said to be derived from the underlying form /-etVV/ with the quality of the first vowel spread to the remaining two. The identity of the two vowels in the suffix *amaa* is attributed to coincidence (1998:324).

49. Verbal Suffixes in Fula.

| | Active | Middle | Passive |
|---|---|---|---|
| Perfect | | | |
| 1 | - | i | a |
| 2 | i | ii | aa |
| 3 | ii | iima | amaa |
| Imperfect | | | |
| 1 | - | o | e |
| 2 | a | oo | ee |
| 3 | at | oto | ete |
| 4 | ata | otoo | etee |

Since no other consonants occur in this context, it is impossible to test whether only coronals are transparent to this spreading (1989:329). It seems unlikely that any consonant would fail to be transparent to such a spreading since the empty V-slots to the right of the consonant must obtain features. For example, if one were to assume that a suffix had the underlying form /ekVV/ and that only coronals were transparent to this process, there would be no way to assign the final vowels of this suffix any value since *k* would block the necessary spreading. Therefore, it would seem necessary that all consonants be transparent to this particular spreading process, which then fails to provide evidence that obstruents are transparent.[6]

There does not appear to be any evidence for the transparency of coronal obstruents, while the transparency of sonorants has been demonstrated in Guere and Mau (Paradis and Prunet 1989) as well as in the present analysis of Rwaili Arabic. Rwaili does provide a counter example for the transparency of coronal obstruents since they do not allow the same long-distance linking that the sonorants *r*, *l*, and *n* do. For this reason, the claim that coronals are universally unspecified, and ultimately transparent, must be modified so that only sonorants are included in the special class of segments.

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[5] The sonority of [ɗ] is based in part on an alternation between [ɗ] and [l].

[6] If only coronals were transparent, then the hypothetical suffix /ekVV/ conld only obtain a specification for the final vowels from a default rule which seems to be otherwise unmotivated in Fula.

## 4. Root Cooccurrence Restrictions and Coronal Transparency.

It is widely accepted that among Semitic roots, there is a tendency to avoid combinations of segments of the same place of articulation. Greenberg (1950) analyzed 3775 trilateral verbal roots from Classical Arabic charting the occurrence of each consonant with every other consonant. His conclusions are summarized in (50).

50. 1. In the first two positions, not only identical, but homorganic consonants are excluded.
2. Homorganic consonants are likewise excluded from positions two and three, though not quite as rigorously as the first two positions.
3. In positions one and three, there is a marked, but less rigorous exclusion of homorganic, including identical consonants, than in the other combinations of positions. (Geenberg 1950:162)

Greenberg's first conclusion is not as absolute as it is stated in (50.1) since it predicts that combinations such as *r n* _ never occur since they are homorganic, yet there are five roots which begin with this sequence in his survey (1950:164). The statements in (50.1-3) are best considered tendencies rather than precise statements of occurrence exclusion. Greenberg himself weakens each claim by stating that the restriction for II and III positions is 'less rigorous' than that of I and II while the restriction for I and III is less rigorous than for the other two permutations. Consequently, it is difficult to state precisely what the cooccurrence restriction predicts beyond a tendency to avoid similar segments in a root. McCarthy (1991:14) makes the following statement regarding the cooccurrence restriction, 'The basic observation is that the consonants within a root are not homorganic with one another (within certain manner classes).'

An active, absolute exclusion on the cooccurrence of similar consonants in a root would pose a problem for the analysis of Rwaili presented here since a morphological restriction sensitive to consonant quality in the underlying representation is incompatible with underspecification. Since the present analysis depends upon the underspecification of place underlyingly for coronal sonorants, some account must be provided to reconcile the predictions of the root cooccurrence restriction and the underspecification of coronal sonorants.

Any alternative presented here must be evaluated on the basis of its ability to account for the same phenomena as the cooccurrence restriction. However, since this restriction has never been formalized so that it holds for the facts for which it is said to account, such an evaluation is impossible.

One alternative is to state the cooccurrence restriction so that for any trilateral root, only one member may lack a place node in its underlying representation. This would ensure that all roots must have at least two place nodes. In this way, a limit is placed upon the number of coronal sonorants which may occur in a root since they are the only underspecified consonants in Rwaili. Since Greenberg groups *r*, *n*, and *l* into a single place of articulation, the same predictions can be made by both accounts. The weakness in this account is that the absence of a feature is given a value, which is undesirable. This is similar to the criticism directed to underspecification theory which allows a ternary contrast among [+], [-], and [ø] for a given feature (see Mohanan 1991).

A second alternative is to state the cooccurrence restriction so that two sonorants may not cooccur in a root. This would prevent *r*, *n*, and *l* from cooccurring since they are all sonorants. This account is problematic since *m* is also a sonorant, yet is classified as a labial. Greenberg cites 38 roots which begin with *mr_* , *ml_* , or *mn_* . This account is unworkable since *m* violates the cooccurrence predictions made by restricting sonorants.

51. Cooccurrence of Coronal Sonorants.

| | | | | | |
|---|---|---|---|---|---|
| r __ __ | 29/288 | 12.7% | __ __ r | 26/335 | 7.76% |
| n __ __ | 43/283 | 15.1% | __ __ n | 26/188 | 13.8% |
| l __ __ | 10/160 | 6.25% | __ __ l | 32/249 | 12.8% |
| | | | total | 166/1443 | 11.5% |

Where I and III are coronal sonorants.

A third alternative is to make coronal sonorants exceptions to the cooccurrence restriction so that they are equally likely to occur in a root containing another coronal sonorant as a root without *r*, *n*, and *l* . Greenberg records that of 1443 roots containing coronal sonorants, 166 are roots containing two occurrences of *r*, *n*, or *l*. These 166 roots comprise 11.5% of all the roots containing coronal sonorants as shown in (51). The segments *r*, *n*, and *l* represent 10.7% (3 of 28) of the consonantal inventory included in Greenberg's survey. Thus one would expect cooccurrence in approximately 10.7% of the roots containing one coronal sonorant which is slightly less than the proportion which actually exists. Thus, there is some evidence that the cooccurrence restriction does not apply for *r*, *n*, and *l*. This is more evident in comparison to the class of labials *b*, *f*, and *m* which one would expect to occur in the same proportion as coronal sonorants since each group contains three members.

52. Cooccurrence of Labials.

| | | | | | |
|---|---|---|---|---|---|
| b __ __ | 6/152 | 3.9% | __ __ b | 1/240 | 0.04% |
| f __ __ | 12/181 | 6.6% | __ __ f | 1/185 | 0.05% |
| m __ __ | 0/171 | 0.0% | __ __ m | 16/243 | 6.5% |
| | | | total | 36/1172 | 0.02% |

Where I and III are labials.

The labials, in contrast to the coronal sonorants, occur far less frequently than 10.7% as would be expected from a set of three consonants. The bilabial nasal, for example, never occurs root-initial in a root containing another labial. The fricative *f* occurs most often in roots with other labials, but fewer than 7% of the roots which begin with *f* contain another labial in position III. Since labials cooccur far less frequently than expected while coronal sonorants occur as frequently as expected, the proposal that *r*, *n*, and *l* are not subject to the cooccurrence restriction is plausible.

The coronal obstruents also occur far less frequently than do coronal sonorants. While the obstruents *s, z, ṣ, ṭ, d, ṭ, θ, ð̌, θ̣, ḍ, š* comprise 39.3 % (11 of 28) of the segments in Greenberg's survey, only 20% (203 of 1012) of roots that have a coronal obstruent initially will have another coronal obstruent in the second or third consonant position. In addition, 50% of roots which begin with *t* or *d* also have a coronal sonorant in the root. This suggests that coronal sonorants are different from coronal obstruents both in the way they pattern among themselves and the way pattern with each other. Among themselves, a root containing one coronal sonorant is as likely to have another coronal sonorant in the same root as any other consonant. Coronal obstruents, however, show a stronger tendency not to cooccur in the same root. The two groups show no tendency to avoid the other in roots so that a root containing a coronal obstruent is not restricted from containing a coronal sonorant in the same root.

It could be argued that coccurrence restrictions do not play an active role in synchronic Arabic phonology, but the tendency for similar segments to avoid cooccurrence is the result of a historic restriction. In this view, it is an anomaly of morphology that there is the systematic gap in consonantal distribution and the phonology is independent of this constraint. If the cooccurrence plays no part in the phonology of Rwaili, then the underspecification of coronal sonorants is no longer incompatible with the restriction. Support for this view lies in loan words which Greenberg documents such as [saḏa:b] 'rue' which do not adhere to the restriction since as coronal fricatives, *s* and *ḏ* should not occur in the same root. The weakness of this view is that it provides no synchronic explanation for the limited distributions of certain consonants as is found for the labials in (52).

It is suggested here that the third alternative, that coronal sonorants are special in that they are not subject to the cooccurrence restrictions to which the remaining consonants must adhere in varying degrees, is most plausible. This is supported by the data in (51), but cannot be confirmed nor denied until a precise statement of the coccurrence restriction is formulated. Until such a formalization is posited, it will be suggested that coronal sonorants are outside the domain of the cooccurrence restriction .

## 5. Conclusion.

The phonology of Rwaili has two rules which change underlying *a* to *i*, Raising and Coronal Spread. While the assimilatory rule of Coronal Spread appears to be exceptionless, Raising has a large number of exceptions. Within that group of forms which do not undergo Raising there are two types of verbs, those like [gaʕad] 'he sat' and [gʕadat] 'she sat' in which the target vowel is adjacent to a guttural, and those like [nzalat] 'she got down' in which the target vowel is followed by a coronal sonorant and another *a*.

Previous accounts of this phenomenon in similar dialects have accounted for these exceptions by allowing Raising to apply universally, but correcting the problematic forms with an additional rule of Lowering which lowers *i* to *a* in the environments described above; when the target *i* is preceded or followed by a guttural and *a* appears in the following syllable as well as when followed by a coronal sonorant and *a*. Al-Mozainy (1981) formulates this rule as in (53) in his account of a Bedouin dialect of Jordan. But this sort of account is undesirable for a number of reasons. Foremost among these is that this account fails to provide any relationship between the process and its structural description. The formulation in (53) does not reveal that the vowel following the target triggers dissimilation. In (53), the following vowel is as likely to be *i* as *a*.

53.

$$\begin{bmatrix}+\text{syl}\\+\text{hi}\end{bmatrix} \rightarrow [-\text{hi}] \;/\; \underset{[+\text{L}]}{\text{C}} \;\_\_\; \left\{\begin{array}{c}\text{C}\\ [+\text{L}]\\ \begin{bmatrix}+\text{cor}\\+\text{son}\end{bmatrix}\end{array}\right\} \underset{[+\text{low}]}{\text{V}}$$

Al-Mozainy's account provides no explanation as to why Lowering should apply to //giʕad// (the product of applying Raising to /gaʕad/), but does not apply in [ʕirif]. This disparity falls out naturally from the account proposed here. Raising, which delinks an association line, is subject to the Linking Constraint and fails to apply to geminates, whether involving a guttural and *a*, or two pharyngeal vowels multiply-linked over a coronal sonorant.

While the rule in (53) offers some explanation of why lowering should apply adjacent to a guttural, it provides no account of why Lowering should apply to a vowel followed by a coronal sonorant. An adjacent guttural could explain the effects of Lowering as a process of assimilation just as it triggers a similar process in Maltese discussed in Hume (1992). There is nothing about the structure of a coronal sonorant which would trigger Lowering. In the account provided here, the structure of a coronal sonorant permits VV Fusion which in turn creates a long distance geminate that resists Raising based upon the Linking Constraint.

The account provided here of the forms that do not undergo Raising is superior to traditional accounts like that in (53) since it relates the structure of forms like [gaʕad] and [nzalat] to their failure to raise. The adjacent guttural and *a* form a partial geminate and the two pharyngeal vowels form a complete geminate over the intervening coronal sonorant, both of which show inalterability effects. Since Raising is a process which delinks the feature [pharyngeal], it is expected to fall within the domain of the Linking Constraint while Coronal Spread does not.

This account provides another example of a process in which the uvular, pharyngeal, and laryngeal consonants act as a natural class of gutturals as they alone fuse with *a* to block Raising. This blocking of Raising also provides another example of inalterability governed by the Linking Constraint. The account of forms like [nzalat] provide an example of a long distance geminate which hitherto was only a theoretical possibility. The part of the analysis that involves long distance geminates is consistant with the proposal of coronal transparency provided by Paradis and Prunet (1989) insofar as only coronal sonorants exhibit the transprency effects: the analysis of Raising shows that only sonorants have special status in Rwaili.

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# A NON-METRICAL THEORY OF SUKUMA TONE[*]

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## 1. Introduction

This paper discusses the tonal system of the Bantu language Sukuma. The interest of Sukuma tone centers around a tone shift whereby a H tone generally shows up two syllables to the right of its underlying location. The example in (1a.i) demonstrate that the 2 sg. object prefix /ku/ has a L tone, as do the verb stem /sol/, the future tense prefix /ku/, and the 3 sg. subject prefix /a-/. An example of H showing up two syllables to the right of its underlying location is seen in (1a.ii), where the underlying H tone of the 3 pl. subject prefix /bá/ is realized phonetically on the object prefix [kú]. Likewise, the verbal extension /anij/ has no underlying H as shown by (1b.i), but when that affix follows the underlyingly H toned verb stem /bón/, the H of /bón/ is phonetically realized on the affix [aníj] in (1b.ii), again appearing two syllables to the right of its underlying location. This tone shifting phenomenon also applies at the phrasal level, as seen in (1c): when the noun *amahagala* stands in isolation, or is preceded by the L toned verb /sol/, it bears no H tone. But when preceded by the H toned verb /bón/, a H tone appears on its initial vowel.

| | | | | | |
|---|---|---|---|---|---|
| (1) | a. i. | /a-ku-ku-sol-el-a/ | → | [a-ku-ku-sol-el-a] | "he will choose for 2 sg." |
| | ii. | /bá-ku-ku-sol-el-a/ | → | [ba-ku-kú-sol-el-a] | "they will choose for 2 sg." |
| | b. i. | /ku-sol-anij-a/ | → | [ku-sol-anij-a] | "to choose simultaneously" |
| | ii. | /ku-bón-anij-a/ | → | [ku-bon-aníj-a] | "to see simultaneously" |
| | c. i. | /akasola amahagala/ | → | [akabona amahagala] | "he chose the tree forks" |
| | ii. | /akabóna amahagala/ | → | [akabona ámahagala] | "he saw the tree forks" |

In each case, underlying H surfaces two syllables to the right of its underlying location.

Nonlinear analyses of Sukuma tone shift are presented in Goldsmith (1985) and Sietsema (1989). The problem with writing a rule to shift H two syllables is that the syllable with the surface H tone is not adjacent to the syllable with the underlying H. Under the theoretical tenets of linear phonology, one could construct a rule which explicitly marks off in parentheses the vowel that intervenes between the H toned vowel and the target of this tone shift, allowing the intervening vowel to be skipped:

(2)
H
V (V) V

However, it is a widely held tenet of current phonological theory that mechanisms such as parentheses are excessively powerful and undesirable.

Alternatively, one could simultaneously link H to 2 vowels, and subsequently delink all but the rightmost link to the H tone. This requires a counting mechanism which, it has been argued in the theoretical literature (c.f. McCarthy and Prince 1986) also should not be allowed. If a H can spread simultaneously to the next two TBU's as in (3), then that H tone has "access" to segments that are not adjacent. Furthermore, such a rule in inherently undesirable since it performs two actions, contrary to the goal of reducing the power of phonological rules so that only single operations can be performed by a rule.

(3) Rightward Spread

$$\begin{array}{ccc} \text{H} & & & & \text{H} & & \\ V_1 & V_2 & V_3 & \rightarrow & V_1 & V_2 & V_3 \end{array}$$

And it should be obvious that reformulating (3) to iteratively spread H one syllable to the right, applyiong that rule to successive syllables, would in fact shift H to the rightmost syllable of the phonological string. There would be no way to stipulate that the rule should cease application after two passes.

Thus, the mechanism for handling H tone shift in Sukuma is of theoretical interest. In this paper, I first review a metrical analysis of Sukuma tone proposed in Sietsema (1989), showing that there are serious theoretical and empirical problems with that analysis. An alternative is then proposed which avoids these problems and also obviates the need for abstract metrical structure.

## 2. Sietsema (1989): A Metrical Account of Sukuma Tone

Metrical theory has a device for grouping syllables into units of two, namely the binary foot. Sietsema (1989) claims that tone shifting over two syllables is to be explained in terms of feet. The primary task of the metrical account becomes assignment of the correct metrical structure, which allows H tone shift to be stated as a purely local rule referring to no non-adjacent elements. In general, maximally binary feet are built starting at any point in the string where a H tone is located. Once the proper metrical structure is constructed, a rule of High Tone Spread (HTS) applies. The rule, as Sietsema states it, is intended to spread H to the right as far as possible, up to a vowel at the left edge of the foot.

(4) High Tone Spread

```
        (*             (*
X ..... X    →   X ...... X
|
H                    H
```

This works for the forms in (5) below:

(5) a. (*  *)(*  *)

/bá ku sol a/ → [ba-ku-sól-a] "they will choose"

H

b. (*  *) (*  *)(*)

/a ka bón el a/ → [a-ka-bon-el-á] "he looked for"

H

The surface forms show that the H spreads, but then shows up only on the last of the syllables which it has spread to. All but the rightmost association line of a multi-attached H are deleted by (6).

(6) Delinking

```
(X)...(X)...X   →   (X)...(X)...X
      H                   H
```

Example (7) shows that the requirement for putting H tones at the left edge of the foot overrides the otherwise left-to-right binary foot grouping.

```
(7)     UR      /bá-ku-ku-bón-el-a/      /a-ka-bón-el-a/
                 |         |                   |
                 H         H                   H

        MSA     (*  *)(*) (*  *)(*)      (*  *)(*  *)(*)
                bá-ku-ku-bón-el-a        a-ka-bón-el-a
                |         |                   |
                H         H                   H

        HTS     (*  *)(*)(*  *)(*)       (*  *)(*  *)(*)
                bá-kú-kú-bón-él-á        a-ka-bón-él-á
                 \ | /    \ | /              \ | /
                   H        H                  H

        DL      ba-ku-kú-bon-el-á        a-ka-bon-el-á
```

Without the special provision that underlyingly H toned syllables must stand at the left edge of the foot, we would incorrectly predict under the metrical account that H tone would spread one syllable to the right if it stands in an even-numbered syllable and would spread two to the right otherwise.

When two H-toned elements are adjacent in the UR, as in (8), the H of the object prefix [ba] is blocked from spreading by the H tone associated with [bon]:

```
(8)     /bá-ku-bá-bón-el-a/  →  [bakúbabonelá]      "they will find them"
         |     |  |
         H     H  H
```

The H of the OP /bá/ should therefore simply surface on the OP [bá], and we should get **bakuba!bonela!* . The question is, then, what has become of the leftmost H on the left of a pair of adjacent underlying H's? Sietsema suggests a rule of Tone Fusion, where adjacent, underlying H's fuse into one and, due to delinking, only the rightmost syllable realizes this H.

```
(9)     a. Tone Fusion         V  V          V  V
                               |  |    →      \/
                               H  H           H

        b. UR          /bá-ku-bá-bón-el-a/     "they will find them"
                         |     |  |
                         H     H  H

           TF          (*  *)(*)(*  *)(*)
                       bá-ku-bá-bón-el-a
                       |      | /
                       H      H

           HTS         bákúbábónélá
                        \/  \\\\
                        H    H

           DL          bakúbabonelá
```

Some nouns at the phrasal level require special treatment. Compare [ákabona ámahagala] with [akabona mahágala]: as it stands, the phrase [akabona mahágala] is not derived correctly.

(10) UR a. /a-ka-bón-a a-ma-hagala/ b. /a-ka-bón-a ma-hagala/

H H

"he saw the tree forks" "he saw tree forks"

MSA (* *)(* *)(* *)(* *)(*) (* *) (* *)(* *)(* *)
a-ka-bón-a a-ma-hagal a a-ka-bón-a ma-ha gala

H H

HTS, (* *)(* *)(* *)(* *)(*) (* *)(* *) (* *)(* *)
DL a-ka-bon-a á-ma-hagal a *a-ka-bon-a má-ha gala

In (10a) the H correctly shows up two syllables after the underlying H tone. In (10b), it shows up one syllable further in the word than expected: this happens when there is only one prefix.

In order for the stem-initial syllable of the noun to receive a H, it must be leftmost in its foot. To get this result, the first syllable of nouns and adjectives is marked extrametrical. Therefore, that first syllable is not included in the metrical system: it projects no metrical grid position, and is therefore inelegible to bear tone.

(11) UR /a-ka-bón-a ma-hagala/ "he saw tree forks"

H

MSA (* *)(* *) (* *)(*)
a-ka-bón-a <ma>-ha ga la

H

HTS (* *) (* *) (* *)(*)
a-ka-bón-á <ma>-há ga la

H

DL a-ka-bon-a <ma>-há gala

This extrametricality of noun- and adjective-initial syllables is quite general, and therefore should be assigned by a rule which makes the first syllable of every noun or adjective extrametrical. Note that in (10a), the first syllable of the noun may accept a H tone, and, therefore, cannot be extrametrical. Preprefixes are therefore marked as exceptions to the rule assigning extrametricality.

Another problem of Sukuma tone is the distribution of extra-low, or XL tones. The presence of this XL is correlated with a H tone attached to the final vowel of a word. It should be noted that the data in Richardson (1959, 1971) are not always accurate in marking final XL. In fact, it is words with two final XL's that Richardson incorrectly marks as having two regular L's. Batibo (1985) is an important source of data for marking these final XL tones. Since Sietsema (1989) is based on Richardson (1959, 1971) alone, his analysis generates incorrect forms where Richardson's data are incorrect. The following words from Richardson (1959:23) exemplify the motivation for two rules of H tone lowering:

(12) a. /ba-témí/ [batemi] ([batèmì]) "chiefs"
(Batibo 1985:204)

H

b. /ba-dugú/ [badugù] ([badugù]) "relatives"

H

Sietsema proposes two rules to lower a phrase-final H. The first of these, Final Lowering (FL), lowers a H linked only to the final vowel of a phrase to an XL.

(13) Final Lowering H → XL / V V]$_{\text{utterance}}$

The second rule is Final High Modification (FHM). This lowers a H linked to the penultimate and final vowel to a "regular" Low tone. Unlike FL, however, this rule has no restrictions on the number of vowels the H may be linked to.

(14) Final High Modification H → L / V]$_{\text{utterance}}$

In Sietsema's account, FL must precede FHM, and bleed the latter rule.

(15) UR /badugú/ /batémí/

H H

FL badugù N/A

XL

FHM N/A batemi

L

The ordering of rules is moot, since [batèmì] has two XL tones and undergoes the same rule as [badugù]: there is no rule of FHM. Section 4 unites these processes into a single generalization.

3. General criticisms of Sietsema (1989)

There are significant problems with the metrical account of Sukuma tone, both theoretical and empirical. Consider Sietsema's delinking rule repeated as (16) below.

(16) Delinking (X)...(X)...X

H

The first X and the last X are not adjacent, hence the rule is not a local rule; but this rule property was supposedly avoided in the metrical account. Furthermore, the rule requires use of parentheses to indicate that the H tone may be linked to two or three vowels. In fact, given the rule of tone fusion, even this formulation is inadequate since the H could be linked to four vowels.

(17) bákúbábónélá DL bakúbabonelá
H H → H H

However, DL could be reformulated as an iterative, syllable-to-syllable delinking rule and would avoid these criticisms.

A more fundamental problem is the statement of the spreading rule. This rule too has the problem that the leftmost and rightmost association lines are not adjacent, and it uses ellipsis which is equivalent to the linear phonology expression $(C_0V_0)_0$. If we compare Sietsema's HTS rule from (4) to Rightward Spread in (3) which he rejected, we see that the metrical formulation of the rule has exactly the defects which the simultaneous rule suffered from. To avoid these problems, we could try to reformulate the rule as a local rule, as in (18a) which spreads H to an immediately skeletal position which is the head of a metrical foot; alternatively, we might spread to any syllable as in (18c):

(18) a. (*
X X
H

b. (* *)(* *)
ku-bón-an ij-a "to see simultaneously"
H --rule N/A
*[kubónanija]

c. X X
H

d. ku-bón-án-íj-á --rule applies to end of string
H
*[kubonanijá]

If reference is made to metrical structure as in (18a), the rule would not in fact be applicable in (18b) since the structural description is not met, given that *bo* is not adjacent to the foot head *ni*. If no reference is made to metrical structure, the rule applies to the end of the string in (18d), since there is no condition for stopping. A final possibility is that the rule is a foot-domain rule, that is, it applies only to elements within the same metrical foot. Under that interpretation, HTS would spread H from *bo* to *na*, but not to *ni*, since *na* and *ni* are not in the same metrical foot. None of these interpretations of the rule will result in the correct form [kubonaníja].

Sietsema's analysis of [akabona mahágala] also relies on a dubious assumption. The skipping of the prefix [ma] was handled by rendering the prefix syllable extraprosodic. The fundamental problem with this analysis is that it crucially depends on violating a basic constraint of extrametricality, namely the Peripherality Condition, which states that extrametricality may be assigned only at the edge of a domain. The extrametrical syllable from (11) falls directly in the center of a domain, not at the edge:

(19) (* *)(* *) (* *)(*)
[a-ka-bon-a <ma>-há ga la]

Accepting the metrical analysis of Sukuma tone entails rejecting an important constraint on phonological theory, and such an analysis should be adopted only if there is no viable alternative: such an alternative will be presented in section 4.

Besides these theoretical problems, there are empirical problems which justify pursuing a non-metrical reanalysis of Sukuma. These problems will be encountered in the following section: we will see that there is direct evidence against the rule of Tone Fusion, and that there is no possible ordering between the rules H Tone Shift and Final Lowering: HTS appears to precede (feed) Final Lowering in forms where no syllable is skipped by HTS, but Final Lowering appears to precede (conterfeed) HTS when one syllable is skipped by HTS.

## 4. A Non-Metrical Account of Sukuma Tone

The fundamental problem with the metrical account of Sukuma tone shift -- indeed a problem with all previous accounts of Sukuma, is the assumption that there is a single tone shifting rule which moves H two syllables to the right.

### 4.1 Spreading Rules and Delinking

The alternative analysis of Sukuma presented here is constructed around a core of three rules, Initial Spreading (IS), Secondary Spreading (SS), Delinking (DL), and Phrasal Spreading (PS). We begin with the first three rules. Initial Spreading (IS), spreads a H tone to an adjacent TBU:

(20) Initial Spreading   X X X'
                                    H

One condition which must be put on this rule is that the rule does not spread H to a syllable that is itself followed by H. In addition, this rule applies strictly within words.

The second rule, Secondary Spreading spreads H to the right. This rule applies within and between words, and is therefore a postlexical rule. Furthermore, this rule is not blocked from applying by a following H tone.

(21) Secondary Spreading   X X
                                        H

The third rule is the delinking rule, which delinks a left branch of a multiply-linked H tone:

(22) Delinking   X X
                        H

The DL rule applies iteratively to delink a H from a TBU on the left if it is associated with a TBU on the right. A derivation illustrating the application of these rules is given in (23).

| (23) | | |
|---|---|---|
| | UR | /akabónela/ H |
| | IS | akabónéla H |
| | SS | akabónélá H |
| | DL | akabonelá |

It might seem undesirable to posit two spreading rules which, in effect, perform the same task. But there is good evidence that the two rules are, in fact, different. We will see that IS only applies within the domain of the word, but SS applies across word boundaries and within words. Additionally, IS has a restriction that it cannot spread a H tone if that would result in two adjacent H tones. SS is not restricted in this way. Finally, there are two rules which apply between IS and SS, directly showing that there are in fact two separate rules.

The restriction that Initial Spreading only applies word internally can be seen by comparing (24a) with (24b):

```
(24)  UR    a. /kupá amahagala/    b. /akabóna amahagala/
                  |                        |
                  H                        H

      IS       N/A                  akabóná amahagala
                                          H

      SS       kupá ámahagala       akabóná ámahagala
                  H                        H

      DL       kupa ámahagala       akabona ámahagala
```

In (24b), both IS and SS apply. We expect both to apply in (24a), but only one spreading rule does. Since SS applies across a word boundary in (24b), we conclude that it is IS which is a lexical rule, that is, it may only apply word-internally. Under the metrical accont of tone shift, we incorrectly predict the form **kupa amáhagala*.

The fact that the metrical rule HTS cannot spread the H from /bá/ to the H-toned syllable /bón/ in (25) points to a problem with the assumption that there is a single spreading rule. H cannot spread to /bón/ because /bón/ is already linked to a H tone. HTS, like the other spreading rules presented here, spreads H only to a toneless vowel. It is a standard assumption that a given string either meets the structural description of a rule, which is then applicable, or it doesn't. HTS cannot apply to [bakúbonaníja] since the string beginning with /bá/ in [bakúbonaníja] does not meet the structural description of the rule, insofar as the foot-initial vowel is H toned.

```
(25)  UR    /bákubónanija/
              |   |
              H   H

      MSA   (*   *)(*   *)(*  *)
            bá-ku-bón-a nij-a
             |     |
             H     H

      HTS   (*   *)(*   *)(*  *)
            bá-kú-bón-á níj-a
              H     H
```

In fact, the rule applies anyway to the one free syllable in the foot and the H shows up on [kú], the adjacent syllable in the same foot. This provides further evidence that there is not a single rule, but several rules, which spreads H tone in Sukuma. Failure of one spreading rule does not entail failure of all spreading rules.

### 4.2 Phrasal Spreading

We have previously seen that there are times when the H shifts three syllables. This happens only when H has spread from one word into a following noun or adjective. Thus, we find shifts of three syllables in [akabona mahágala], but shifting of only two syllables in [akubonaníja].

| | | | | |
|---|---|---|---|---|
| (26) | a. /a-ka-bón-a mahagala/ | → | [akabona mahágala] | "he saw tree forks" |
| | b. /a-ka-bón-anij-a/ | → | [akabonaníja] | "he saw simultaneously" |

The rule responsible for this phenomenon is Phrasal Spreading (PS). The data available suggest that whenever a nominal prefix has a H tone and stands immediately before the stem, that prefixal H moves one further syllable to the right. The nominal prefix will only bear H tone when the H tone has spread there from the preceding word, which as we know can only happen by applying the rule SS.

(27) Phrasal Spreading   nominal [X   stem [X

H

The contrast between [akabona ma-hágala] and [akabona á-ma-hagala] is the motivation for restricting PS to only spread a H to a stem vowel. In (28a), after applying IS and SS, the H stands before a stem syllable, so PS spreads the H to the following stem vowel. In (28b), PS cannot apply because the H is not before a prefix vowel.

(28) a. /akabóna ma-hagala/ → akabóná má-hagala → [akabona ma-hágala]
b. /akabóna a-ma-hagala/ → [akabona á-ma-hagala]

The derivation for [akabona ma-hágala] is seen in (29):

(29)
IS akabóná ma-hagala
H

SS akabóná má-hagala
H

PS akabóná má-hágala
H

DL akabona ma-hágala

To summarize, there is a considerable degree of variation as to how many syllables a H tone may spread. If H spreads three syllables, IS, SS, and PS have applied. If H spreads two syllables, only IS and SS have applied. If H spreads one syllable, either IS or SS has applied.

### 4.3 Final Lowering

We now consider a phrase-final phenomenon whereby H tone gets lowered to XL. In the first case, a single final syllable is underlyingly attached to a H tone, as in (30a-b).

(30) a. /kupá/ → [kupà] "to give"
b. /badugú/ → [badugù] "relatives"

The second case, in (31), shows underlyingly that a H attached to the penultimate syllable of the phrase is realized as an XL tone on the last two syllables. This is exemplified in (31a-b):

(31) a. /akabóna/ → [akabònà] "he saw"
b. /babíti/ → [babìtì] "passers-by"

Final Lowering (FL) changes H attached to the phrase-final TBU to XL.

(32) Final Lowering X ]$_{\text{phrase boundary}}$ → X ]

| | | | |
|---|---|---|---|
| | X ] phrase boundary | → | X ] |
| | H | | XL |

The next question is the ordering of FL with respect to the spreading rules presented. The present analysis holds that IS and SS are separate rules; to support this claim, it was noted that there are rules which intervene between IS and SS. Final Lowering is one of those rules. When we look at the derivation of [akabònà] compared to [akabonelá], it is clear that FL is ordered between these two rules: FL can apply to either underlyingly final H or to H which stands on the final syllable by application of Initial Spreading, but not to H made final by Secondary Spreading.

| (33) UR | a. /akabóna/ <br> H | b. /akabónela/ <br> H |
|---|---|---|
| IS | akabóná <br> H | akabónéla <br> H |
| FL | akabònà <br> XL | N/A -since H not attached to final vowel |
| SS | N/A -since there is no vowel for H to spread to | akabónélá <br> H |
| DL | N/A | akabonelá |

We can now see a fundamental problem with Sietsema's analysis. If there were only one rule of High tone spread, we would expect [akabònà] and [akabonelá] to behave the same way. If FL were to apply before HTS, we would generate *[akaboná] and [akabonelá]; if FL were to apply after HTS, we would generate [akabònà] and *[akabònèlà]. Either FL would apply to both forms or to neither, depending on rule ordering. The fact that FL applies in (33a) [akabònà] and not in (33b) [akabonelá] presents a paradox. FL must be ordered after HTS to generate the correct form in (34a), but before HTS to generate (34b).

```
(34)  MSA  a.  (* *)(*  *)          b.  (* *)(*  *)(*)
               a-ka-bón-a                a-ka-bón-el-a
                     |                        |
                     H                        H

      HTS      (* *)(*  *)          FL  N/A --since H not
               a-ka-bón-a               attached to final
                     |/                 vowel
                     H

      FL       (* *)(*  *)          HTS (* *)(*  *)(*)
               a-ka-bòn-à               a-ka-bón-él-á
                     |/                       |/ /
                     H → XL                   H

      DL       N/A                      akabonelá
```

No ordering is possible between FL and a single rule of HTS. There is no problem if there is more than one rule of tone spread. The fact that FL is ordered between these rules further supports the existence of more than one spreading rule in Sukuma.

### 4.4 Meeussen's Rule

One final rule is needed. We would predict that when there are two underlying adjacent displacing H tones, tone spreading cannot apply and the leftmost H should surface. However, this is not the case. The first H does not show up at all.

```
(35)  a.  /batémí bákusola/  →  [batemi bakusóla]
            \/    |
            H     H

      b.  /a-ku-bá-bón-el-a/  →  [akubabonelá]
                |   |
                H   H
```

One explanation for the fate of the leftmost H tone, suggested in Sietsema, is that the two H's are fused into a single H, and delinking applies to the leftmost H-toned syllable. The correct explanation is that the H tone has been deleted directly by Meeussen's Rule.

Before considering the MR solution, I first show why tone fusion (TF) is wrong. Sietsema rejects a deletion analysis on the grounds that no matter where delinking is ordered, incorrect forms result. This argument against tone deletion is irrelevant, since it is grounded on the assumption that there is a single rule shifting H tone.The correct ordering of MR with respect to the other rules of the grammar will be given here, showing that there is no ordering paradox involved with Meeussen's Rule. It is claimed that TF explains both how the H of the object prefix [ba] blocks spreading of H from the subject prefix [ba], and how the correct delinkings are generated. In order for TF to work it must be ordered prior to HTS.

TF is able to handle the mapping from /akubábónela/ to [akubabonelá], but cannot handle certain data. The prediction of the tone fusion analysis is that two underlyingly adjacent distinct H's become the same H. Therefore, whatever happens to one of the H's will happen to the other. The Final Lowering rule provides us with a diagnostic for seeing if underlying adjacent

H's really do merge. The evidence from FL is that the tones do not merge: they do not surface with the same tones.

(36) UR a. /kubápá/ b. /kubábóna/
H H H H

TF kubápá kubábóna
H H

HTS N/A kubábóná
H

FL * kubàpà * kubàbònà

The tone fusion analysis does not generate the correct results: the actual forms are [kubapà] and [kubabònà]. A tone deletion rule can be formulated to account for the data. The rule I propose is a version of Meeussen's rule (MR) (Goldsmith (1984: 2)):

(37) Meeussen's Rule X X
H H

This rule iterates from left to right to delete the leftmost H tone in a pair of H tones. It is important to note how Meeussen's Rule fits in with the rule ordering already discussed. This rule will be ordered after IS, but prior to the other rules of the grammar. The evidence of (35a), [batemi bakusóla], shows that MR is also a post-lexical rule. Note too that the underlying form /bákubónela/ undergoes SS, but not MR, and surfaces as [bakúbonelá], which shows that MR does not apply to the output of SS. Were MR ordered after SS, the intermediate form *bakúbónélá* would incorrectly undergo MR becoming *bakubónélá* (eventually *[bakubonelá] by DL). Finally, underlying /batémi bákusola/ undergoes IS giving intermediate *batémí bákúsola,* which feeds MR giving *batemi bákúsola* (eventually [batemi bakusóla] by SS and DL. These ordering facts are completely consistent with the ordering (38):

(38) Lexical rules:
1. Initial Spreading

Phrasal/Post-lexical rules:
2. Meeussen's Rule
3. Final Lowering
4. Secondary Spreading
5. Phrasal Spreading
6. Delinking

Below are the correct derivations of [kubapà] and [kubabònà]:

(39) UR a. /kubápá/ b. /kubábóna/
H H H H

IS N/A kubábóná
H H

MR kubapá kubabóná
H H

FL kubapà kubabònà

Derivation (40a) shows that IS may not spread a H to a syllable which is immediately followed by a H-toned syllable. Were IS not so constrained, the H would be deleted by MR and the wrong form, *[bakubabonelá], would be generated. (40b) gives an example of IS applying, since the syllable it spreads to is not followed by a H-toned syllable.

(40) IS a. bákubábónéla b. bákúsola
H H H H

MR bákubabónéla N/A
H H

SS,DL bakúbabonelá bakusóla

The data of (41a) and (41b) demonstrate that, unlike IS, both SS and PS may apply to spread a H tone to a syllable that is adjacent to another H-toned syllable.

(41) UR a. /akabóna batémí bataale/ b. /akabóna badugú bataale/
H H H H

IS akabóná batémí bataale akabóná badugú bataale
H H H H

SS akabóná bátémí bátaale akabóná bádugú bátaale
H H H H

PS akabóná bátémí bátáale akabóná bádúgú bátáale
H H H H

DL akabona bátemi batáale akabona badúgu batáale
H H H H

Again, the fact that H tone blockage only holds of one of the three spreading rules further supports the claim that there are in fact three separate rules of H-tone spread in Sukuma.

## 5. Conclusion

This paper has presented a non-metrical account of Sukuma tonology. I have examined the metrical analysis presented in Sietsema (1989), which suffered from problems in the formalism, such as requiring simultaneous spreading to multiple vowels and domain-internal extrametricality, as well as empirical problems. I have shown that a metrical account of Sukuma tonology is not necessary. There is substantial evidence to support the claim that there are several spreading rules in Sukuma. The data support the claim that there are three spreading rules. And finally, the non-metrical analysis predicts the facts of Sukuma, where the metrical analysis failed. Although there is evidence for a metrical level of structure to explain aspects of phonology in many languages, Sukuma does not present a convincing case for a metrical theory of tone.

## NOTES

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