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ABSTRACT

VOWEL/GLIDE ALTERNATION IN A THEORY OF CONSTRAINT INTERACTION

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This dissertation examines the distribution of high vowels and glides using Prince and Smolensky's Optimality Theory, which proposes that phonological constraints are violable and hierarchically ranked. The distribution of high vowels and glides is shown to be a consequence of simultaneously comparing moraic and nonmoraic syllabifications of high vowels for satisfaction of phonological constraints. In brief, a high vowel surfaces when the moraic parse best satisfies the constraints and a glide surfaces when the nonmoraic parse best satisfies the constraints. This dissertation investigates three main phenomena associated with the distribution of high vowels and glides.

First, it treats the syllabification of vowel sequences in a number of languages with only surface monophthongal vowels. In Etsako, Luganda, Kimatuumbi, and Ilokano, high vocoids are syllabified as vowels when followed by a consonant, but there are syllabified as their nonmoraic counterparts when followed by another vowel. Furthermore, the syllabification of nonhigh vowels varies across these languages. The syllabification of vowel sequences is shown to follow from the interaction of syllable structure constraints that ensure the surface vowel is a monophthong. The interlinguistic variation in syllabification is shown to follow from different rankings of the same set of syllable structure constraints.

Second, stress can influence the distribution of high vowels. In Lenakel and Spanish, the generalization is that a high vocoid adjacent to a nonhigh vowel is a vowel when stressed otherwise it is a glide. This generalization implies that stress placement must be known prior to syllabification, which is problematic in procedural approaches to constituent construction, where syllabification must precede metrification. In the Optimality-Theoretic approach, the distribution of high vowels is determined by simultaneously best satisfying the metrical and the syllable structure constraints.

Third, the distribution of high vowels and glides cannot always be attributed to an alternation between underlying vowels and glides. In a language like Berber, glides must be present underlyingly, and these underlying glides can alternate with high vowels. This is often called glide vocalization. The alternation between underlying glides and high vowels in Berber is also shown to be the result of constraint interaction. In this case, moraic and nonmoraic syllabifications of the underlying glide are compared for constraint satisfaction.

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CHAPTER 1

INTRODUCTION

1.1 Overview

The alternation between high vowels and glides is shown here to follow from the interaction of phonological constraints as defined by Prince and Smolensky's (1993) Optimality Theory. The alternation stems from simultaneously comparing moraic and nonmoraic parses of high vocoids for constraint satisfaction. A glide surfaces when the nonmoraic parse best satisfies the constraints. The approach to the vowel/glide alternation in Optimality Theory differs significantly from approaches proposed in other frameworks, which rely on the use of levels of syllabification and resyllabification. In Optimality Theory, the alternation is seen as a result of maximally parsing segments with respect to independently required constraints that are ranked hierarchically in a given language. Therefore, there is no need for processes that refer specifically to the syllabification of high vowels.

This dissertation contains four chapters. The first chapter provides an introduction to Prince and Smolensky's Optimality Theory and a discussion of the syllable structure constraints used in the following chapters. The second chapter discusses the syllabification of vowel sequences in languages that have only monophthongal surface vowels. A common pattern found in these languages is that a high vowel, when followed by another vowel, surfaces as its nonmoraic counterpart. This is traditionally known as Glide Formation. Nonhigh vowels in the same environment show different phenomena cross-linguistically. The syllabification of underlying vowel sequences is examined in a number of languages. In every case, it is shown that the syllable structure constraints interact to ensure only monophthongal surface vowels and the different phenomena effecting vowel sequences in different languages reflect differences in the ranking of the same set of syllable structure constraints.

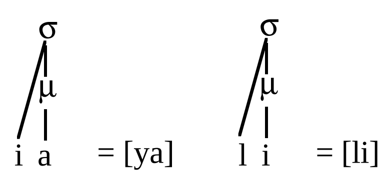
Chapter 3 examines the effects of stress in the alternation between high vowels and glides. In Spanish, for example, the distribution of high vocoids is characterized as follows: high vocoids, when adjacent to nonhigh vowels, are syllabified as vowels when stressed otherwise they are glides. The reference to stress in the distribution generalization means that stress is relevant to syllabification. This is in contrast to the view that syllabification must precede the building of foot structure. In Optimality Theory, the influence of stress is shown to be a consequence of metrical constraints conflicting with syllable structure constraints. The interaction between these two types of constraints is shown to account for high vocoid distribution in Lenakel and Spanish.

The second and third chapters concern alternations of high vocoids specifically when the high vocoids are adjacent to other vowels. The fourth chapter investigates two other sources of glides. Some languages have epenthetic glides homorganic to the preceding high vowel. It is shown here that homorganic glide epenthesis also occurs as a consequence of constraint satisfaction. The last phenomenon associated with high vowels that is examined is vocalization of underlying glides. Following Guerssel (1986), the distribution of high vocoids in Berber, for example, can only be accounted for by admitting an underlying contrast between vowels and glides. Furthermore, surface high vowels alternate with these underlying glides. This alternation, known as Glide Vocalization, is shown to be a consequence of constraint interaction as well. As in all cases of high vocoid alternation, a moraic parse and a nonmoraic parse are simultaneously evaluated for constraint satisfaction. The difference in Berber is that the high vocoid is underlyingly consonantal.

1.2 The Vowel/Glide Alternation

The articulatory similarities between the high vowels [i] and [u] and the glides [y] and [w] have long been observed. Furthermore, it has also long been noted that the difference between high vowels and glides is a difference of affiliation within the syllable, that is, high vowels occur as syllabic peaks and glides occur in non-peak positions. For example, de Saussure recognized that the difference between a word like *fidèle* and *pied* is that the [i] of the former is a *sonant* and the [i] in the latter it is an *adsonant* on a par with other consonants. In hierarchical representations of the syllable, the difference between a vowel and a glide corresponds to the subsyllabic constituent that dominates the high vocoid (see Clements and Keyser 1983, Kaye and Lowenstamm 1984, Levin 1985). In Moraic Phonology (Hyman 1985, McCarthy and Prince 1986, Hayes 1989), which is assumed here, the difference between vowels and glides corresponds to association to a mora. As shown in (1), a glide is a high vocoid linked directly to the syllable node and a vowel is a high vocoid linked to a mora.

(1)



High vowels and glides are often in complementary distribution where the former appear between consonants and the latter appear between vowels. The complementary distribution of high vowels and glides naturally leads to one set of high vocoids being posited in the underlying representation with the surface distribution determined by independently required rules of syllabification rather than rules that convert vowels into glides (Steriade 1984, Levin 1985, Guerssel 1986, Deligiorgis 1988, Waksler 1990). Furthermore, since syllabic affiliation determines the distribution of high vocoids, it has been proposed by Steriade (1984) and Waksler (1990), among others, that underlying high vocoids need not be specified for some major class features. This follows from the fact that the subsyllabic constituents (at least in some theories of the syllable) provide the information contained in some major class features. Chomsky and Halle (1968) implicitly recognize the relation between complementary distribution and the representation of high vocoids in the markedness convention for [vocalic].

(2) $$[\text{u vocalic}] \rightarrow \left\{ \begin{array}{l} [\text{+voc}] \,/\, \text{C} \,\_\_ \\ [\text{-voc}] \,/\, \left\{ \begin{array}{l} [\text{+cons}] \\ \left\{ \begin{array}{l} + \\ \text{V} \end{array} \right\} \_\_ \end{array} \right\} \end{array} \right\}$$

Besides the obvious case where a [+cons] must also be [-vocalic], this marking convention captures the basic pattern of the complementarity of vowels and glides. From one representation, a vocoid becomes [+vocalic] when following a consonant and it becomes [-vocalic] when following a vowel. As will be shown below, the spirit of Chomsky and Halle's markedness convention has been preserved in most subsequent analyses of vowel/glide alternations.

In many analyses of vocoid distribution, underspecification of the major class features is a consequence of the procedural nature of syllabification, which is viewed as a process by which segments are grouped into their constituents. To accomplish this without recourse to rules that convert vowels into glides, high vocoids are not specified for [syllabic]. Steriade's (1984) theory of syllabification exemplifies this point.

Steriade's basic syllabification rules are the CV Rule, which groups a consonant and a following vowel into a syllable, and the Onset Rule, which forms onsets from consonants (unless language-specific restrictions force some consonants to be parsed as codas).

```
(3)      CV Rule:                σ
                                / \
                               O   R
                               |   |
                      C V →    C   V

         Onset Rule:      σ               σ
                         / \             / \
                        O   R     →     O   R
                        |   |          / \  |
                    C   C   V         C  C  V
```

The CV Rule applies freely in the syllabification of CV sequences. Problems emerge, however, when a high vocoid precedes a vowel, as in /Cia/. By the CV Rule, the vocoid must be dominated by a C on the CV tier so it should surface as a glide. If a high vocoid occurs between consonants, it must be dominated by a V on the CV tier. The question now is how to allow for this variability.

According to Steriade, the pattern of Cs and Vs on the CV tier is predictable from the major class features of the segments. Any [-syllabic] segment must be dominated by a C and any [+syllabic] segment must be dominated by a V. To capture the variable surface forms of high vocoids, Steriade claims that high vocoids are not specified for [syllabic], although the nonhigh vocoids are specified as [+syllabic]. Since high vocoids lack a specification for [syllabic], the CV Rule applies regardless and high vocoids receive their specification from the CV tier. Consider the following examples from Latin.

```
(4)   a.              →     O R R
                             | | |
        C X X C             C V V C
         | |  |  |           |  |  |  |
        p  i  u  s          p  i  u  s     →    [pi.us]

      b.              →     O R R
                             | | |
        X X V               C  V V
         |  |  |             |  |  |
        u  i  a             u  i  a        →    [wi.a]
```

In (4a), the CV Rule, applying from left-to-right, dictates that the high vocoid must be dominated by a V since it follows a C. Given certain restrictions on onsets in Latin, the high vocoid cannot be syllabified in the onset by the Onset Rule. In (4b), the Onset Rule ensures that the high vocoid must be dominated by a C and so it surfaces as a glide.

It is apparent that underspecification of [syllabic] follows from the procedural nature of the syllabification algorithm. If high vowels are specified as [+syll], the CV Rule will always syllabify them as vowels. A rule would then be required to convert them into glides. Since the vowel/glide alternation is a matter of syllabicity, their distribution should follow from the independently required syllabification algorithm. This is only possible if the algorithm determines the syllabic affiliation of the high vocoids.

Levin (1985) proposes an enriched theory of syllable structure that makes the feature [syllabic] redundant and so eliminates the [+syll]/[øsyll] partition of the vowels used by Steriade. According to Levin, vowels are specified as [-consonantal] and syllabic affiliation for all vocoids is determined by a nucleus (an N node) dominating a vocoid. The syllabification of vocoids is accomplished by three possible rules of N-placement.

(5)
Redundancy Rule: obligatory syllable head.
Phonological Rule: syllabic head if unsyllabified.
Lexically Marked: allows for underlying distinctions of syllabicity.

The Redundancy Rule of N-placement assigns nuclei to vowels in most cases and N-placement by phonological rule assigns nuclei to high vowels that are not syllabified as onsets. Following Guerrsel (1986), Levin allows for lexical assignment of nuclei to some high vocoids. Therefore, a language can contain the contrast in (6) in underlying representation.

(6) a. N
|
i

b.
i

According to Levin, lexically marked vocoids, as in (6a), must surface as vowels and cannot alternate with glides. This contrast is required in Berber where there are some vocoids that alternate and others that do not.

(7)	a.	i-ru		'he cried'
		y-ari		'he writes'
	b.	arba-y-u	*arbaw	'this boy'

According to Levin, the alternating high vocoids in (7a) have the underlying representation in (6b) and receive a nucleus by phonological rule. The nonalternating high vocoid in (7b) is lexically marked with a nucleus, as in (6a), hence it must always be a vowel.

Although theories of syllable structure and syllabification have changed, the basic problem of alternating high vocoids has led to some form of underspecification, be it feature underspecification or lexical marking of certain vowels. Hyman's (1985) theory of syllabification attempts to avoid the problem of lexical marking. Hyman, like Levin, eliminates [syllabic], but proposes an impoverished syllable structure that only contains an X-tier. The Xs serve as units of phonological weight which can also serve as anchors for tones. Since [syllabic] is redundant and all segments have weight underlyingly, vowels and consonants are distinguished by [consonantal]. According to Hyman, weight units can be removed and indeed must be because onsets neither contribute syllabic weight nor do they bear tones. This generalization forms the basis of Hyman's syllabification algorithm and is called the Onset Creation Rule (henceforth OCR) which removes the weight unit of a prevocalic consonant. The output of the OCR is an onset linked to the weight unit of the vowel.

(8) Onset Creation Rule

x x
ǂ ç |
t a

The OCR is similar to Steriade's CV Rule for both rules require that a prevocalic consonant is organized into the same syllable as the vowel it precedes. Hyman, however, claims that the OCR is preferable because it also accounts for the above mentioned properties of onsets.

The leading idea behind the OCR is that syllabification organizes [+cons] and [-cons] segments by placing them under one weight unit. The reliance on [consonantal] for this organization has specific consequences for high vocoids which can surface as either [+cons] or [-cons], but their underlying specification remains a question. Hyman proposes that glides are always [+cons] on the surface and vowels are always [-cons]. This distinction allows the same syllabic representation to be interpreted in two different ways depending upon the specification for [cons].

```
(9)     a.   x                  b.        x
            2                            2
           k   i   a                    k   i   a
            [+cons]                       [-cons]
            =[kʸa] or [kya]             =[kya]
```

In (9a), the vocoid is a glide and so it is phonetically interpreted as part of the onset either as part of a complex segment or as a consonant-glide sequence. (9b), on the other hand, contains a rising diphthong because the [-cons] specification forces the vocoid to be interpreted as a vowel.

Hyman's [+cons] specification of glides leads to a different account of the Berber facts mentioned above. Since all segments have weight underlyingly, there are no lexically marked vowels. Hyman proposes that the alternating vocoids in (7a) must involve [+cons] glides and the OCR.

```
(10)      a.  /y +ari/ → [yari]

              X   X   X   X   →      X       X
              |   |   |   |          /\      /\
              y   a   r   i         y a      r i

          b.  /y+ru/  → [iru]

              X   X   X       →      X       X
              |   |   |              |       /\
              y   r   u              y       r u
```

In (10a), the OCR applies as it would to any other [+cons] segment so the high vocoid surfaces as a glide. In (10b), the OCR cannot apply; therefore, the [+cons] glide surfaces linked to its own weight unit. According to Hyman, this is the representation of a syllabic segment just like a nasal linked to its own weight unit is a syllabic nasal. A syllabic [y] is equivalent to [i].

Hyman's proposal eliminates lexical marking, but it encounters complications with respect to the specification of [cons] and Hyman admits that underspecification of high vocoids might be necessary to account for other types of glide formation. Although they propose different syllabification algorithms, underspecification is also used by Deligiorgis (1988) and Waksler (1990) to account for peculiarities in the distribution of high vocoids. Deligiorgis and Waksler investigate languages, like Berber, that contain high vocoids that must surface as vowels and others that alternate. They propose that this follows from specifying some high vocoids as [øcons] and others as [-cons] in underlying representation. Waksler, in fact, proposes the three possibilities below.

(11) [øcons]: high vocoid alternates.
[-cons]: high vocoid must be a vowel.
[+cons]: high vocoid must be a consonant.

This three way contrast for [cons] is dictated by the procedural approach to syllabification proposed by Waksler. The high vocoids identified as the vocoids that must surface as vowels are in fact stressed high vowels. A procedural approach to syllabification cannot have access to the locus of stress because syllabification must precede stress assignment. Therefore, the only way to account for the influence of stress is to specify these vocoids differently from the vowels that alternate.

The use of underspecification and a syllabification algorithm can only account for the basic complementary distribution of high vocoids, that is, glides occurring between vowels and high vowels occurring between consonants. Any other distribution of vocoids requires additional resyllabification rules. For example, glides in Luganda (which is discussed in detail in chapter 2) occur between a consonant and a lengthened vowel, e.g. /li+ ato/ → [lyaato]. For vowel lengthening to occur, the high vocoid must be a vowel at some level of representation and then a glide formation rule must apply. According to Steriade, the CV Rule assigns a V-slot to the high vocoid and Clements's (1986) Glide Formation, shown (12), then reassociates the high vocoid to the onset and the low vowel spreads to the empty V-slot.

(12)

```
C    V    V
d∑      f
 l    i     a to
```

Another case of glide formation occurs in Romanian where only unstressed high vocoids are glides, e.g. /studi+ u/ → [stúdyu] 'study'. The CV Rule once again assigns a V-slot to the high vocoid and the occurrence of the glide is due to a resyllabification rule called Contraction, which merges an unstressed high vocoid with the onset.

(13)

```
  σ     σ                 σ
 / \    |                / \
O   R   R       →       O   R
|   |   |              / \  |
C   X   X             C  X  X
    |   |                |  |
    i   u                i  u
[-stress]             [-stress]
```

These examples of glide formation from Luganda and Romanian cannot follow from initial syllabification without complicating the underlying representations. Deligiorgis, in fact, proposes a [-cons]/[øcons] underlying contrast for high vowels explicitly to avoid any interaction between syllabification and stress. In Steriade's approach, underspecification and procedural syllabification provide the initial syllabification to which the resyllabification rules apply.

To summarize, in previous analyses, the distribution of high vocoids is considered a consequence of independently required syllabification algorithms that are procedural in nature insofar as they all operate by grouping segments into progressively larger constituents. For the distribution of high vocoids to follow as a consequence of an algorithm, high vocoids are proposed to be underspecified for syllabicity. More complex distributions of high vocoids, as in Luganda and Romanian, require glide formation rules which are resyllabification processes. The procedural nature of syllabification, therefore, forces more complex underlying representations or additional rules or both. Eliminating procedural syllabification eliminates these complications from the grammar.

The proposal here shares with these previous proposals the view that the vowel/glide alternation is a result of syllabification. However, the proposal here differs significantly from these previous proposals with respect to the assumptions concerning syllabification and the role of constraints in phonology. Prince and Smolensky’s Optimality Theory proposes that syllabification is a consequence of best satisfying conflicting constraints that can lead to surface violations of constraints. Viewing the alternation between vowels and glides as consequence of constraint conflict eliminates the need for underspecification and repair strategies, such as Glide Formation. Glides are simply underlying high vowels that best satisfy the constraints by being parsed nonmoraically.

1.3 Optimality Theory

The main tenet of Prince and Smolensky’s (1993) Optimality Theory is that phonological constraints are ranked and violable; hence the phonetic form of an underlying representation can violate some constraints. This is contrary to the traditional view which assumes that phonetic forms are well-formed insofar as they satisfy all relevant constraints (see for example Calabrese 1988, Goldsmith 1991, Kaye, Lowenstamm and Vergnaud 1985, Myers 1991, Paradis 1989). Constraint violation in Optimality Theory must be minimal and this is achieved by defining the surface form as the form that best-satisfies (or minimally violates) the constraints with respect to other potential surface forms. The surface form is the preferred candidate form from the set of potential surface forms; hence the surface form is described as optimal or most harmonic.

The overview of Optimality Theory provided here summarizes Prince and Smolensky’s introduction. To begin, the surface form of a given underlying form is considered optimal or harmonic in comparison to other potential surface forms of the underlying form. The set of potential surface forms (called candidates) is generated by a function called GEN applied to an underlying form. The surface form, that is, the preferred candidate, is chosen by an evaluation procedure.

(14) $\text{GEN}(\text{input}_i) \rightarrow (\text{cand}_1, \text{cand}_2, \text{cand}_3, \ldots\text{cand}_n)$
$\text{Eval}(\text{cand}_1, \text{cand}_2, \text{cand}_3, \ldots\text{cand}_n) \rightarrow [\text{output}_i]$

According to Prince and Smolensky, GEN produces candidate surface forms based on very general conditions. For the purposes of this work, the candidate produced by GEN will consist of all possible syllabifications and metrifications of an underlying form. The burden of the work of the grammar in Optimality Theory falls on the evaluation of the candidate surface forms produced by GEN. Evaluation entails simultaneously comparing each candidate surface form for constraint satisfaction, which is discussed in detail below. Universal grammar in Optimality Theory, as proposed by Prince and Smolensky (1993), consists of GEN, the evaluation procedure, and the set of constraints.

By having an evaluation procedure that compares potential surface forms for constraint satisfaction, some constraint violations are tolerated in surface forms. These surface violations arise through conflict between constraints that cannot be simultaneously satisfied by any potential surface form. When two constraints conflict, a candidate that violates one constraint must be deemed more harmonic (or optimal) than a candidate that violates the other constraint. The constraints in Optimality Theory, therefore, are violable and furthermore the constraints must be hierarchically ranked with respect to each other in order to determine a surface form. The constraints, as mentioned, are supplied by universal grammar, but the hierarchical ranking of the constraints is language-specific. Thus, all differences among languages are accounted for by different rankings of the constraints. The violability and ranking of constraints are two of the four defining properties of Optimality Theory outlined by Prince and Smolensky (1993). These properties are given below.

(15)	Violability:	Constraints are violable; but violation is minimal.
	Ranking:	Constraints are ranked on a language-particular basis: the notion of minimal violation (or best-satisfaction) is defined in terms of this ranking.
	Inclusiveness:	The candidate analyses, which are evaluated by constraint hierarchy, are admitted by very general considerations of structural well-formedness; there are no specific rules or repair strategies with specific structural descriptions or structural changes or with connections to specific constraints.
	Parallelism:	Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set.

All constraints are independently necessary constraints in the grammar whose only interaction with other constraints is defined by the hierarchical ranking. Constraints are not satisfied by having associated with them particular repair strategies (cf. Paradis 1989, Goldsmith 1991). For example, a language might have strict phonotactic restrictions on possible codas. If by morphological concatenation an illicit coda appears, that coda is “fixed” by some rule in repair strategy approaches. Repair strategies are unnecessary in Optimality Theory because GEN produces a set of candidates that includes results of all possible repairs. This is the property of Inclusiveness.

Optimality is determined by simultaneously comparing all candidates with respect to the complete hierarchy of ranked constraints. This is the property of Parallelism, which differs significantly from what Prince and Smolensky call serial harmony, which involves determining a surface form by applying an evaluation procedure to produce a candidate that is then evaluated again until a unique surface form is found.

The remainder of this section explores Optimality Theory in more detail by illustrating the notion of constraint conflict and harmonic evaluation. This is shown in very general terms before turning to the constraints required for the analyses of vowel/glide alternations.

The resolution of constraint conflict is determined by the hierarchical ranking of the constraints. Following the overview provided by McCarthy and Prince (1993a), constraint conflict and interaction can be demonstrated by imagining a language L with constraints A and B. The grammar of L will pair underlying forms with surface forms by generating a candidate set for each underlying form. As mentioned before, for each underlying form ($input_i$) there is a surface form ($output_i$) which is the candidate from the set ($candidate_1$, $candidate_2$…$candidate_n$) that best satisfies the constraint ranking. Assume that for $input_i$ there are two candidate surface forms generated by the grammar; $candidate_1$ violates constraint A and $candidate_2$ violates constraint B. Furthermore, suppose that $candidate_2$ is the correct surface form irrespective of the violation of B. The fact that there is complementary constraint satisfaction, that is, $candidate_1$ violates A and $candidate_2$ satisfies A and $candidate_1$ satisfies B and $candidate_2$ violates B, is sufficient to determine the ranking of A and B. The violation of A by $candidate_1$ is fatal insofar as $candidate_1$ cannot be the optimal surface form. In this case, A decides which candidate is optimal and the violation of B by $candidate_2$ is irrelevant. To express the priority of A over B in deciding the output form, we say that A dominates B. This is written as A » B and means that A is ranked higher than B in the constraint ranking for L. The constraint ranking is illustrated in a 'constraint tableau' in which the rows correspond to each possible candidate and the columns correspond to different constraints ranked in order from left-to-right.

(16) A » B, /$input_i$/

Candidate	A	B
$cand_1$	*!	
+ $cand_2$		*

Prince and Smolensky have developed the following convention for interpreting constraint tableaux: 1. constraint ranking is interpreted from left to right, that is, the highest ranking constraints are listed in the leftmost columns, 2. a constraint violation is marked by a '*' and constraint satisfaction is not marked, 3. constraint violations accompanied by a '!' indicate a fatal violation which is responsible for the nonoptimality of a candidate, and 4. a '+' marks the optimal candidate. The simultaneous comparison of the candidates for constraint satisfaction starts with the highest ranking constraint, A, which in (16) is violated by $cand_1$ and satisfied by $cand_2$. $Cand_1$, therefore, is less harmonic than $cand_2$. Since there are no other candidates to consider, $cand_2$ is optimal and so it is the surface form.

It is mentioned above that the violation of B by $cand_2$ is irrelevant. This is one of the crucial aspects of Optimality Theory: a constraint violation is only fatal when other candidates satisfy the same constraint. No constraint violation in itself is ever fatal. Note that optimality is not altered if both candidates violate B. Suppose another underlying form ($input_j$) from L produces the following candidate set.

(17) A » B, /$input_j$/

Candidate	A	B
+ $cand_1$		*
$cand_2$	*!	*

For $input_j$, $cand_2$ violates A and both candidates violate B. The deciding constraint violation is still A since $cand_1$ satisfies it and $cand_2$ violates it. The violation of B by both candidates is irrelevant because the violation of A by $cand_2$ (as indicated by '*!') is fatal and so $cand_1$ is most harmonic.

Two candidates can tie with respect to satisfaction or violation of any given constraint. This is actually shown in (17), but it is irrelevant because satisfaction of A is decisive. Assume another underlying form from L which produces the following candidate set.

(18) A »B, /$input_k$/

Candidate	A	B
$cand_1$		*!
+ $cand_2$		

$Input_k$ produces candidates that both satisfy A; hence A does not contribute to deciding optimality. As a result of this tie with respect to satisfying A, the next constraint in the ranking must be consulted. For $input_k$, $cand_1$ violates B whereas $cand_2$ satisfies B. Therefore, the violation of B by $cand_1$ is fatal and $cand_2$ is the optimal output. Looking at (18) another way, $cand_2$ satisfies both constraints (i.e. all the constraints), so it would naturally be preferred to the other candidate regardless of constraint ranking. A situation similar to (18), where both candidates tie with respect to the higher ranking constraint, is a candidate set where both candidates violate A. Assume an $input_t$ from L produces the following candidate set.

(19) A » B, /$input_t$/

Candidate	A	B
+ $cand_1$	*	
$cand_2$	*	*!

Both candidates violate A and so A makes no contribution to the matter of optimality. As in the tie in (18), the next constraint in the ranking must be consulted. In (19), $cand_2$ violates B, which is fatal, whereas $cand_1$ does not ; hence $cand_1$ is the preferred candidate.

The last type of tie to consider is when multiple violations of a constraint occur in the same candidate. For example, consider $input_n$ from L which produces the following candidate set.

(20) A » B, /$input_n$/

Candidate	A	B
$cand_1$	**!	
+ $cand_2$	*	

The multiple violations of A in $cand_1$ is less harmonic than the single violation in $cand_2$. Therefore, $cand_2$ is the preferred candidate. It is important to note that constraint violations are not being counted. $Cand_1$ and $cand_2$ are being compared for violations of A. Both violate it so there is a tie and so both candidates are compared with respect to A again. On the second pass, $cand_1$ violates A but $cand_2$ does not. Constraint A is now decisive and its violation in $cand_1$ is fatal.

In summary, the surface form of an underlying form is the preferred candidate from the candidate set produced by GEN. The preferred candidate is most harmonic (or optimal), that is, it has the highest success of constraint satisfaction when compared to other candidates. The evaluation of optimality proceeds as follows: all candidates are simultaneously evaluated with respect to the constraint hierarchy. Any candidate that violates a high ranking constraint is nonoptimal and the candidates that satisfy the constraint are evaluated with respect to the next highest constraint in the hierarchy. This is repeated until only one candidate remains.

Although surface violations of constraints are possible, these violations occur only under duress to satisfy higher ranking constraints. For example, the violation of B in L occurs in [$output_i$] because the other candidate violates the higher ranking constraint A. In any other circumstance, the violation of B is fatal, e.g. [$output_k$] and [$output_t$], where there is a tie with respect to A. The fact that constraint conflict occurs only under duress minimizes constraint violation. Similarly, multiple violations of constraints are always less harmonic than single violations of a constraint. For example, consider the candidate set for $input_m$.

(21) A » B, /$input_m$/

Candidate	A	B
$cand_1$	*	**!
+ $cand_2$	*	*

The candidates tie with respect to A, but the second violation of B is fatal for $cand_1$; therefore, $cand_2$, which minimally violates B, is preferred.

It is important to note that constraint interaction is defined by ranking. Two constraints can be ranked only when satisfaction of one in the optimal candidate leads to a violation of the other constraint in a nonoptimal candidate. This is the ranking configuration in (16) for constraints A and B in L. Given this definition of constraint interaction, it is possible that two constraints are not ranked with respect to each other. This is represented in the constraint tableau as a dotted line between columns. So assume language L has a constraint C that is ranked above B, but is it not ranked with respect to A.

(22) A, C » B, /$input_n$/

Candidate	A	C	B
$cand_1$	*		*!
+ $cand_2$		*	

Violations of A and C are treated as equal because these constraints are not ranked with respect to each other. Constraint B, therefore, is called upon to decide the preferred candidate. $Cand_2$ is the preferred candidate since it satisfies B and $cand_1$ violates it.

1.3 Syllable Structure Constraints

The primary role of syllabification in Optimality Theory, according to Prince and Smolensky, is to incorporate segments into higher prosodic constituents. Segments that are licitly incorporated are prosodically licensed (Itô 1986, 1989) and segments that are not incorporated violate prosodic licensing. Optimality Theory makes use of prosodic licensing through constraints which require the parsing of all phonological constituents i.e. segments, moras, syllables, feet. This means that all phonological units must be dominated by the appropriate node of the prosodic hierarchy (Selkirk 1980, McCarthy and Prince 1986, 1990a,b). Phonological units are said to be “parsed” insofar as they are properly incorporated into higher prosodic constituents. Optimality Theory provides a number of constraints that ensure parsing; for example, PARSE-SEGMENT requires that all segments belong to syllables and PARSE-μ requires that all moras are parsed into syllables.[1]

Critical to the theory of syllabification is the interaction of PARSE-SEGMENT (henceforth PARSE) and the syllable well-formedness conditions. Consider the interaction of PARSE and the syllable structure constraint NOCODA (Prince and Smolensky 1993) which states that syllables are open, that is $*C]_\sigma$. This can lead to either a closed syllable or

[1]PARSE will be shown to be a family of constraints which refer to the different nodes of phonological structure, that is, PARSE-PLACE, PARSE-FEATURE, PARSE-σ.

the failure of a segment to appear in the phonetic form. Leaving a segment unparsed to ensure that the syllable is open shows that NOCODA is ranked above PARSE.[2]

(23) NOCODA » PARSE, /CVC/

Candidate	NOCODA	PARSE
CVC.	*!	
+ CV. <C>		*

NOCODA and PARSE truly conflict because there is no way to simultaneously satisfy both constraints. The surface violation of PARSE is compelled by the satisfaction of NOCODA.

A language in which /CVC/ surfaces as [CVC] has a parse of all underlying segments even though NOCODA is violated. In this language PARSE dominates NOCODA, as shown in (24).

(24) PARSE » NOCODA , /CVC/

Candidate	PARSE	NOCODA
+ CVC.		*
CV. <C>	*!	

Once again, the constraints conflict because there is no way for all segments to surface without creating a coda. The violation of NOCODA is compelled by the satisfaction of the higher ranking PARSE.

The ranking in (23), where NOCODA dominates PARSE, shows how conformity to a well-formedness constraint can lead to a deviation from the underlying form by leaving the final consonant unparsed. Syllable structure constraints are often satisfied by epenthesis, which is one way to ensure that all segments of the underlying form are parsed while satisfying the syllable well-formedness constraints. According to Prince and Smolensky, the position of epenthetic segments follows from empty positions which are posited to fill out syllabic templates (Selkirk 1981, Itô 1986, 1989). In Optimality Theory, epenthesis is governed by a constraint called FILL (Prince and Smolensky 1993) which states that all nodes of syllable structure must licence segments. FILL, like PARSE, interacts with syllable structure constraints. For example, violations of NOCODA can occur at the expense of satisfying FILL. This is shown in (25).

(25) FILL » NOCODA , /CVC/

Candidate	FILL	NOCODA
CV.CΔ.	*!	
+ CVC.		*

[2]Note that the final consonant is not deleted. The notion of deletion has no function in Optimality Theory; segments that do not surface are simply left unparsed (Prince and Smolensky 1993).

(25) shows a surface violation of a syllable structure constraint to satisfy the restriction against epenthesis. The opposite ranking produces the conditions under which epenthesis occurs. This is shown in (26) where the satisfaction of NOCODA leads to positing an empty vowel position.

(26) NOCODA » FILL, /CVC/

Candidate	NOCODA	FILL
+ CV.CΔ.		*
CVC.	*!	

Consonantal epenthesis occurs when FILL conflicts with ONSET (Itô 1986, 1989) which prohibits vowel-initial syllables, that is $*_{\sigma}[V$. If ONSET dominates FILL, then a form like /CVV/ will prefer an onset at the expense of having an empty position, that is [CV.ΔV].

(27) ONSET » FILL, /CVV/

Candidate	ONSET	FILL
+ CV.ΔV.		*
CV.V	*!	

Prince and Smolensky call PARSE and FILL faithfulness constraints since these constraints ensure that the surface form is as close as possible (or faithful) to the underlying form. Violations of PARSE lead to underparsing of the underlying form and FILL violations lead to overparsing since FILL violations allow for epenthetic segments. Deviations from the underlying form occur as a consequence of syllable structure and metrical constraints interacting with PARSE and FILL.

The constraints on syllable structure well-formedness used here are very general in nature and most of them have been proposed elsewhere. Of particular interest is how these constraints interact with the faithfulness constraints to account for the syllabification of vocoids. The well-formedness constraints introduced in this section concentrate on the shape of syllabic nuclei. The inventory of syllabic nuclei in a given language is a consequence of the interaction of these constraints.

Languages exhibit little variety in the inventory of possible nuclei. There are actually four main types of nuclei: 1. short vowels, 2. long vowels, 3. rising diphthongs, and 4. falling diphthongs. All languages, of course, have short vowels, but the presence of other types of nuclei are regulated by constraints. Consider long vowels, which in moraic phonology, have two moras attached to a single vocalic melody (Hyman 1985, McCarthy and Prince 1986). Any language that prohibits long vowels must have a constraint like (28).

(28) No Long Vowels (NLV) * σ

```
 / \
μ   μ
 \ /
  V
```

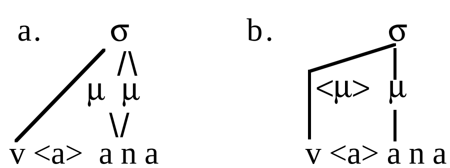
A prohibition against long vowels such as (28) has been proposed by many including Selkirk (1984), Paradis (1989, 1990), and Kaye (1989). The status of NLV in Optimality Theory is significantly different than in other frameworks. In theories of parameterized constraints (see Paradis 1989, 1990 and Kaye 1989), a language without long vowels has NLV set to ‘on’ and it is always satisfied. A language with long vowels has NLV set to ‘off’. In Optimality Theory, constraints are never turned off, rather they are low ranking and dominated by other constraints. Only when a constraint is undominated by other constraints is it always satisfied.

Since all languages have all constraints, a language with long vowels requires NLV to be dominated. One crucial constraint interaction is NLV and the faithfulness constraint PARSE-μ. This interaction can be demonstrated with an example from Shona (Myers 1987). According to Myers, Shona has only short, open syllables. Underlying vowel sequences that occur at certain morphological boundaries surface as short monophthongs.

(29)	/va+ nhu/	[vanhu]	‘people’
	/va+ ana/	[vana]	‘children’

To see the constraint interaction, assume that there is a mora for each vocoid in the underlying representation. This means that there are at least the two candidate syllabifications of /va+ana/ in (30) that must be considered.

(30) [va.na] [va:.na]



(30a) violates NLV and (30b) violates PARSE-μ. The two constraints cannot be satisfied in the preferred candidate because there is no candidate that contains a parse of both moras and has a short vowel. Since the surface form has a short vowel, NLV must dominate PARSE-μ.[3]

[3] Length is represented in the tableaux as a colon.

(31) NLV » Parse-μ, /va+ ana/

Candidate	NLV	Parse-μ
(30a) + v<a>a<:>na		*
(30b) v<a>a:na	*!	

Note that both candidates contain a violation of Parse, which arises from interaction with other constraints. This is discussed in detail in chapter 2. In (31), both candidates tie with respect to Parse; therefore, this constraint violation is not fatal.

In Optimality Theory, according to Prince and Smolensky, all constraints exist in all languages and typological variation is a consequence of different constraint rankings. The reverse of the ranking in (31) entails there should be a language that prefers to parse moras at the expense of creating a long vowel. Such languages not only exist, but all cases of long vowels are produced by this ranking. This can be seen in Luganda (Clements 1986), which is discussed in detail in chapter 2. Luganda, unlike Shona, has contrastive vowel length so a sequence of two low vowels surfaces as a long vowel, e.g. /ka+ ana/ → [ka:na] 'children'. The candidate syllabifications shown in (30) are produced by the grammar of Luganda as well. In Luganda, however, the preferred candidate has both moras parsed at the expense of a violation of NLV. Therefore, Parse-μ is ranked above NLV.

(32) Parse-μ » NLV, /ka+ ana/

Candidate	Parse-μ	NLV
+ k<a> a:na		*
k<a>a<:>na	*!	

More complex nuclei such as diphthongs require constraints that dictate geometric configurations and sonority relations between adjacent vowels. Diphthongs are similar to long vowels insofar as they are bimoraic, but the difference, of course, is that the two moras of a diphthong are linked to two separate vocalic root nodes. From this configuration, a constraint (called No Diphthongs) can be established that prohibits two moras linked to two vowels (cf. Paradis 1990).

(33) No Diphthongs (NoDiph)

```
  *σ
  / \
 μ   μ
 |   |
 Vi  Vj
```

The absence of diphthongs in a language is the result of NoDiph ranked as an undominated constraint. Conversely, the presence of diphthongs follows from NoDiph being dominated. This can be shown by comparing the ranking of NoDiph and Parse.

NODIPH is undominated in a language with only monophthongal vowels. When a vowel sequence occurs underlyingly, surface monophthongs can be maintained by leaving one vowel unparsed. This is the case in the Cushitic language Iraqw (Mous 1993).

(34)	a.	/hi:ma+ u +rén/	[hi:murén]	‘our rope’
	b.	/hhara+ ta+ í/	[hharatí]	‘this stick’
	c.	/dugno+ u +dá/	[dugnudá]	‘that finger’

The crucial candidate syllabifications that must be considered for (34a), for example, are shown in (35).

(35) a. hi:.m<a>u.rén.
b. hi:.mau.rén.

The surface form, (35a), has a PARSE violation which is more harmonic than the tautosyllabic parse of the vowels in (35b). Therefore, NODIPH dominates PARSE.

(36) NODIPH » PARSE, /hi:ma+ u +rén/

Candidate	NODIPH	PARSE
+ hi:.m<a>u.rén.		*
hi:.mau.rén.	*!	

The reverse ranking can be established in the Indonesian language Larike (Laidig 1992) which has diphthongs.

(37)	[lai]	‘here’
	[tau]	‘not yet’

In Larike, the diphthongal parse of the vowel sequence is preferred to leaving a vowel unparsed. Hence, PARSE dominates NODIPH.

(38) PARSE » NODIPH, /lai/

Candidate	PARSE	NODIPH
+ lai.		*
la<i>	*!	

PARSE and NODIPH clearly conflict in Iraqw and Larike. In Iraqw, maintaining surface monophthongs compels a PARSE violation and in Larike maintaining a faithful parse compels a violation of NODIPH. There are other ways to maintain surface monophthongs that require interactions of other constraints along with NODIPH. These interactions will be discussed throughout this work.

The formulation of NODIPH in (33) only refers to two vowels, but this is too general because it means that any vowel sequence can be syllabified tautosyllabically when NODIPH is dominated. Clearly, not any vowel sequence can form a diphthong, but only sequences that begin or end with a high vowel can. To exclude tautosyllabic sequences of nonhigh vowels, a sonority restriction (called Sonority Fall) is imposed so that tautosyllabic vowel sequences must have a decrease in sonority. In other words, the sonority of the first vowels must be greater than the sonority of the second vowel.

(39) Sonority Fall (SONFALL)

$$
\begin{array}{cc}
\multicolumn{2}{c}{*\sigma} \\
/ & \backslash \\
\mu & \mu \\
| & | \\
V_i & V_j
\end{array}
\qquad son_i < son_j
$$

SONFALL is part of a more general restriction that requires a fall in sonority from the syllable peak to the syllable margin, but this is not pursued here (see Clements 1990). The sonority hierarchy assumed here does not distinguish between mid and low vowels (cf. Selkirk 1984). The relevant distinction is that [i, u] are less sonorous than [e, o, a]. Therefore, combinations like [ae], [eo], etc. violate SONFALL. An apparent problem emerges because SONFALL prohibits combinations of high vowels like [iu] and [ui] that occur in Afrikaans (Lass 1987). To account for these diphthongs, SONFALL should be amended so that the sonority of the two vowels can be equal provided that the sonority of V_j is equal to the sonority minimum. The strong form of SONFALL in (39) is assumed here, but it seems that finer sonority restrictions are required.[4]

As formulated in (39), SONFALL does not include rising diphthongs since rising diphthongs require the sonority of the second vowel to be greater than the sonority of the first vowel. However, bimoraic rising diphthongs do occur and are often the result of diphthongization of a long vowel (Andersen 1972, Hayes 1990). Consider Slovak

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[4]SONFALL might be better understood as a scalar constraint (see Prince and Smolensky (1993)) that states that there is a preference for a maximal sonority distance between the vowels of a diphthong. This would account for the fact that all languages with diphthongs have at least [ai] and [au], but languages differ with respect to other tautosyllabic vowel sequences. This is not pursued here.

(Kenstowicz and Rubach 1987) which has six short vowels, three long vowels, and three rising diphthongs.

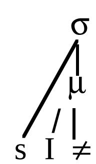
(40)

short		long		diphthongs	
i	u	í	ú	ie	uo
e	o			ia	
ä	a		á		

In the pursuit of a symmetrical vowel system, Kenstowicz and Rubach propose that the rising diphthongs are derived from the long vowels that are absent in (40), i.e. [ie] (<é), [uo] (<ó), and [ia] (<ä;). Their analysis of the rising diphthongs is based on the fact that long vowels and the diphthongs have the same distribution. They propose that there is a lengthening rule which produces long vowels which is then followed by the diphthongization of certain vowels. The nature of diphthongization in general is not well understood, for it is usually a morphologized process that applies to stressed vowels. In general, an account of the diphthongs in Slovak would require constraint interaction to create a diphthongized long vowel. This interaction would lead to surface violations of SONFALL.

Outside of diphthongization, bimoraic rising diphthongs are not common. However, rising diphthongs are often described as monomoraic. This is evident from the fact that rising diphthongs occur in languages without bimoraic nuclei (Kaye 1983, Paradis 1989). For example, the only vowel sequence allowed in Vata is a high vowel followed by a low vowel, but as Kaye (1982, 1983) notes, these sequences pattern as short vowels with respect to tonology and vowel harmony. These vowel sequences, therefore, require the monomoraic representation in (41).

(41)



Another property of rising diphthongs that indicates their monomoraicity is that they can occur in closed syllables, as in Italian and Spanish. According to Calabrese (1988), a metaphony rule in Italian spreads [+high] to the preceding vowel. If the target vowel is [-ATR], a rising diphthong occurs.

(42)

a.	pEte	piEti	‘foot/feet’
b.	lEnta	liEntu	‘slow fem./masc.’
c.	toso	tusi	‘boy/boys’
	vedo	te vidi	‘I see/ you see’

If the rising diphthong in (42b) were heavy, the syllable would exceed the bimoraic maximum on syllable weight. This is true of the bimoraic falling diphthongs which cannot occur in closed syllables.

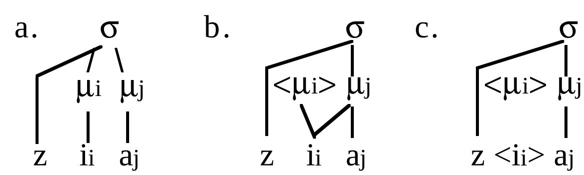
Monomoraic diphthongs are characterized by their particular configuration which is a mora branching to two vowels (cf. Kaye 1983, Schane 1987, Paradis 1990). This configuration is subject to a constraint called Branching-μ.

(43) Branching-μ (BRANCH-μ)

*μ
/ \
V_i V_j

BRANCH-μ is undominated in languages without monomoraic rising diphthongs, but it is dominated in languages with these syllabic nuclei. For example, a word like [zia] in Gere (Paradis 1990) has a BRANCH-μ violation compelled by conflict with the bimoraic parse of the vowel sequence. In other words, the segmental parse is maximized while respecting the constraint against bimoraic nuclei. Consider the following syllabifications of /zia/.[5]

(44) [zia] [z<u>ia</u>] [za]



(44a) violates NODIPH and (44c) violates PARSE. (44b) satisfies these two constraints, but violates BRANCH-μ and PARSE-μ. Once again there is constraint conflict since these constraints cannot be satisfied in the same candidate. In Gere, therefore, NODIPH and PARSE dominate BRANCH-μ and PARSE-μ.[6]

[5]The vowel [i_i] in (44b) is presumably linked to its mora μ_i, although the mora is not parsed into higher prosodic structure. PARSE-SEG is satisfied by the link from [i_i] to μ_j.
[6]Monomoraic diphthongs are represented in the tableau by an underline.

(45) NoDiph, Parse » Branch-μ, Parse-μ, /zia/

Candidate	NoDiph	Parse	Branch-μ	Parse-μ
(44a) zia	*!			
(44b) + zia			*	*
(44c) zi<a>		*!		

The independent constraints for syllabic nuclei imply there is a relative amount of freedom in possible inventories of syllabic nuclei. This appears to be correct since languages can have bimoraic falling diphthongs, but monomoraic rising ones (see Schane 1987, Chung 1989, Kaye 1989). This follows from the domination of NoDiph and Branch-μ, but SonFall is undominated. The typological distinctions captured by the constraints are set out in (46).

(46) Languages with:

short vowels only: NLV is undominated
NoDiph is undominated

long vowels only: NLV is dominated
NoDiph is undominated

falling diphthongs only: Branch-μ is undominated
NoDiph is dominated
NLV is undominated

rising diphthongs only: Branch-μ is dominated
NoDiph is undominated
NLV is undominated

falling and rising diphthongs: Branch-μ is dominated
NoDiph is dominated

The independence of the constraints is justified by the fact that there are languages like Luganda, discussed in chapter 2, where there are long vowels, but no diphthongs and languages like Spanish, discussed in chapter 3, that have diphthongs but no long vowels. Furthermore, the presence of monomoraic rising diphthongs in a language does not depend upon the presence of any other type of nuclei. Note that short vowels cannot be ill-formed in any language and co-occur with each language type in (46). This is due to the fact that an underlying form such as /CVCV/ is faithfully parsed as [CV.CV.] regardless of the ranking of the syllable structure constraints discussed here.

Interaction of the syllable structure constraints is exemplified by the syllabification of vowel sequences in Boumaa Fijian (Dixon 1988), which has several diphthongs and all other vowel combinations constitute two distinct syllables.

(47) a. diphthongs
ai, au, eu, oi, ou ex. [pu.lou]
b. hiatus
u.a, o.a, i.a, u.i, u.e, i.o ex. [va.nu.a] ‘place’

The diphthongs are accounted for by a tautosyllabic parse of the underlying vowel sequence, which must be preferred to a heterosyllabic parse. These candidate parses show that there is conflict between ONSET and NODIPH since there is complementary constraint satisfaction. Based on (47a), ONSET must dominate NODIPH.

(48) ONSET » NODIPH, /pulou/

Candidate	ONSET	NODIPH
+ pu.lou.		*
pu.lo.u.	*!	

In the hiatus cases in (47b), the first vowel has a greater sonority than the second. As in (48), the tautosyllabic and the heterosyllabic parses must be compared; this time, however, a tautosyllabic parse of the vowel sequences in (47b) violates SONFALL. If the vowels are parsed heterosyllabically, SONFALL is satisfied, although ONSET is violated. Therefore, SONFALL dominates ONSET.

(49) SONFALL » ONSET, /vanua/

Candidate	SONFALL	ONSET
va.nua.	*!	
+ va.nu.a.		*

Combining the rankings in (48) and (49) produces the ranking in (50), which is applied to the vowel sequences in (47).

(50) a. SONFALL » ONSET » NODIPH, /pulou/

Candidate	SONFALL	ONSET	NODIPH
+ pu.lou.			*
pu.lo.u.		*!	

b. SONFALL » ONSET » NODIPH, /vanua/

Candidate	SONFALL	ONSET	NODIPH
va.nua.	*!		*
+ va.nu.a.		*	

The ONSET violation is only harmonic in (50b) where the other candidate violates SONFALL. In (47a), SONFALL is satisfied by both candidates so the ONSET violation is fatal . The NODIPH violation is inconsequential, hence the surface form has a diphthong.

The constraints proposed here fail to prohibit monomoraic falling diphthongs, which according to Kaye (1982, 1983, 1989), do not occur. In moraic phonology, this means all falling diphthongs must be bimoraic. The obligatory bimoraicity of falling diphthongs would account for the fact that they generally do not occur in closed syllables, for this would create a trimoraic syllable since each vocoid is moraic and the coda consonant is also moraic. However, falling diphthongs are reported to occur in closed syllables. For example, Árnason (1980) notes that diphthongs in Icelandic can be either long or short, e.g. [daimÖ] ~ [daimdI] 'to judge' (past ~ pres.). Even though monomoraic variants of falling diphthongs can be found, such diphthongs are generally ill-formed. To ensure that falling diphthongs are bimoraic, a constraint is introduced that prohibits monomoraic falling diphthongs by restricting the sonority profile of a branching mora. The restriction is that the second vowel of the branching mora must be more sonorous than the first vowel.

(51) Sonority Rise (SONRISE)

$*\mu$

/ \

V_i V_j $son_i > son_j$

SONRISE is probably never violated; hence it may considered a property of GEN. This means that no violation of SONRISE occurs in any candidate. Cases of falling diphthongs in closed syllables can be accounted for by syllabifying the coda as a nonmoraic syllable appendix (Sherer 1993).

There are other constraints, besides the ones proposed above, that will be used in the following chapters. These constraints are introduced where appropriate. For example, the analysis of Spanish in chapter 3 requires interaction between the metrical constraints proposed by Prince and Smolensky and the analysis of homorganic glides in chapter 4 requires McCarthy and Prince's (1993a, b) ALIGN constraint.

1.5 Underlying Representations

The preceding discussion of the syllable structure constraints contains certain assumptions concerning the representation of the vowels. For example, it is assumed that there is a mora for each vowel. The moras, however, are not part of the underlying representation, but rather there presence is subject to constraint interaction.

In an Optimality Theoretic account of gemination in Pali, Zec (1992) modifies Hayes's (1989) Weight-by-Position by proposing that the mora associated with the assignment of weight-by-position is only introduced in the representation, but not linked to the coda consonant. Zec formulates Weight-by-Position as a constraint that coindexes a mora and the coda consonant. This is shown in (52).

(52) Weight-by-Position (WXP) (Zec 1992)

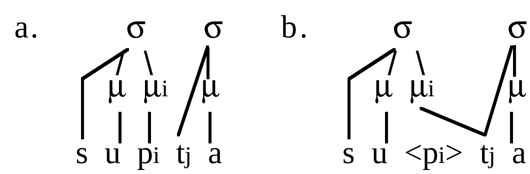
μ_i

C_i C_j

The role of the index itself is not germane to the discussion at the moment. The important contribution of Zec's Weight-by-Position is the disassociation between sponsoring the mora and the linking of the mora. The mora is introduced by a constraint and GEN produces a candidate set of possible linkings of which one is most harmonic. In other words, the surface form contains the linking of the mora that best-satisfies the constraint hierarchy.

In Pali, according to Zec, the only possible codas are homorganic nasals and the first half of a geminate. To account for this in Optimality Theory, the relevant constraints are PARSE-μ, which ensures the mora is parsed, and the Coda Condition (Itô 1986), which prohibits a place node in the coda that is not linked to the following onset. Given the formulation of Weight-by-Position in (52), Zec is able to illustrate how a geminate can surface in [suppa] from an underlying form like /sup+ ta/. Consider the possible syllabifications in (53).

(53) [sup.ta] [sut.ta]



Each syllabification violates a constraint. (53a), where the mora is linked to its coindexed consonant, violates the Coda Condition and in (53b), where there is a geminate, PARSE is violated. The violation of PARSE is compelled by the satisfaction of the Coda Condition. From this, Zec shows an argument can be made for ranking the Coda Condition above PARSE.

(54) CODA-COND » PARSE, /sup+ta/

Candidate	CODA-COND	PARSE
(53a) sup.ta	*!	
(53b) + su<p>t:a		*

Zec's coindexation provides an interesting approach to Pali gemination which is viewed as the result of maximizing the parse of moras and segments with respect to the constraint hierarchy. This maximal parse includes parsing the coindexed mora, but leaving a segment unparsed. In procedural approaches, Pali gemination is considered a case of compensatory lengthening (Hayes 1989) where Weight-by-Position links a mora to the coda consonant and then gemination applies after delinking of the coda. In Optimality Theory, compensatory lengthening has no role because there is no loss of a segment that feeds gemination. The combination of the geminate and the unparsed coda consonant is simply the maximal, i.e. most harmonic, parse of segments and moras with respect to the constraint hierarchy.

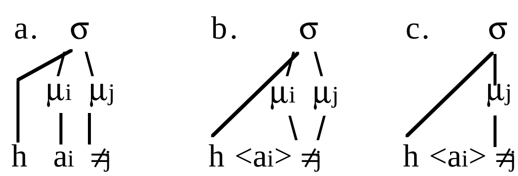
In a parallel fashion, a vowel has a coindexed mora and the linking of a mora to a vowel is dictated by constraint satisfaction (Kirchner 1992). Moras, therefore, are not present in underlying representation (McCarthy and Prince 1986), but rather the presence of moras is dictated by the constraint called Vowel-Mora in (55).

(55) Vowel-Mora (V-MORA)
For every vocalic root node rt_i, there is a mora μ_i.

V-MORA ensures that there is a mora for every vocoid, but the association of vowels to moras is a consequence of constraint satisfaction. Underlying long vowels consist of two moras coindexed to the same vocalic root node.

The role of V-MORA is illustrated with an example of derived vowel length in the Kwa language Igede (Bergman 1971), e.g. /ha+ ≠/ → [h≠≠] 'to give to him'. The fact that a long monophthong surfaces means that the number of surface moras is equal to the number of underlying vowels. In Optimality Theory, GEN produces a number of candidate linkings of the vowels and moras. Three candidate syllabifications that must be compared, shown in (56), have the vowels linked to their coindexed moras forming a diphthong, (56a), two moras linked to one vowel, (56b), and a monophthong as in (56c).

(56) [haO] [hO:] [hO]



The one-to-one linking of vowels to moras in (56a) violates NODIPH and the two-to-one linking in (56b) violates NLV (and PARSE). From this an argument can be made for ranking NODIPH above PARSE in Igede.

(57) NODIPH » NLV, PARSE, /ha+O/

Candidate	NODIPH	NLV	PARSE
(56a) + h<a>O:		*	*
(56b) haO	*!		

(56c), where there is a surface monophthong, violates V-MORA because the vowel /a/ does not have a corresponding mora. V-MORA and NLV clearly conflict since NLV is satisfied if the representation has only one mora. Therefore, V-MORA dominates NLV.

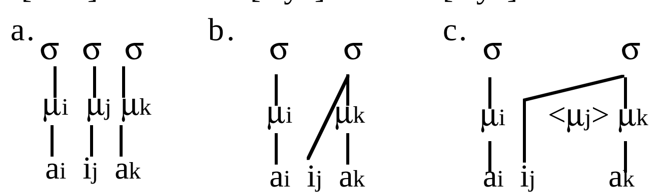
(58) V-MORA » NLV, /ha+O/

Candidate	V-MORA	NLV	PARSE
(56a) + h<a>O:		*	*
(56c) h<a>O	*!		

Igede is another example of maximizing PARSE with respect to the constraint ranking. The association of vowels to moras must satisfy NODIPH (as well as other constraints) at the expense of a PARSE violation.

V-MORA, like other constraints, can be violated. This means that constraint interaction can create a situation where the surface form does not have a one-to-one correspondence between vowels and moras. The environment that crucially requires a mismatch between underlying vowels and surface moras is a trivocalic sequence with a medial high vocoid. The high vocoid should satisfy V-MORA; however, they do not contribute weight. Consider the possible syllabifications of the sequence /aia/ that surfaces as [aya].

(59) [a.i.a] [a.ya] [a.ya]



The preferred candidate is (59b) even though it is phonetically indistinguishable from (59c). The fact that the high vocoid surfaces as an onset shows that ONSET is high ranking so (59a) is less harmonic than the other candidates. (59c) satisfies V-MORA since there is a coindexed mora for each vowel and (59b) violates V-MORA since the high vowel does not have a coindexed mora. If the interaction between ONSET and V-MORA were all that is required for [aya], (59c) would be preferred because this candidate satisfies both constraints. However, (59b) is proposed to be the more harmonic candidate. Therefore, (59c) must violate some other constraint ranked above V-MORA. This constraint is called Syllable-Segment, which states that segments linked directly to syllables cannot contribute weight.

(60) Syllable-Segment (SYLL-SEG)
if rt_i is linked directly to σ, then $*\mu_i$.

One consequence of SYLL-SEG is that onsets do not contribute weight. In this way, SYLL-SEG captures the essence of Hyman's (1985) Onset Creation Rule which removes the timing unit of an onset. In the constraint based approach pursued here, the absence of a mora is the result of conflict between SYLL-SEG and V-MORA. The preferred candidate in (59) has a V-MORA violation which is compelled by the satisfaction of SYLL-SEG.

(61) ONSET, SYLL-SEG » V-MORA, /aia/

Candidate	ONSET	SYLL-SEG	V-MORA
(59a) a.i.o.	*!		
(59b) + a.yo.			*
(59c) a.yo<:>		*!	

SYLL-SEG can be violated, as indeed it is when there is a geminate consonant. In the Pali example (53b) there is a root node linked directly to the syllable node plus the root node is linked to a mora which happens to be linked to the preceding syllable. The constraint responsible for the presence of the mora, WXP, compels a violation of SYLL-SEG.

(62) WXP » SYLL-SEG, /sup+ta/

Candidate	WXP	SYLL-SEG
(53a) su<p>.ta	*!	
(53b) + su<p>t:a		*

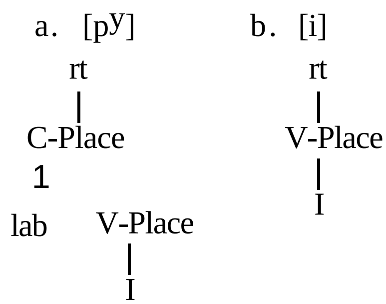
Other cases of SYLL-SEG violations will be discussed in the following chapters. In particular, the relation between SYLL-SEG and V-MORA is used to account for length distribution following intervocalic glides in chapter 2 and SYLL-SEG violations form the bases of the analysis of epenthetic homorganic glides in chapter 4.

The last aspect of representation to consider is the autosegmental structure of the segments. The following chapters only concern the syllabification of vowels and so only their internal structure needs to be discussed. It is assumed here that vowel consist of combinations of the particles {A, I, U} shown in (63) (cf. Anderson and Jones 1974, Schane 1984a,b, Kaye, Lowenstamm and Vergnaud 1985).

(63) i = {I} u = {U}
e = {I, A} o = {U, A}
a = {A}

No particular version of feature-geometry is assumed. The only aspect of feature-geometry relevant here is the separation of features for vowels and consonants into V-Place and C-Place, respectively (see Clements 1991, Ni Chiosain and Padgett 1993, Clements and Hume 1993). The vowel particles are dominated by the V-Place node of the feature-geometry. Consonantal place features, voice features, and manner features are not addressed here since they play no role in the analyses that follow. C-Place nodes are only relevant in the representation of secondary articulated consonants, as in (64a), which contain a C-Place node and V-Place node.

(64)



Following Hayes (1990), the association lines in the feature-geometry can be replaced by indices. An underlying representation contains a set of nodes that are coindexed, as shown in (65).

(65) rt_i
$V\text{-}place_i$
{I}

The linking of the place nodes to the root nodes, like the linking of the root nodes to the moras, maximally satisfies PARSE with respect to the constraint ranking. This means that coindexed place nodes and root nodes can be parsed independently of each other. Cases of this type of parsing are illustrated in chapters 2 and 4.

In summary, the syllable structure constraints discussed here dictate the types of syllabic nuclei. These constraints are shown to interact with the other constraints, particularly PARSE, to account for the distribution of high vowels and their nonmoraic counterparts. The constraints introduced in this chapter are listed below. These constraints, together the other constraints that will be introduced where appropriate, are all universal constraints.

(66) Faithfulness Constraints: (Prince and Smolensky 1993)

PARSE:
phonological units are licensed by higher prosodic structure.

FILL:
Syllable positions are filled with segmental material.

Syllable Structure Constraints:

ONSET: (Itô 1986, 1989)
Syllables must have onsets.

NLV:
Two moras cannot link to a single vocalic root node.

NODIPH:
Tautosyllabic moras cannot link to two separate vocalic root nodes.

SONFALL:
Sonority must fall between tautosyllabic moras.

BRANCH-μ:
Moras cannot branch.

Other Constraints:

V-MORA:
For every vocalic root node rt_i, there is a mora μ_i.

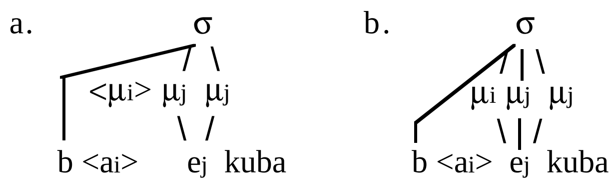
SYLL-SEG:
If rt_i is linked directly to σ, then $*\mu_i$.

(70) {ONSET, NODIPH} » NLV, /ba+ a+ kuba/

Candidate		ONSET	NODIPH	NLV
(69a)	ba.a.ku.ba	*!		
(69b)√	b<a>a:.ku.ba			*
(69c)	baa.ku.ba		*!	

Turning now to the trivocalic sequences in (68), note that the segmental parse of the underlying sequence satisfies SYLL-CONT since the rightmost vowel is parsed in (68c &d). As for the moraic parse, (68c) shows an interesting mismatch between underlying vowels and surface moras. The long vowel /ee/ and /a/ provide three moras yet the surface form, shown in (71a), contains a bimoraic vowel. As Clements notes, this is not surprising given that Luganda adheres to a bimoraic maximum on syllable weight. The constraint BIMAX, which restricts syllables to maximum bimoraicity, (McCarthy and Prince 1986) must dominate PARSE-μ since faithfully parsing all moras, as in (71b), leads to a trimoraic syllable.[9]

(71) [be.ku.ba] [be::.ku.ba]



What is evident from (71) is that leaving a mora unparsed is preferable to a faithful parse of moras which violates BIMAX. The ranking of BIMAX above PARSE-μ is illustrated in (72).

(72) BIMAX » PARSE-μ, /ba+ ee+ kuba/

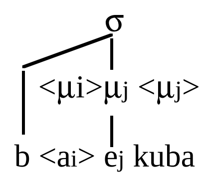
Candidate		BIMAX	PARSE-μ
(71b)	b<a>e::.ku.ba	*!	
(71a)√	b<a>e:<:>kuba		*

Although PARSE-μ is now dominated, the constraints still interact so that violations of PARSE-μ are minimal. Since PARSE-μ is dominated by BIMAX, but still dominates NLV, two moras will always be parsed. A surface form like (73), where there is a short

[9]The fact that the two moras with the same indices are coindexed with the vocalic root in (71a) is arbitrary since NLV violations require moras with different indices to be associated to the same vowel. The long vowel could be composed of μ_i and one μ_j.

vowel, violates PARSE-μ twice; hence, it is less optimal than (71b) which has only one violation of PARSE-μ.

(73) [be.ku.ba]



The preservation of exactly two moras (when there are more than two) follows from the two rankings already developed, i.e., BIMAX is ranked above PARSE-μ and PARSE-μ is ranked above NLV. These rankings can be combined to show the optimal syllabification.

(74) BIMAX » PARSE-μ » NLV, /ba+ee+ kuba/

Candidate		BIMAX	PARSE-μ	NLV
(71a) √	b<a>e:<:>kuba		*	*
(73)	b<a>e<::>kuba		*!*	
(71b)	b<a>e::kuba	*!		*

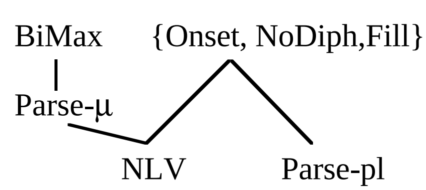
(68d), where the underlying vowels produce a total of four moras, is accounted for by the same ranking in (74). The only difference is that the preferred candidate contains two violations of PARSE-μ.

(75) BIMAX » PARSE-μ » NLV, /ba+a+ ee+ kuba/

Candidate		BIMAX	PARSE-μ	NLV
	b<a>e<:::>kuba		***!	
√	b<a>e:<::>kuba		**	*
	b<a>e:::kuba	*!		*

The ranking established in (72) is easily added to the constraint diagram in (66b) to form (76).

(76)



This ranking is illustrated by /ba+ ee+ kuba/ in (77).

(77) {ONSET, FILL, BIMAX} » PARSE-μ » PARSE-PL, NLV,
/ba+ ee+ kuba/

Candidate	ONSET	FILL	BIMAX	PARSE -μ	PARSE -PL	NLV
ba.e:.ku.ba	*!					
ba.Δe:.ku.ba		*!				
b<a>e<:::>ku.ba				***!	*	
√ b<a>e:<::>ku.ba				**	*	*
b<a>e:::ku.ba			*!		*	*

There is one remaining behaviour of vocoids noted by Clements that can easily be accounted for by constraint interaction. A high vocoid adjacent to another high vocoid does not surface as the corresponding nonmoraic vocoid.

(78) /mi+ iko/ [miiko] 'trowels'
/lu+ uyi/ [luuyi] 'side'

This phenomenon has been encountered before in Etsako and the same constraint interaction in Etsako is involved here. The preferred candidate for (78), based on (76), should be [m^{y}iiko] and [l^{w}uuyi]. These candidates, however, violate the OCP, which dominates PARSE-PL. Therefore, the preferred candidate leaves one vowel unparsed.

2.4.3 High Vocoids and Vowel Length

An underlying sequence with an initial high vocoid surfaces as a long monophthong, as expected given the established constraint ranking. as in Etsako. the high vocoid surfaces as a secondary articulation.[10]

[10]Clements notes that nonmoraic /i/ does not occur with [c, j, s, z, ¬] and nonmoraic /u/ does not occur with [f, v, w]. It appears that here is an undominated constraint prohibiting the co-occurrence of certain C-place and V-place features.

(79) a. /ki+ buga/ [kibuga] ‘town’
/ki+ gele/ [kigele] ‘foot’
/mu+ kazi/ [mukazi] ‘woman’
/mu+ limi/ [mulimi] ‘tiller’
b. /li+ ato/ [l^yaato] ‘boat’
/ki+uma/ [k^yuuma] ‘metal object’
/mu+iko/ [m^wiiko] ‘trowel’
/mu+ oyo/ [m^wooyo] ‘soul’

The surface forms in (79b) require further development of the constraint ranking in (76) so that only high vocoids occur as secondary articulations. The requisite rankings are similar to those found in Etsako, which has the same the distribution of high vocoids.

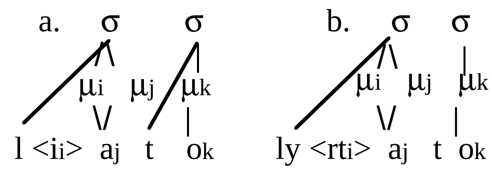
Given the dominance of ONSET and NODIPH, it is apparent that parsing the high vowel with its coindexed mora is not optimal for it would violate one of these constraints, e.g., /li+ ato/ as [li.a.to.] violates ONSET and as [lia.to.] violates NODIPH. Leaving aside the question of vowel length for the moment, the parsing of the high vocoid is predicted by the ranking in (76). Recall that a mid vowel in a sequence is not parsed because the nonmoraic parse of a mid vowel compels a violation of {A}=V, which is not relevant in the case of high vowels. This means that the place node of a high vowel can be parsed nonmoraically. This is shown in (80) where the preferred candidate contains a parse of all place nodes.

(80) {ONSET, NODIPH} » PARSE-PL, /li+ ato/

Candidate	ONSET	NODIPH	PARSE-PL
lia.to.		*!	
√ l^ya:to			
l<i>a:.to			*!
li.a.to.	*!		

Turning to the moraic parse, the distribution of long vowels in (79) is accounted for in the same way as in the vowel elision cases. The presence of long vowels crucially requires a one-to-one correspondence between underlying vocoids and surface moras and this one-to-one correspondence occurs as a result of V-MORA. As before, any candidate that includes a one-to-one linking of contiguous vowels and moras satisfies PARSE-μ, but is nonoptimal. This is actually demonstrated in (80) where the candidates that violate ONSET and NODIPH contain a one-to-one association. The two-to-one associations of moras to vowels in (81), which also satisfy PARSE-μ, must be evaluated.

(81) [la:.to] [l^ya:.to]



The crucial conflict in (81) is between PARSE-PL, which is violated in (81a), and SECARTIC, which is violated in (81b). Once again, the satisfaction of one compels a violation of the other and on this basis an argument can be made for ranking PARSE-PL above SECARTIC.

(82) PARSE-PL » SECARTIC, /li+ ato/

Candidate	PARSE-PL	SECARTIC
(81b) √ l^ya:to		*
(81a) l<i>a:to	*!	

Following Clements, it is necessary for the nonmoraic vocoid to be considered as a secondary articulation because without it, the following long vowel is not possible. Recall that V-MORA requires all [-cons] root nodes to be coindexed with a mora regardless of whether or not the root node is parsed. If the root node were parsed moraically, either NODIPH or ONSET would be violated. More importantly, if it were parsed as a glide, there would be no one-to-one correspondence between underlying vocoids and surface moras because a glide in the onset is not subject to V-MORA. However, the minimal violation of PARSE (which is to leave only the root node unparsed while parsing the place node as a secondary articulation) enables the unparsed root node to have a coindexed mora.

2.4.4 High Vocoids and Short Vowels

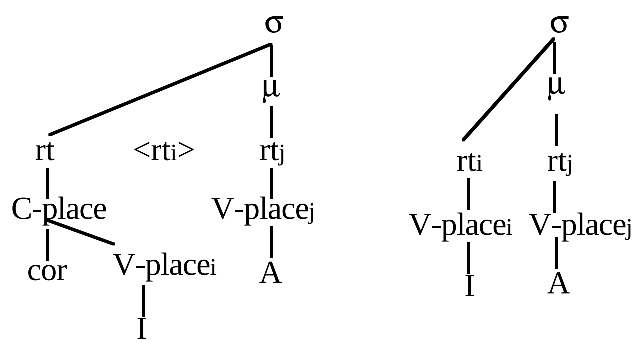
The relationship between the distribution of high vocoids and vowel length is complicated by the short vowels that appear after the intervocalic vocoids in (83a).

(83)
a. kìbúyágá ‘storm’
mùwáfù ‘incense tree’
gàwàlâ ‘girl’
màwúlìlé ‘news’
kàyùbâ ‘young dove’
mùyígìlízá ‘teacher’
b. kàwáálí ‘small pox’
mùyááyû ‘wild cat’

The contrast in length in (83) is a consequence of the phonemic length contrast discussed earlier, so the root of [kàwáálí] is /uaali/ and the root of [gàwàlâ] is /uala/. The problem presented by the data in (83) concerns the lack of neutralization of vowel length since the constraint ranking in (76) predicts long vowels should occur after nonmoraic vocoids. Nonetheless, Clements (1986), Steriade (1984), and Hyman (1985) note that the distribution of long vowels and nonmoraic vocoids (be it a secondary articulation or a glide) is predictable: nonmoraic vocoids occur when adjacent to vowels and long vowels are concomitant with high vocoids except when the vocoid is the sole member of the onset. Therefore, high vowels and nonmoraic vocoids are in complementary distribution.

The source of the difference in the distribution of vowel length between (83) and (79) is that the vocoids in the former are glides and they are the sole member of the onset rather than being a secondary articulation. There is a very clear difference in the representation of the vocoid as an onset and as a secondary articulation because the root node of the vocoid must be parsed when it is the sole member of the onset.

(84) a. secondary articulation ex. [d^{y}a] b. glide in onset ex. [ya]



Parsing the root node, as opposed to just the place node, is significant because it directly affects the mora assignment constraints discussed in chapter 1, which are repeated below.

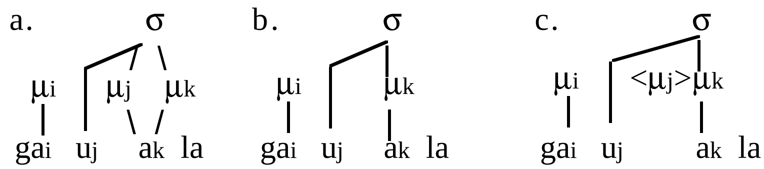
Mora Assignment:

a. V-MORA: for every vocalic root node V_i, there is a mora μ_i.

b. SYLL-SEG: if a root node rt_i is linked to the syllable node, then $*\mu_i$.

V-MORA, as proposed here, is satisfied when the root node is left unparsed irrespectively of parsing the place node. The situation is quite different in (84b) where the glide is the sole member of the onset because the root node must be parsed in order to parse the place node. Hence, SYLL-SEG becomes relevant. So far, V-MORA has not been treated like other constraints insofar as it has not been shown to conflict with other constraints. However, V-MORA violations can be compelled by SYLL-SEG. If SYLL-SEG dominates V-MORA, the vocoid will not have a coindexed mora when its root node is parsed as part of the onset. This is the case in Luganda. Consider /ga+ual+a/ and the possible associations of coindexed vocoids and moras.

(85) [ga.wa:.la] [ga.wa.la] [ga.wa.la]



(85c) satisfies V-MORA and violates SYLL-SEG because the vocoid /u_j/ is attached to the syllable node and also has a coindexed mora. Even though (85c) produces [gawala], it cannot be the correct representation because PARSE-μ is violated and this is less harmonic than a candidate in which both moras are parsed as part of a long vowel. However, (85a) (where there is a long vowel) is not the correct surface form, so the only way to produce a glide followed by a short vowel is by violating V-MORA and satisfying SYLL-SEG, as in (85b).

(86) SYLL-SEG » V-MORA, /ga+ uala/

Candidate	SYLL-SEG	V-MORA
(85b) √ gawala		*
(85a) gawa:la	*!	

V-MORA, which was previously considered an undominated constraint, must be dominated by SYLL-SEG. V-MORA is also dominated by the complete set of undominated constraints. For example, NODIPH violations requires the high vocoid to have a coindexed mora, but NODIPH can be satisfied by a V-MORA violation since there is only one coindexed mora. Most importantly, ONSET dominates V-MORA since both vowels (parsed heterosyllabically) have coindexed moras when ONSET is violated. Conversely, the satisfaction of ONSET compels a violation of V-MORA since the high vocoid is in the onset.

(87) a. ONSET » V-MORA, /ga+ uala/

Candidate	ONSET	V-MORA
ga.u.a.la	*!*	
√ gawala		*

b. NODIPH » V-MORA, /ga+ uala/

Candidate	NODIPH	V-MORA
ga.ua.la	*!	
√ gawala		*

Note that violations of V-MORA do not alter the results from the previous section where V-MORA is crucial for the occurrence of long vowels. All that is required is that V-MORA dominates NLV. These constraints are ranked with respect to each other since the satisfaction of V-MORA leads to a violation of NLV.

(88) V-MORA » NLV, /li+ ato/

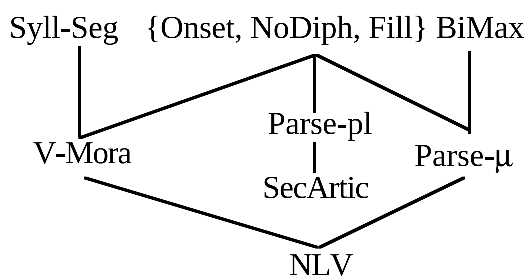
Candidate	V-MORA	NLV
√ l^{y}a:to		*
lyato	*!	

The constraint rankings established to account for the distribution of glides can be added to the constraint tree in (76). First, a summary of the constraint rankings is given in (89).

(89) PARSE-PL » SECARTIC (82)
SYLL-SEG » V-MORA (86)
V-MORA » NLV (88)

SYLL-SEG is undominated as are NODIPH, ONSET, and BIMAX. V-MORA is dominated by SYLL-SEG, but it is not ranked with respect to PARSE-μ and V-MORA dominates NLV. Finally, SECARTIC is dominated by PARSE-PL. (90), like (76), shows the interaction between prosodic and segmental constraints. This is evident from ONSET, NODIPH, and FILL, which dominate PARSE-μ and PARSE-PL.

(90)



The relevant subsections of (90) needed to account for long vowels, unparsed vowels, and intervocalic glides are illustrated in (91).

(91) a. /li+ ato/

Candidate	Onset	NoDiph	Parse-μ	Parse-pl	Sec Artic	NLV
li.a.to	*!					
lia.to		*!				
√ l^{y}aa.to					*	*
l<i>a:.to				*!		
l<i>a<:>.to			*!	*		

b. /ka+ oto/

Candidate	Onset	{A} =V	No Diph	Par.-μ	Parse-pl	Sec Artic	NLV
ka.o.to	*!						
k^{a}o:.to		*!				*	*
kao.to			*!				
√ k<a>o:.to					*		*
k<a>o<:>to				*!	*		

c. /ga+ uala/

Candidate	Onset	Syll-Seg	NoDiph	V-Mora	Parse -μ	NLV
ga.u.ala	*!*					
ga.ua.la	*!		*			
√ gawala				*		
gawa<:>la		*!			*	
gawa:la		*!				*

The difference between intervocalic high vocoids and prevocalic high vocoids is that the intervocalic vocoids must surface as the sole member of the onset and so Syll-Seg is relevant. Since Syll-Seg dominates V-Mora, the preferred candidate does not have a mora coindexed with the vocoid when the vocoid is parsed as a segment in the onset. When the vocoid is parsed as a secondary articulation or left unparsed, its root node still has a coindexed mora because Syll-Seg is not relevant and the preferred candidate must satisfy V-Mora.

To summarize, the surface patterns of vowel sequences in Luganda follow mainly from the ranking {A}=V » Parse-pl » SecArtic. This ranking ensures that high vocoids are parsed as secondary articulations and that nonhigh vocoids are left unparsed. The surface long vowel is a consequence of ranking Parse-μ above NLV; thus ensuring that as many moras as possible are parsed even in violation of NLV. It should be noted that Parse-μ in all languages requires the preferred candidate to have the maximum parse of the moras: the difference between languages is how Parse-μ is ranked. In Luganda, Parse-μ is best satisfied when NLV is violated, but in Etsako, on the other hand, the satisfaction of Parse-μ must respect the satisfaction of NLV.

The relation between PARSE-μ and NLV provides an explanation of Clements's compensatory lengthening, which operates to maintain the prosodic representation after a phonological process, namely Glide Formation, has applied. In Optimality Theoretic terms, compensatory lengthening cannot be a process because there is no loss of segmental material for which to compensate. The long vowel on the surface and the surface form of the high vocoid are the result of minimizing PARSE violations with respect to the constraint ranking. Minimizing PARSE violations means that a root node is left unparsed when the initial vocoid of a sequence is high and it means leaving the root node and the place node unparsed when the initial vowel is nonhigh.

In comparison, the distribution of vocoids in Luganda is similar to Etsako with the only difference being that the former language has long vowels on the surface and the latter does not. Luganda, therefore, represents another surface pattern of underlying hiatus to be added to the typology.

(92)

Language	Surface Form of V1 in VV			
	High	Mid	Low	Surface Length
Etsako				
ONSET » PARSE-PL » SECARTIC	sec. artic	unparsed	unparsed	short
Luganda				
ONSET » PARSE-PL » SECARTIC	sec. artic.	unparsed	unparsed	long
Yoruba				
ONSET, SECARTIC » PARSE-PL	unparsed	unparsed	unparsed	short

2.4.5 Vowel Length and Prenasalization

The basic premise of the above analysis of surface long vowels from underlying vowel sequences can be used to account for the predictable occurrence of long vowels in another environment. Clements notes that long vowels are also concomitant with prenasalized consonants, as shown in (93).

(93)	/ku+ linda/	[kulii^{n}da]	'to wait'
	/mu+ ntu/	[muu^{n}ta]	'person'
	/ba+ ntu/	[baa^{n}tu]	'people'
	/mu+ lenzi/	[mulee^{n}zi]	'boy'

Clements proposes that long vowels before prenasalized consonants are another example of compensatory lengthening. In this case, according to Clements, the timing unit of the nasal is acquired by the long vowel. Like the analysis of vowel length in the preceding section, the long vowels in (93) can be shown to follow from minimal violations of Parse-μ.

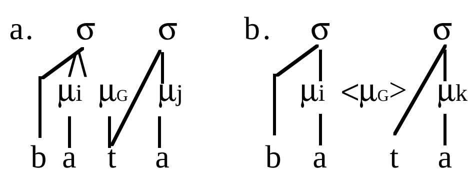
The relation between prenasalized consonants and long vowels requires the consideration of constraints not yet discussed. Throughout this chapter, rankings have been established for vocalic sequences and for onsets, but the data in (93) require the inclusion of coda constraints. Once the constraint ranking for codas is established, it will be combined with the constraint ranking already confirmed, hence providing a complete constraint ranking for Luganda syllabification. This complete ranking will then be used to account for cases which contain both secondary articulations and prenasalized consonants.

According to Clements, only the first part of a geminate can close a Luganda syllable, for example, [batta] ‘they killed’ and [ma¬¬o] ‘teeth’. The way to account for this in Optimality Theory is to say that NOCODA is violated when the coda is part of a geminate. The discussion now turns to the constraints that must interact with NOCODA. The appearance of geminates in codas can be attributed to their unique representation. In Moraic Phonology, underlying geminates are linked to a mora and, as Inkelas and Cho (1993) argue, this prespecification of geminates can be used to account for a number of the integrity and inalterability properties of geminates discussed by Schein and Steriade (1986) and Hayes (1986). According to Inkelas and Cho, geminate inalterability is the result of the geminate remaining linked to its mora. This can be formulated as a specific case of mora coindexation, that is, a consonantal root node of a geminate, root$_G$, must be linked to its coindexed mora μ_G. This constraint on coindexation is written as in (94).

(94) Geminate-Mora Linking (GEM-MORA)
A geminate root$_G$ must be linked to its coindexed mora μ_G.

GEM-MORA and NOCODA clearly conflict since NOCODA must be violated if an underlying geminate surfaces as a geminate. This is shown in (95a) where half a geminate is in the coda. In (95b), on the other hand, NOCODA is satisfied by leaving the geminate’s mora unparsed.

(95) [bat.ta] [ba.ta]



From (95), it is evident that GEM-MORA must dominate NOCODA.

(96) GEM-MORA » NOCODA , /batta/

Candidate	GEM-MORA	NOCODA
√ bat.ta		*
ba<t>.ta	*!	

GEM-MORA allows geminates to close syllables, but NOCODA must dominate PARSE to ensure that no other consonant can close a syllable. Furthermore, FILL dominates PARSE making vowel epenthesis less harmonic. A nonsense word must be used to show the effects of this ranking because Luganda does not have a C~ø alternation in coda position.

(97) a. NOCODA » PARSE, /muxti/[11]

Candidate	NOCODA	PARSE
muxti	*!	
√ mu<x>ti		*

b. FILL » PARSE, /muxti/

Candidate	FILL	PARSE
√ mu<x>ti		*
mu.xΔ.ti	*!	

The constraint rankings established in (96) and (97) predict that a nasal preceding an obstruent should also be left unparsed, e.g. /mu +ntu/ → [mu<n>.ti]. Hence, more constraints must be involved to ensure that the nasal is parsed as part of a prenasalized consonant from the underlying nasal-consonant sequence.

Although heterosyllabic nasal-consonant clusters are not allowed in Luganda, tautosyllabic nasal-consonant clusters, that is, prenasalized consonants, are allowed. The difference between a nasal-consonant cluster and a prenasalized consonant is a matter of parsing with respect to the syllable boundary. This difference in syllabification is evident in Sinhalese where Feinstein (1979) nasal-consonant sequences alternate between clusters and prenasalization. In Luganda, parsing the nasal and the consonant on different sides of the syllable boundary is less preferred than parsing both segments as part of the onset, that is, the sequence is parsed as a prenasalized consonant. Attention now turns to the appropriate constraint characterizing prenasalization.

The occurrence of prenasalized consonants in any language is marked and this markedness stems from their complex articulation which requires a homorganic nasal and nonnasal articulation in the span of a single segment (Herbert 1975, 1986). Furthermore, prenasalized consonants behave phonologically as single segments, for example, they occur in languages without onset clusters (Herbert 1986, Sagey 1986). The markedness of prenasalization can be characterized by a constraint that prohibits the configuration where both the nasal and the consonant are parsed as a single segment. Following Padgett (1991) and Steriade (1991) prenasalized consonants consist of two prevocalic root nodes dominating [+nasal] and [-nasal], respectively, attached to a single place node. Any constraint prohibiting prenasalized consonants must specifically refer to the multiply linked

[11]The actual surface form of /muxti/ would be [muuti] due to assumptions about syllable weight under discussion. Of course, an underlying form like /muxti/ would never be postulated for the surface form [muuti] (see Prince & Smolensky's discussion of Stampean Occultation)

place node in the onset. The constraint that prohibits prenasalized consonants, called Prenasalization, is shown in (98).

(98) Prenasalization (PRENASAL)

$*_{\sigma}[[+nasal] \quad [-nasal]$

\/

place

PRENASAL and NOCODA conflict since parsing a nasal-consonant sequence heterosyllabically satisfies PRENASAL and violates NOCODA. Conversely, an open syllable occurs when the nasal-consonant sequence is parsed in the onset in violation of PRENASAL. By ranking NOCODA above PRENASAL, nasal-consonant clusters in Luganda are preferably parsed in the onset as a prenasalized consonant. This also requires PARSE to be ranked above PRENASAL. The issue of length is discussed below.

(99) a. NOCODA » PRENASAL, /mu+ntu/

Candidate	NOCODA	PRENASAL
mun.ti	*!	
√ mu:.nti		*

b. PARSE » PRENASAL, /mu + ntu/

Candidate	PARSE	PRENASAL
mu<n>.ti	*!	
√ muu.nti		*

As it stands, the analysis of prenasalization does not account for the long vowels in (93) which have a different origin from those that are concomitant with secondary articulations. Recall that high vocoids satisfy V-MORA and so there are two moras in the representation. In the case of prenasalized consonants, there is only one vocoid so V-MORA can only supply one mora. The second mora must come from the nasal segment, but only from a nasal that is between a vowel and a consonant since intervocalic nasals are not preceded by long vowels. The preconsonantal environment is also the environment for the assignment of Weight-by-Position (Hayes 1989) and, as discussed in chapter 1, Zec (1992) proposes Weight-by-Position, shown in (100), is assigned by coindexing a mora with a postvocalic consonant.

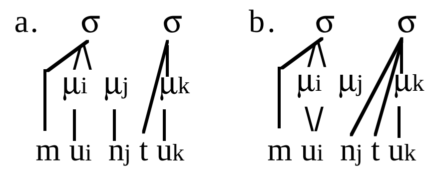
(100) Weight-by-Position (WXP) (Zec 1992)

μ_i

$C_i \quad C_j$

WXP, like V-MORA, introduces weight into the representation, but the actual realization of weight depends upon constraint interaction. Therefore, the possible linkings of moras to segments must be compared for constraint satisfaction. A one-to-one linking of coindexed moras and segments, as in (101a), violates NOCODA, but linking both moras to the vowel violates NLV and PRENASAL, which are both low ranking constraints.

(101) [mun.tu] [mu:.ⁿtu]



The violation of NOCODA in (101a) is sufficient to guarantee its nonoptimality since NOCODA is ranked above PRENASAL. The fact that NLV and PRENASAL are both violated in (101b) is irrelevant since these constraints do not conflict so they are not ranked with respect to each other. There is, however, a more intriguing constraint violation in (101b). Notice that the nasal is coindexed to a mora but the nasal's root node is linked directly to the syllable node in violation of SYLL-SEG. Furthermore, SYLL-SEG and NOCODA can be satisfied by parsing the nasal as a prenasalized consonant preceded by a short vowel. This requires a WXP violation; hence WXP and SYLL-SEG conflict and the former must dominate the latter.

(102) WXP » SYLL-SEG, /mu +ntu/

Candidate	WXP	SYLL-SEG
√ mu:.ntu		*
mu.ntu	*!	

The violability of SYLL-SEG (under pressure to satisfy WXP) does not alter the account of glides and short vowels because WXP is relevant in this environment. The ranking relation between SYLL-SEG and V-MORA remains the same so a vocoid cannot satisfy V-MORA when it is linked directly to the syllable.

Not all the constraints discussed with respect to (101) can be ranked. NOCODA and WXP, for example, cannot be ranked with respect to each other because the preferred candidate satisfies both constraints.

(103) NOCODA, WXP, /mu+ ntu/

Candidate	NOCODA	WXP
mu.ntu		*!
√ mu:.ntu		
mun.tu	*!	

Similarly, PRENASAL and SYLL-SEG cannot be ranked with respect to each other since both are violated in the preferred candidate. Looking at the constraint rankings established thus far, WXP dominates SYLL-SEG and NOCODA dominates PRENASAL, but neither NOCODA and WXP nor PRENASAL and SYLL-SEG are ranked with respect to each other. The combination of these rankings is illustrated in (104).

(104) {WXP, NOCODA} » {PRENASAL, SYLL-SEG}, /mu +ntu/

Candidate	WXP	NOCODA	PRENASAL	SYLL-SEG
mu.ntu	*!		*	
mun.tu		*!		
√ muu.ntu			*	*

Two independent constraint rankings for Luganda have been developed: one for onsets and nuclei and the other for nuclei and codas. These two constraint rankings when combined account for the syllabic phonology of Luganda. The necessity of combining the constraint rankings is evident from surface forms that contain both a prenasalized consonant and a nonmoraic vocoid.[12]

(105)
a. /mu+ laba/ [mulaba] 'you (pl.) see'
b. /mu+ N+ laba/ [muu^{n}daba] 'you (pl.) see me'
c. /mu+ a+ laba/ [m^{w}aalaba] 'you (pl.) saw'
d. /mu+ a+ N+ laba/ [m^{w}aa^{n}daba] 'you (pl.) saw me'

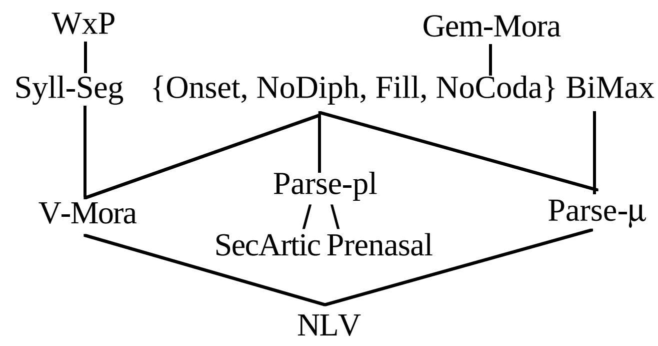
(105a) is trivial, for it is simply a faithful parse of the underlying form. (105b) is accounted for by the constraint ranking in (104) and (105c) is accounted for by the constraint ranking in (89). (105d) contains both a nonmoraic vocoid and a prenasalized consonant and so both constraint rankings are required. The two independent constraint rankings can be combined by adding the constraint rankings in (106) to (90).

(106)
GEM-MORA » NOCODA (96)
NOCODA » PARSE (97)
PARSE » PRENASAL (99)
WXP » SYLL-SEG (102)

The new tree diagram is given in (107).

[12] /l/ becomes [d] after a nasal.

(107)



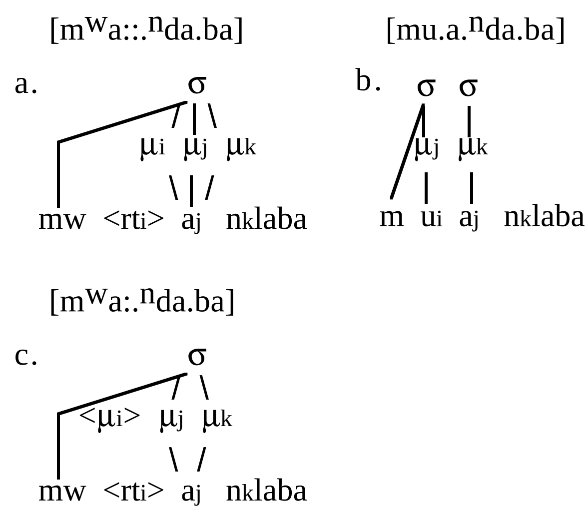
The interactions in this tree diagram can be applied to (105d) which contains both a secondary articulation and a prenasalized consonant. Consider first some possible syllabifications and the constraints they violate.

(108)

	Candidate	Violated Constraint(s)
a.	mu.an.laba	ONSET, NOCODA
b.	muan.laba	BIMAX, NOCODA
c.	m^wa:n.laba	NOCODA, SECARTIC
d.	m^wa::.nlaba	BIMAX, SECARTIC, PRENASAL

All of the above candidates violate an undominated constraint except (108d) which violates SECARTIC and PRENASAL. This output, shown in (109c), is preferred to the BIMAX violation in (109a) and the ONSET violation in (109b).

(109)



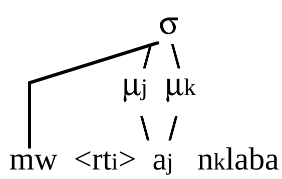
Only (109c) satisfies all undominated constraints.

(110) {BIMAX, ONSET} » PARSE-μ » NLV, SECARTIC, PRENASAL,
/mu +a + N +laba/

Candidate	BI MAX	ON-SET	PARSE -μ	NLV	SEC ARTIC	PRE NASAL
(109a) m^wa::.nl..	*!				*	*
(109b) mu.a.nl..		*!				*
(109c)√ m^wa:<:>.nl..			*	*	*	*

The constraint ranking in (107) can produce the correct surface form in another way. Since V-MORA is dominated by WxP, it is possible that a V-MORA violation is compelled by satisfying BIMAX and WXP. This means that one mora is coindexed with the nasal and another is coindexed with a vowel, but the other vocoid does not have a coindexed mora.

(111) [m^wa:.^{n}da.ba]

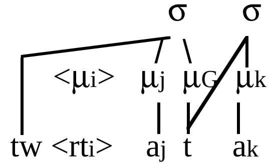


(111), which is indistinguishable from (109c), satisfies PARSE-μ and violates V-MORA. Since V-MORA and PARSE-μ are not ranked with respect to each other, the ranking in (107) predicts two potential surface forms. One way to distinguish (111) and (109c) is to rank V-MORA above PARSE-μ.

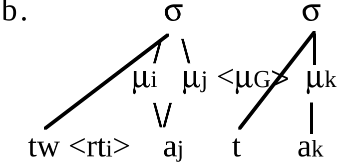
Another phenomenon noted by Clements that can be accounted for with the established constraint ranking is the occurrence of nonmoraic vocoids and short vowels when the syllable is closed by the first half of a geminate, e.g. /tu + a +tta/ → [t^watta] 'they killed'. This exception to the distribution of long vowels and nonmoraic vocoids follows from BIMAX and ONSET. The surface form of /tu +a +tta/ must be bimoraic since PARSE-μ violations are minimal. Furthermore, the geminate must be parsed because GEM-MORA is undominated. Therefore, (112b), where there is a singleton consonant, is less harmonic than (112a) where there is a geminate.

(112) [t^wat.ta] [t^wa:.ta]

a.



b.



The only way to parse all moras is to parse the vowels tautosyllabically in violation of ONSET, which is undominated. Hence, the preferred parse must include a secondary articulation followed by a short vowel.

(113) {GEM-MORA, BIMAX, ONSET} » PARSE-μ » SECARTIC,
/tu +a +tta/

CANDIDATE		GEM-MORA	BIMAX	ONSET	PARSE-μ	SEC-ARTIC
	tuat.ta		*!			
	tu.at.ta			*!		
	t^wa:t.ta		*!			*
(112a)√	t^wa<:>t.ta				*	*
(112b)	t^wa<:><t>.ta	*!			*	*

In summary, the distribution of prenasalized consonants and long vowels is accounted for in the same way as the distribution of secondary articulations and long vowels. These distributions, which Clements analyzes as compensatory lengthening, occur as a result of satisfying the constraint hierarchy with minimal violations of PARSE. Since PARSE-μ is ranked above NLV, maximal satisfaction of PARSE-μ ensures the preferred candidate has a long vowel.

2.4.6 Previous Analyses of Luganda

Vocoid distribution in Luganda involves two related problems: 1. the distribution of long vowels and 2. the distribution of nonmoraic vocoids. The relation between these distributions are discussed by Clements (1986) and Wiltshire (1992), who say little about intervocalic vocoids, and Steraide (1984) who presents an analysis of intervocalic glides while assuming Clements's analysis of the relation between long vowels and nonmoraic vocoids. This section begins by first examining Steriade's proposal for intervocalic glides and then turning to aspects of Clements's compensatory lengthening analysis that lead to Wiltshire's analysis of Luganda using Goldsmith's (1991) Harmonic Phonology.

Steriade proposes an account of glide distribution using the syllabification algorithm discussed in chapter 1. According to Steriade, syllabification proceeds by the left-to-right application of the CV-Rule which syllabifies [+syllabic] segments as rimes and [-syllabic] segments as onsets. The alternation between high vowels and glides occurs because high vowels are not specified for [syllabic], whereas other vowels are [-syllabic] and so the former can be assigned to either onsets or rimes. The CV-Rule iterates from left-to-right maintaining a C/V alternation; hence, a postconsonantal high vocoid is assigned [+syllabic] (a V on the CV tier) because the preceding consonant is [-syllabic] (a C on the CV tier) and an intervocalic vocoid is assigned [-syllabic] because the preceding vowel is assigned [+syllabic].

```
(114)      a.  X → C                  b.  X → V

            σ  σ   σ                    σ    σ
            |   /\   /\                 /|\     /\
           V X V C  V                 C X V C V
           |  |  |  |   |              |  |  |  |  |
           a  i  a  l  a    → ayala     l  i  a  t  o  → liato → lyaato
```

Steriade does not discuss the distribution of vowel length, but it is easily accounted for as a consequence of the syllabification algorithm. The CV-Rule assigns a V-slot in (114b) and then the contiguous V-slots are linked to the same vowel and the high vocoid is resyllabified in the onset as a glide. The rule of vowel lengthening must apply after the syllabification algorithm has applied otherwise there is no way the second vowel can be associated to two [+syllabic] positions in (114b). Intervocalic glides are assigned [-syllabic], as shown in (114a); therefore, the structural configuration for vowel lengthening, i.e. contiguous [+syllabic] positions, is never created and so there is no lengthening.

Steriade's Syllabification Algorithm requires a three-way distinction for [syllabic]: [-syllabic] = C, [ø syllabic] = X, and [+syllabic] = V. This distinction is necessary for a procedural approach to syllabification. High vocoids must be underspecified so they can be syllabified as either onsets or nuclei. If high vocoids are underlyingly [+syllabic] in this framework, the distribution of intervocalic glides becomes quite complex (see Clements 1986, Hyman 1985). The nonprocedural nature of Optimality Theory makes redundant the need for a three-way distinction because different potential output forms are compared simultaneously. Therefore, high vowels are [+syllabic] ([-cons] in the feature system used here) like other vowels and the moraic and nonmoraic parses are compared for constraint satisfaction. Whether the vocoid is parsed moraically or not is a consequence of which parse best-satisfies the constraints.

Using feature-specification to determine syllabicity encounters problems when looking at a language like Logo that has a mid vowel~high nonmoraic vocoid alternation. Underspecification would require that mid vowels are [øsyllabic] too. The common thread between alternating high vowels and alternating mid vowels is that low vowels do not alternate, which is captured here by {A}=V. Hence, all vowels are specified for major class features in the Optimality Theoretic approach, but languages vary with respect to which vocoids can be parsed nonmoraically through the interaction of PARSE-PL, PARSE-FEAT and SECARTIC.

A different type of procedural syllabification appears in Clements's compensatory lengthening analysis. According to Clements, two levels of representation are required for compensatory lengthening to apply. The need for an initial stage of syllabification is crucially argued for in the case of prenasalization since a prenasalized consonant is represented as a single unit on the timing tier. The only way compensatory lengthening can occur, according to Clements, is if the nasal somehow introduces a timing unit into the representation. Therefore, there must be a derivational stage, where /mu+ ntu/ is syllabified as [mun.tu], and another stage where it is resyllabified as [muu.ntu]. Clements notes that the required stages correspond to the traditional lexical and post-lexical levels since compensatory lengthening applies across word boundaries.[13]

(115)	/ba+naa+ tunda N+tebe/	[banaatuu^{n}daa^{n}tebe] 'they will sell chairs'
	/a+ li+ yimba N+ buzi N+saata/	[aliyii^{m}baa^{m}buzii^{n}saata] 'he will tether a fat goat'
	/o+ lu+naku o+lu+o/	[olunak^{w}ool^{w}o] 'that day'
	/a+ba+kulu a+ba+o/	[abakul^{w}aabo] 'those elders'

Although the levels used by Clements are the levels of lexical phonology, there is no need to appeal to such levels in the Optimality Theoretic approach. The data in (115) show that the domain of constraint interaction is larger than the word. Hence the external sandhi in (115) conforms to the same constraint ranking as the internal sandhi. Furthermore, mora coindexing enables the nasal of a prenasalized stop to contribute weight without the nasal linking to the mora so no derivational stage is necessary to accomplish this.

Clements supports the compensatory lengthening analysis of long vowels by looking at a case where a nasal-consonant cluster is preceded by a short vowel. This occurs as a part of Meinhof's Rule, which changes a nasal-consonant sequence into a geminate when followed by a nasal consonant. This geminate is preceded by a short vowel.

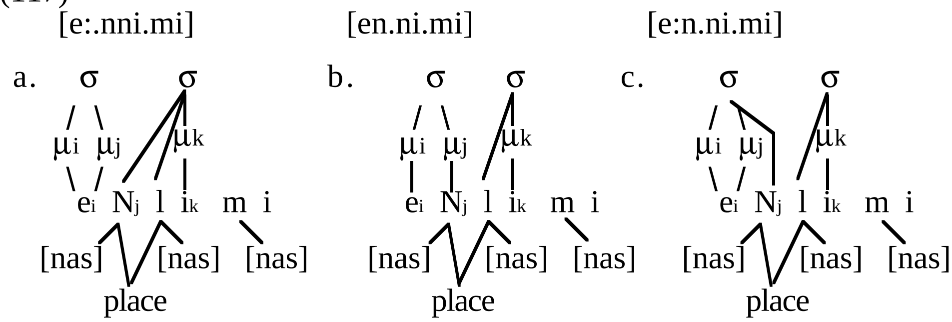
(116)	/o+ lu+ limi/	[olulimi]	'tongue'
	/e+ N+ limi/	[ennimi]	'tongues'
	/o+ lu+ bengo/	[olubee^{n}go]	'grindstone'
	/e+ N+ bengo/	[emmee^{n}go]	'grindstones'

Clements states that Meinhof's Rule must apply before (and block) compensatory lengthening. The fact that the nasal surfaces as a geminate indicates that it must contributing a timing unit (a mora in Moraic Phonology); hence, there must be a derivational stage where the nasal is linked to the mora.

Surface forms exhibiting Meinhof's Rule can be accounted for without derivational stages. This means that (116) is subject to the constraint ranking established here plus some other constraints that have not yet been discussed. What is unique about Meinhof's Rule is that the mora coindexed with the nasal cannot be associated with the preceding vowel and so it must link to the nasal. To see how this is accomplished, consider the following syllabifications for /e+ N+ limi/.

[13]Clements claims in a footnote that the absence of long vowels following intervocalic glides can be attributed to a lexical Glide Formation Rule. Steriade's Syllabification Algorithm can be viewed as the lexical glide formation process.

(117)

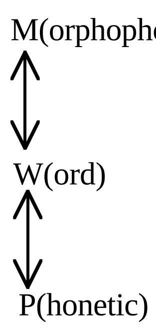


The nature of Meinhof's Rule is not well understood so it is assumed here that the rule requires that a consonant between two nasal consonants must be nasal. This is shown in (117) by specifying both root nodes in the cluster as [+nasal]. (117a) is the expected surface form given the constraint ranking established so far since it is the same representation seen in cases of prenasalized consonants. However, (117a) contains a two-root geminate (see Selkirk 1990) in the onset which is arguably less preferred than the heterosyllabic two-root geminate in (117b). (117c) has a two-root geminate and a long vowel, but here the first half of the geminate is a syllable appendix because it is not moraic. This is less preferred than the moraic coda in (117b).

Meinhof's Rule, therefore, involves a special case of a geminate that is a consequence of parsing two nasal segments. Although it applies only within words, Meinhof's Rule does not supply evidence for procedural syllabification because these geminates do not require a different constraint ranking from the one already established. All that needs to be added to account for Meinhof's Rule is the constraint interaction allowing two-root geminates and an undominated constraint against syllable appendices.

The role of levels in Luganda is used explicitly by Wiltshire's (1992) analysis set within Goldsmith's (1991) theory of Harmonic Phonology. Wiltshire proposes that the phonotactics of Luganda are different at W(ord)-level and at the P(honetic)-level. Clements's rules of Glide Formation and Prenasalization are repair strategies that apply to increase harmony.

(118) Goldsmith's Harmony Phonology (in part)



According to Wiltshire, the W-level of Luganda differs from the P-level insofar as the W-level allows the licensing of a broader range of syllables than the P-level. For example, homorganic nasal codas and the assignment of a grid element, i.e. Weight-by-Position, are licensed at the W-level. At the P-level, only the grid is licensed. The consequence of this change in licensing is that an underlying form like /mu+ntu/ cannot surface as [mun.tu] because the nasal coda is not licensed at the P-level. Therefore, a repair strategy must occur to improve the harmony, that is, it must match the phonotactics of the P-level. This repair strategy is Prenasalization. The grid does not delete because it is licensed at both levels and so the vowel associates to the grid producing a long vowel.

Wiltshire only briefly mentions glide formation, but is clear how the argument would progress. The phonotactics of Luganda do not tolerate unlike vowels in the same syllable. This is only true at the P-level, but dissimilar vocalic sequences are permitted at the W-level. The repair strategy in this case is to create a glide or delete the vowel and then the remaining vowel associates to the vacant timing unit. The different phonotactic constraints of the W-level and of the P-level produce the following types of syllables.

(119)	W-level	P-level
	CV	CV
	CV_iV_i	CV_iV_i
	CV_iV_j	CVC_iC_i
	CVN	
	CVC_iC_i	

The Harmonic Phonology approach to Luganda exemplifies Prince and Smolensky's general criticism or repair strategy theories (cf. Paradis 1989, Myers 1991). Prince and Smolensky (1993;205) say "the very idea of repair strategies demands that surface-inviolable constraints can be violated in the course of the derivation." This is clear from (119) where CVN and CV_iV_j violate P-level phonotactics just so that a repair can apply. In fact, the W-level and the P-level show a complementarity of phonotactic constraints: diphthongs and syllable-final nasals must be allowed at the W-level, but complex segments like secondary articulated and prenasalized consonants must be prohibited at the W-level otherwise compensatory lengthening cannot apply. Conversely, these complex consonants must be allowed at the P-level, but diphthongs and syllable-final nasals are not allowed.

The notion of a repair strategy is untenable in Optimality Theory because constraint satisfaction is evaluated over possible outputs as opposed to the sequential constraint satisfaction in Harmonic Phonology. Any possible repair is represented in the candidate set. As Prince and Smolensky note, a surface-unviolated constraint is always unviolated in Optimality Theory. This is evident in Luganda where NODIPH is never violated. The constraints that are violated are violated minimally and only when under duress. The surface-violated constraints in Optimality Theory, like SECARTIC and PRENASAL in Luganda, are the phonotactic constraints that must be satisfied at the W-level and violated at the P-level in Harmonic Phonology. Constraint ranking and interaction in Optimality Theory directly accounts for the complementarity of constraint satisfaction.

2.5 Kimatuumbi

There have been two types of variation among the three languages discussed so far. First, there is the length of the surface vowel which has been shown to depend upon the ranking of PARSE-μ with respect to NLV. Second, nonmoraic high vocoids in Luganda and Etsako are secondary articulations due to ranking PARSE-PL above SECARTIC, but in Yoruba, on the other hand, the high vocoid in an underlying vocoid sequence is always left unparsed. This is due to SECARTIC dominating PARSE-PL. These variations in constraint rankings interact with NODIPH, ONSET, and FILL (which are all undominated in the languages discussed so far) to ensure that the surface vowel is a monophthong. However, monophthongal vowels can arise through parsing the vowels heterosyllabically separated by hiatus or an epenthetic consonant. In these cases, there are two monophthongal vowels instead of one. This heterosyllabic parse of a vowel sequence is predicted since all syllables will be monophthongs as long as NODIPH is undominated. This is observed by Odden (1992) in Kimatuumbi (a Bantu language spoken in Tanzania) which has the same distribution of secondary articulations and long vowels found in Luganda. However, Kimatuumbi differs from Luganda in two interesting ways: 1. sequences of nonhigh vocoids are parsed with hiatus and 2. glides in the onset are followed by long vowels.

(120)	Kimatuumbi		Luganda	
	ma.oto		k<a>o:to	
	yuula	*yula	gawala	*gawaala

The constraint ranking of Kimatuumbi must differ from Luganda in such a way that nonhigh vowels are parsed and that intervocalic glides contribute weight. The relevant constraints here are ONSET, which has been undominated in the other languages, and SYLL-SEG, which is high ranking in each case. These constraints, however, are crucially dominated in Kimatuumbi.

2.5.1 Sequences with a Nonhigh Vowel

The discussion of Kimatuumbi begins by looking at sequences with nonhigh vowels before turning to sequences with high vowels and, finally, intervocalic high vocoids. The first step towards accounting for the surface forms of underlying sequences in Kimatuumbi is to establish the presence of long vowels. As before, this requires PARSE-μ to dominate NLV.

(121) PARSE-μ » NLV, /toope/

Candidate	PARSE-μ	NLV
√ to:pe		*
to<:>pe	*!	

According to Odden, the surface form of a sequence with an initial nonhigh vowel is identical to the underlying form with the two vowels parsed heterosyllabically.

(122) /ma+ oto/ [ma.o.to] ‘large fires’

/ka+ ula/	[ka.u.la]	‘small frog’
/pa+ i+ puka/	[pa.i.puka]	‘where the rats are’
/ba+ ekite/	[ba.e.kite]	‘they laughed’
/a+ akite/	[a.a.kite]	‘he hunted’[14]

The fact that a vowel sequence surfaces with hiatus indicates that ONSET is dominated and there are a number of constraints that compel a violation of ONSET. First, the lack of epenthesis in this environment shows that FILL must dominate ONSET and second the violation of ONSET means all syllables are parsed as monophthongs so NODIPH dominates ONSET as well.

(123) FILL » ONSET, /ma+ oto/

Candidate	FILL	ONSET
ma.Δo.to	*!	
√ ma.o.to		*

NODIPH » ONSET, /ma+ oto/

Candidate	NODIPH	ONSET
√ ma.o.to		*
mao.to	*!	

Lastly, the surface forms in (122) contain a faithful parse of the underlying segments; therefore, PARSE-PL also dominates ONSET.

(124) PARSE-PL » ONSET, /ma+ oto/

Candidate	PARSE-PL	ONSET
m<a>o.to	*!	
√ ma.o.to		*

Ranking PARSE-PL over ONSET is crucial in accounting for the absence of long vowels in this environment. Recall from the discussion of Luganda that ONSET (and NODIPH) dominate PARSE-PL. Therefore, the preferred syllabification contains a long monophthong and leaves a vowel unparsed.

(125)

Kimatuumbi	Luganda
PARSE-PL » ONSET	ONSET » PARSE-PL
ma.o.to.	*ka.o.to.
*m<a>o:.to.	k<a>o:.to.

[14]According to Odden, an /a+a/ sequence can be either heterosyllabic or a long vowel. Both possibilities are available given the constraint ranking to be proposed.

In Kimatuumbi, there is no pressure from constraint satisfaction to parse a long monophthong because the constraints interact to maintain monophthongs by parsing two heterosyllabic monophthongs in violation of ONSET.

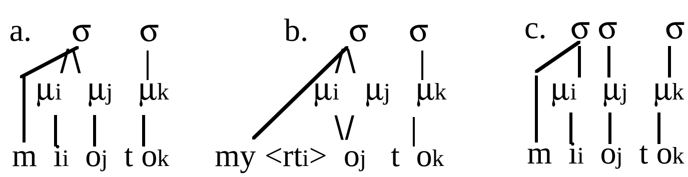
2.5.2 The Distribution of Nonmoraic Vocoids

High vocoids in underlying sequences, as observed by Odden, are parsed as secondary articulations followed by a long vowel.

(126)	a.	/ki+ kalaango/	[kikalaango]	'frying pans'
		/mi+ kaate/	[mikaate]	'loaves'
		/tu+ toope/	[tutoope]	'little hands'
	b.	/mi+ oto/	[m^{y}ooto]	'fires'
		/ki+ ula/	[k^{y}uula]	'frog'
		/tu+ isiwa/	[t^{w}iisiwa]	'to the island'

The surface pattern of underlying hiatus in Kimatuumbi is the result of a number of the same constraint interactions already discussed in the analysis of Luganda. First, the occurrence of the long vowel follows from ranking PARSE-μ above NLV, which has already been established in Kimatuumbi. To account for the distribution of secondary articulations, vocalic sequences must be prohibited when the first vowel is high. This follows from NODIPH dominating NLV as is evident by comparing (127a) and (127b).

(127) [mio.to] [m^{y}o:.to] [mi.o.to]



The long vowel in (127b) follows from PARSE-μ dominating NLV (shown in (121)). The distribution of vowel length is, as Odden proposes, an instance of compensatory lengthening which is characterized here by maximizing the parse of the moras. The monophthong in (127b) follows from ranking NODIPH above NLV. Notice that a long monophthong is preferred to the hiatus in (127c). Hence, the ONSET violation in (127c) must be less harmonic than the long vowel in (127b). ONSET and NLV conflict since NLV is satisfied when ONSET is violated. This ranking, of course has to be reconciled with the preference for the ONSET violation in the case of a nonhigh vowel. This will be discussed presently. First, the rankings for (127b), which is the preferred syllabification, are given.

(128) a. NODIPH » NLV, /mi+ oto/

Candidate	NODIPH	NLV
(127a) mio.to	*!	
(112b) √ m^{y}o:.to		*

b. ONSET » NLV, /mi+oto/

Candidate	ONSET	NLV
(127c) mi.o.to	*!	
(127b) √ m^{y}o:.to		*

c. PARSE-μ » NLV, /mi+ oto/

Candidate	PARSE-μ	NLV
m^{y}o<:>.to	*!	
(127b) √ m^{y}o:.to		*

As in the analysis of Luganda, the nonmoraic vocoid must be a secondary articulation since a long vowel in (127b) is only possible if both vocoids satisfy V-MORA. The secondary articulation satisfies PARSE-PL, which has already been shown to dominate ONSET.

At this point, it is possible to combine the constraint rankings for mid vowels and the high vowels. The difference between a sequence with an initial high vowel versus a sequence with an initial low vowel is that the high vowel can satisfy PARSE-PL by being parsed as a secondary articulation. This allows the high vocoid's coindexed mora in (127b) to be parsed as part of a long vowel. This is not possible for low vowels since low vowels do not have nonmoraic counterparts. Low vowels cannot be long without compelling a PARSE-PL violation. Therefore, the difference between high vowels and low vowels is illustrated in (129), where the low vowel in (129a) must violate PARSE-PL when NLV is violated. Since PARSE-PL is ranked above ONSET, the candidate with the violation of ONSET is preferred. This is not the case for the high vowel in (129b), where a violation of NLV does not compel a PARSE-PL violation.

(129) a. PARSE-PL » ONSET, NLV, /ma+ oto/

Candidate	PARSE-PL	ONSET	NLV
√ ma.o.to		*	
m<a>o:.to	*!		*

b. PARSE-PL » ONSET, NLV, /mi+ oto/

Candidate	PARSE-PL	ONSET	NLV
mi.o.to		*!	
√ myo:.to			*
m<i>o:.to	*!		*

To allow a high vocoid to appear as a secondary articulation, SECARTIC must be ranked below PARSE-PL. Furthermore, SECARTIC is ranked below NODIPH and ONSET as well.

(130) PARSE-PL » SECARTIC, /mi+ oto/

Candidate	PARSE-PL	SECARTIC
√ m^{y}o:.to		*
m<i>o:.to	*!	

NODIPH » SECARTIC, /mi+ oto/

Candidate	NODIPH	SECARTIC
mio.to	*!	
√ m^{y}o:.to		*

ONSET » SECARTIC, /mi+ oto/

Candidate	ONSET	SECARTIC
mi.o.to	*!	
√ m^{y}o:.to		*

Ranking SECARTIC below ONSET is also crucial for the different behaviours of high and low vowels since this ranking allows a high vowel to be parsed. The absence of the nonmoraic counterpart of the low vowel is the result of {A}=V being undominated. Low vowels in Kimatuumbi are not left unparsed as in Etsako and Luganda, but rather the vowels surface in hiatus showing that {A}=V dominates ONSET.

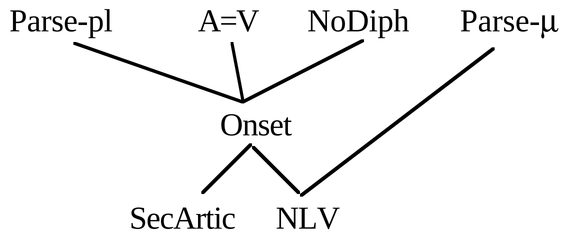
(131) {A}=V » ONSET, /ma+ oto/

Candidate	{A}=V	ONSET
√ ma.o.to		*
m^{a}o:.to	*!	

The constraint rankings established so far are listed below and represented in the tree diagram in (132b).

(132) a. PARSE-μ » NLV (121)
NODIPH » ONSET (123)
PARSE-PL » ONSET (124)
NODIPH » NLV (128)
ONSET » NLV (128)
PARSE-PL » SECARTIC (130)
ONSET » SECARTIC (130)
NODIPH » SECARTIC (130)
{A}=V» ONSET (131)

b.



The combined ranking PARSE-PL » ONSET » SECARTIC is at the core of the difference between the surface forms of sequences with initial high and low vowels because low vowels cannot satisfy ONSET by violating SECARTIC whereas high vowels can. Furthermore, low vowels cannot satisfy ONSET by violating PARSE-PL (as in Luganda) because PARSE-PL dominates ONSET. Therefore, ONSET violations occur when the first vowel is low. This is evident in (133) where the preferred candidate in (133a) is the only candidate that satisfies all undominated constraints. In (133b), two candidates satisfy all undominated constraints and the violation of ONSET is fatal.

(133) a. {{A}=V, NODIPH, PARSE-PL} » ONSET » {SECARTIC, NLV}, /ma+oto/

Candidate	{A}=V	NO DIPH	PARSE -PL	ONSET	SEC ARTIC	NLV
mao.to		*!				
√ ma.o.to				*		
m<a>o:.to			*!			*
m^{a}o:.to	*!				*	*

b. /mi +oto/

Candidate	{A}=V	NO DIPH	PARSE -PL	ONSET	SEC ARTIC	NLV
mio.to		*!				
mi.o.to				*!		
m<i>o:.to			*!			*
√ m^{y}o:.to					*	*

At this point, it is worthwhile to compare Kimatuumbi to the other languages to see how they differ with respect to constraint ranking. One difference, shown in (125), is the ranking of ONSET and PARSE-PL. In Luganda, ONSET dominates PARSE-PL, hence nonhigh vowels are left unparsed under the duress to satisfy ONSET. The opposite holds in Kimatuumbi where nonhigh vowels are parsed with hiatus. Both languages have the same distribution of vocoids when the initial vowel of a vowel sequence is high. This similarity is the result of PARSE-µ » NLV and PARSE-PL » SECARTIC in both languages. Notice that all that is required for high vocoids to surface as secondary articulations is the ranking of SECARTIC below PARSE-PL. Whatever constraints come between these are irrelevant because these constraints will dominate SECARTIC as well. Therefore, the violation of SECARTIC is always preferred. Now compare the following rankings for Luganda and Kimatuumbi.

(134)	Luganda:	{A}=V, ONSET » PARSE-PL » SECARTIC, NLV
	Kimatuumbi:	{A}=V, PARSE-PL » ONSET » SECARTIC, NLV

The constraints which do dominate SECARTIC are crucial in cases where a SECARTIC violation compels a violation of a higher ranking constraint, in particular {A}=V. Since PARSE-PL dominates ONSET in Kimatuumbi, a candidate that cannot satisfy PARSE-PL by violating SECARTIC will have to satisfy PARSE-PL by violating ONSET. The reverse situation occurs in Luganda since ONSET dominates PARSE-PL. ONSET is satisfied by SECARTIC violations and candidates that cannot satisfy ONSET this way satisfy it by violating PARSE-PL. The constraints in both languages interact to maintain surface monophthongs, but do so in different ways.

2.5.3 Glides As Onsets

Odden notes that word-initial vocoids in Kimatuumbi, like secondary articulations, are followed by long vowels.

(135)	a.	/u+ teliike/	[uteliike]	'you cooked'
		/i+ taabua/	[itaab^{w}a]	'books'
	b.	/i+ a+ tuumbuka/	[yaatuumbuka]	'they will fall'
		/i+ otu+ i+ k+ e/	[yootwiike]	'they have holes'
		/u+ a+ teleke/	[waateleke]	'you should cook'
		/i+ula/	[yuula]	'frogs'
				(cf. ma-ula 'large frogs')

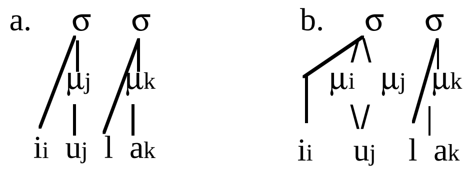
Putting aside the issue of vowel length for the moment, the candidate syllabification [i.u.la] of /i+ ula/, for example, might seem appropriate because ONSET is dominated by NODIPH. However, there is no constraint interaction which prohibits parsing the vocoid as a glide in the onset, e.g. [yu:la] (</i+ula/) since this syllabification contains a parse of all the segments and it satisfies NODIPH and ONSET.

(136) NODIPH » ONSET, /i+ula/

Candidate	NODIPH	ONSET
.iu.la	*!	
i.u.la		*!
√ yu:la		

What is interesting about glides in Kimatuumbi is that they are followed by long vowels, which is contrary to the situation in Luganda where long vowels never follow glides in the onset.[15] Recall from the discussion of Luganda that the distribution of intervocalic glides and vowel length is accounted for by the interaction of V-MORA and SYLL-SEG where SYLL-SEG dominates V-MORA. Looking at the syllabifications for the Kimatuumbi form /i+ula/, (137b) with the long vowel is preferred.

(137) [yu.la] [yu:.la]



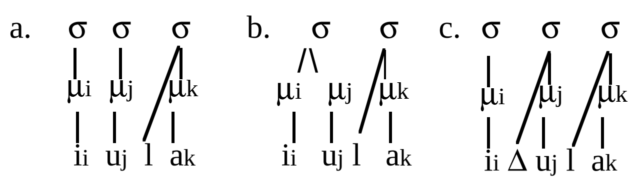
(137a) has a short vowel as a result of violating V-MORA and satisfying SYLL-SEG. The converse is true in (137b) where V-MORA is satisfied and SYLL-SEG is violated. Therefore, V-MORA must dominate SYLL-SEG.

(138) V-MORA » SYLL-SEG, /i+ula/

Candidate	V-MORA	SYLL-SEG
(137b) √ yu:.la		*
(137a) yu.la	*!	

SYLL-SEG is actually dominated by all the constraints that require a one-to-one linking of vowels and moras, including NODIPH, ONSET, and FILL.

(139)



The syllabifications in (139) satisfy SYLL-SEG since no representation contains a vocalic root node linked directly to the syllable node. Therefore, NODIPH, ONSET, and FILL all dominate SYLL-SEG.

(140) a. NODIPH » SYLL-SEG, /i+ ula/

Candidate	NODIPH	SYLL-SEG
(137b) √ yu:.la		*

[15]I was unable to find examples of intervocalic glides in Odden's work.

(139b) iu.la	*!	

b. FILL » SYLL-SEG, /i +ula/

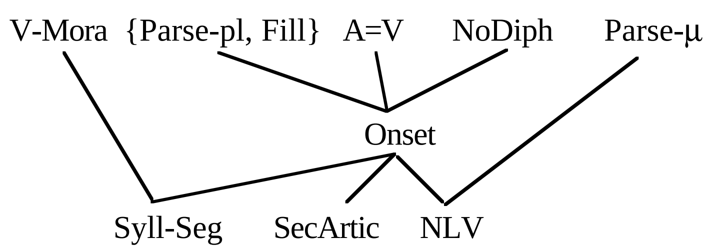
Candidate	FILL	SYLL-SEG
(139c) i.Δu.la	*!	
(137b) √ yu:.la		*

c. ONSET » SYLL-SEG, /i+ ula/

Candidate	ONSET	SYLL-SEG
(139a) i.u.la	*!	
(137b) √ yu:.la		*

The rankings established in this section are added to (132b) and, as can be seen, SYLL-SEG is quite low ranking.

(141)



The relevant subsection of (141) required to account for word-initial glides is illustrated below.

(142) V-MORA, NODIPH, ONSET, FILL » SYLL-SEG, /i+ ula/

Candidate	V-MORA	NODIPH	FILL	ONSET	SYLL-SEG
yu.la	*!				
i.Δu.la			*!		
i.u.la				*!	
iu.la		*!		*	
√ yu:.la					*

Once again, Kimatuumbi provides an interesting contrast to Luganda. The long vowels following onset glides in Kimatuumbi are the result of V-MORA dominating SYLL-SEG and the short vowels in the same environment in Luganda are the result of the reverse ranking.

In summary, Kimatuumbi, like Luganda, has only monophthongal vowels on the surface, but these languages differ with respect to parsing underlying sequences of nonhigh vowels. The disparity stems from a crucial difference in the constraint ranking. Furthermore, Kimatuumbi and Luganda have a different distribution of vowel length following onset glides. This too follows from a difference in the constraint ranking which is reflected in the complementary status of certain constraints.

(143)

	ONSET	PARSE-PL	V-MORA
Kimatuumbi:	dominated	undominated	dominated
Luganda:	undominated	dominated	undominated

The constraints that are dominated in one language are undominated in the other and vice versa. It is unclear what connections among the constraints lead to this complementarity.

The surface form of underlying sequences in Kimatuumbi can be added to the developing typology.

(144)

Language	Surface Form of V1 in VV			
	High	Mid	Low	Surface Length
Etsako				
ONSET » PARSE-PL » SECARTIC	sec. artic	unparsed	unparsed	short
Luganda				
ONSET » PARSE-PL » SECARTIC	sec. artic.	unparsed	unparsed	long
Yoruba				
ONSET, SECARTIC » PARSE-PL	unparsed	unparsed	unparsed	short
Kimatuumbi				
PARSE-PL»ONSET » SECARTIC	sec. artic.	parsed	parsed	long
Logo				
PARSE-PL »PARSE-FEAT, SECARTIC	sec. artic.	sec. artic.	unparsed	short

From (144), it is evident that different rankings of the same constraints lead to different surface patterns. Kimatuumbi, like Luganda and Etsako, has secondary articulations due to the low ranking of SECARTIC. On the other hand, ONSET is undominated in Etsako and Luganda whereas it is dominated in Kimatuumbi. In Yoruba, SECARTIC and ONSET are undominated and so underlying sequences lead to PARSE-PL violations. There are surface forms of underlying sequences other than those represented in (144). The discussion of Ilokano in the following section shows a pattern which is quite different from those seen so far.

2.6 Ilokano

The Optimality Theoretic approach to the surface patterns of underlying sequences is based upon maximizing the parse of phonological elements while best-satisfying the constraint hierarchy. Maximizing the parse determines whether a vocoid surfaces as a secondary articulation or is left unparsed. Similarly, maximizing the parse determines the length of the surface vowel. The surface patterns of vowel sequences in Ilokano (spoken in the Philippines) is quite different from other patterns which have been discussed. Like the other languages, Ilokano has only monophthongal vowels.[16] When initial in an underlying sequence, high and mid vowels surface as the corresponding secondary articulation, whereas low vowels surface with an epenthetic consonant. This is the first case of FILL violations to be discussed.

The distribution of nonmoraic vocoids in Ilokano is concomitant with the distribution of geminates, e.g. [lutt^{w}en] (</luto+ en/). As Hayes (1989) notes, this phenomena is another example of compensatory lengthening which, like other cases of compensatory lengthening, is shown here to be a consequence of maximizing the satisfaction of PARSE-μ.

2.6.1 Ilokano Syllable Structure

Ilokano syllables contain a short vowel preceded maximally by three consonants and followed maximally by two consonants (Hayes and Abad 1989). Prevocalic clusters consist of an obstruent followed by a glide in the native vocabulary and obstruent-liquid clusters occur in loanwords. Trisegmental clusters occur only in loanwords. Similarly, the coda in the native vocabulary is limited to one segment and all bisegmental codas occur in loanwords. According to Hayes and Abad, CVC syllables must be heavy due to their behaviour in the reduplication morphology and the fact that closed penults (in native words) attract stress.

Some of the constraint rankings required for Ilokano are familiar from the other languages discussed here. First NODIPH is undominated and NLV is very high ranking. According to Hayes and Abad, long vowels can occur under two conditions: 1. as a result of reduplication and 2. as a result of stress in a non-final open syllable. The long vowels that occur as a result of reduplication follow from template filling requirements discussed by McCarthy and Prince (1986, 1990b, 1993a,c), but the prosodic and morphological constraints that must dominate NLV are not discussed here. The presence of codas in Ilokano indicates that NOCODA is dominated, particularly by PARSE. Furthermore, these codas contribute weight so WXP is also undominated.

2.6.2 Vowel Sequences in Ilokano

In most of the languages discussed so far, the surface form of hiatus differs depending upon the height of the first vowel in the sequence. High vowels surface as secondary articulations and nonhigh vowels are either left unparsed or are parsed with

[16]Hayes and Abad (1989) claim that there are diphthongs, but they have a different origin. These are discussed in chapter 4.

hiatus. Ilokano has a pattern similar to Logo (discussed in 2.2.2) where both high and mid vowels correspond with high nonmoraic vocoids. The phonology of vowel sequences in Ilokano can be stated as follows: if the first vowel is low in Ilokano, an epenthetic glottal stop appears between the two vowels, but the nonlow vowels /i, e, o/ become the corresponding nonmoraic [y, y, w].[17]

(145)

a.	/basa+ en/	[basa÷en]	'read (goal-focus)'
	/cyenda+ an/	[cyenda÷an]	'market place'
b.	/masahe+ en/	[masahyen]	'massage (goal-focus)'
	/sa√o+ en/	[sa√wen]	'face forwards'
c.	/babawi+ en/	[babawyen]	'regret (goal-focus)'

All surface forms in (145) contain monophthongal vowels. In (145a), the underlying vowel sequence surfaces as a heterosyllabic sequence that is separated by an epenthetic glottal stop. This is the first case in this chapter where FILL is dominated and it can be shown to directly conflict with ONSET, PARSE-PL, and NODIPH. For example, surface hiatus violates ONSET and satisfies FILL since there are no empty positions. A FILL violation, however, leads to satisfaction of ONSET since there is an empty position serving as a place for an onset. Therefore, ONSET dominates FILL in Ilokano.

(146) a. ONSET » FILL, /basa+ en/

Candidate	ONSET	FILL
√ ba.sa.Δen		*
ba.sa.en	*!	

b. PARSE-PL » FILL, /basa+en/

Candidate	PARSE-PL	FILL
√ ba.sa.Δen		*
ba.s<a>en	*!	

c. NODIPH » FILL, /basa+en/

Candidate	NODIPH	FILL
√ ba.saen	*!	
ba.sa.Δen		*

The occurrence of nonmoraic vocoids in (145b &c) is interesting given the fact that ONSET dominates FILL. This ranking implies that epenthesis should occur between any two vowels. However, all the constraints mentioned in (146) are satisfied by the nonmoraic parse of the vocoid. The nonmoraic vocoids are not parsed as secondary articulations at this

[17]The phenomenon of interest here occurs between the root and the suffixes -en and -an. The phoneme /u/ does not participate in the alternation because it never occurs stem-finally (Hayes and Abad 1989). Furthermore, Hayes and Abad note that prefixes and roots do not exhibit a vowel~nonmoraic vocoid alternation, but rather there is glide epenthesis, e.g. [÷agiyabut] (</÷agi+ abut/). The difference between prefix+ stem juncture and stem+ suffix juncture can be accounted for by ALIGN (McCarthy and Prince 1993a,b).

point because their status in the onset is complex and will be discussed in greater detail in 2.6.3.

(147) ONSET, NODIPH, PARSE-PL » FILL, /babawi+ en/

Candidate	ONSET	NODIPH	PARSE-PL	FILL
babawi.Δen				*!
babaw<i>en			*!	
baba.wien.		*!		
babawi.en	*!			
√ babaw.yen				

As discussed elsewhere, the disparity between the low and and high vowels stems from the inability of low vowels to have nonmoraic counterparts. Hence, {A}=V dominates FILL as well since satisfying {A}=V compels a FILL violation.

(148) {A}=V » FILL, /basa + an/

Candidate	{A}=V	FILL
√ ba.sa.Δen		*
bas.a÷en	*!	

The constraint ranking established thus far accounts for high and low vowels, but not for mid vowels. To account for the alternation between mid vowels and high nonmoraic counterparts in (145b), PARSE-PL must be ranked with respect to PARSE-FEAT. In the discussion of a similar alternation in Logo in 2.2.2, where is it shown that the preferred candidate included a maximal parse of vowel particles by ranking PARSE-PL above PARSE-FEAT, only {A} is left unparsed. This is the same situation in Ilokano. More importantly, FILL and PARSE-FEAT conflict because mid vowels are not followed by an epenthetic glottal stop. Therefore, FILL must dominate PARSE-FEAT.

(149) a. {A}=V » PARSE-FEAT, /sa√o + en/

Candidate	{A}=V	PARSE-FEAT
sa√.o÷en	*!	
√ sa√.wen		*

b. PARSE-PL » PARSE-FEAT, /sa√o+ en/

Candidate	PARSE-PL	PARSE-FEAT
sa.√<o>e n	*!	
√ sa√.wen		*

c. FILL » PARSE-FEAT, /sa√o+ en/

Candidate	FILL	PARSE-FEAT
√ sa√.wen		*

sa.√o.Δ en	*!	

The fact that {A}=V dominates PARSE-FEAT raises another candidate for low vowels. The ranking predicts that low vowels can be parsed as onsets as long as {A} is not parsed. However, low vowels consist of a lone {A} so leaving this feature unparsed produces as empty place node which is a FILL violation. Therefore, parsing a low vowel in the onset violates both FILL and PARSE-FEAT which is less preferred than the candidate with the FILL violation.

(150) PARSE-PL » FILL » PARSE-FEAT, /basa+ en/

Candidate	PARSE-PL	FILL	PARSE-FEAT
bas.Δ<a>en		*	*!
√ ba.sa.Δen		*	
ba.s<a>en	*!		

To summarize, Ilokano maintains surface monophthongs by parsing high and mid vocoids nonmoraically and parsing an epenthetic glottal stop after a low vowel. The undominated constraints are ONSET, NODIPH, PARSE-PL and {A}=V which all dominate FILL. The occurrence of nonmoraic counterparts to mid vowels is the result of leaving {A} unparsed when compelled to do so by constraint interaction. This is accounted for by ranking PARSE-PL above PARSE-FEAT. The rankings established here are summarized in (151).

(151) {{A}=V, ONSET, PARSE-PL, NODIPH} » FILL » PARSE-FEAT

The constraint ranking in (151) is applied below to produce the different surface forms in (145).

(152) a. {ONSET, PARSE-PL, NODIPH} » FILL, /babawi+ en/

Candidate	ONSET	PARSE-PL	NODIPH	FILL
babawi.Δ en				*!
baba.wien			*!	
babaw<i> en		*!		
√ babaw.yen				
babawi.en	*!			

b. {{A}=V, ONSET, PARSE-PL, NODIPH} » FILL » PARSE-FEAT, /sa√o+en/

Candidate	{A} =V	ONSET	PARSE-PL	NODIPH	FILL	PARSE-FEAT

sa.√o.en		*!				
√ sa√.wen						*
sa.√oen				*!		
sa.√<o>e n			*!			
sa.√o.Δen					*!	
sa√.o÷en	*!					

c. {{A}=V, ONSET, PARSE-PL, NODIPH} » FILL, /basa+en/

Candidate	{A}= V	ONSET	NODIPH	PARSE-PL	FILL
√ ba.sa.Δen					*
ba.saen			*!		
ba.sa.en		*!			
ba.s<a>en				*!	
bas.a÷en	*!				

The preferred candidate in (152a) satisfies all constraints and in (151c) the preferred candidate satisfies all undominated constraints. Two candidates in (151b) satisfy all undominated constraints, but the FILL violation is fatal and so the candidate that violates PARSE-FEAT is preferred.

2.6.3 Nonmoraic Vocoids and Geminates

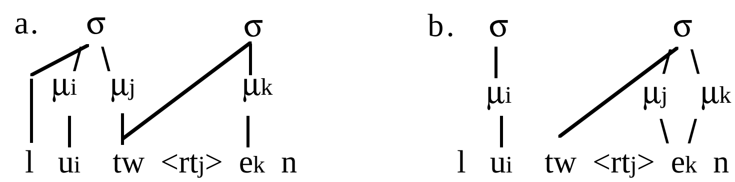
Unlike Kimatuumbi and Luganda where nonmoraic vocoids (appearing as secondary articulations) are accompanied by long vowels, nonmoraic vocoids in Ilokano are accompanied by geminates when the preceding consonant is an obstruent. Hayes (1989) notes that the distribution of geminates in Ilokano and the distribution of long vowels in Luganda are both examples of compensatory lengthening. As in Luganda and Kimatuumbi, the nonmoraic vocoids in Ilokano must be secondary articulations.

(153)	/luto+ en/	[lutt^{w}en]	‘cook (goal-focus)’
	/bagi+ en/	[bagg^{y}en]	‘to have as one’s own’
	/÷aso+ an/	[÷ass^{w}an]	‘place where dogs are raised’

Geminates are actually optional and their frequency depends upon the sonority of the segment. According to Hayes (1989) and Hayes and Abad (1989), obstruents usually geminate, nasals and laterals sporadically geminate, and rhotics, glottal stops, and glides never geminate. The discussion will proceed by first discussing the relation between geminates and nonmoraic vocoids and then the discussion will turn to the gradient nature of geminate frequency.

The distribution of geminates in Ilokano is accounted for in a similar way to the account of long vowel distribution in Luganda and Kimatuumbi. The geminate that is followed by a nonmoraic vocoid is a reflection of the one-to-one correspondence between underlying vowels and surface moras. The only realization of the one-to-one correspondence between vowels and moras discussed so far has been long vowels, but another possibility (considered briefly in connection with Meinhof's Rule) is that the mora links to the preceding consonant. Consider the candidate syllabifications of /luto+ en/ in (154). Note that in order for the vocoid to be parsed nonmoraically and still satisfy V-MORA, the vocoid must be parsed as a secondary articulation.

(154) [lut.tʷen] [lu.tʷe:n]



The constraints in Ilokano must interact in such a way so that the geminate in (154a) is preferred. As for the segmental parse, the high vocoid must surface as a secondary articulation; therefore, SECARTIC is dominated. It is evident, in fact, that it is dominated by the undominated constraints in (151).

(155) a. ONSET » SECARTIC, /luto+ en/

Candidate	ONSET	SECARTIC
lu.to.en	*!	
√ lut:ʷen		*

b. PARSE-PL » SECARTIC, /luto+ en/

Candidate	PARSE-PL	SECARTIC
lu.t<o>en	*!	
√ lut:ʷen		*

SECARTIC is also dominated by FILL, but it is not ranked with respect to PARSE-FEAT since secondary articulations from mid vowels violate both SECARTIC and PARSE-FEAT.

The more interesting aspect of (154) is the moraic parse. Both (154a &b) satisfy PARSE-μ, but (154b) contains a violation of NLV, which is highly ranked in Ilokano and crucially dominates PARSE-μ. Hence, the only parse that satisfies both constraints is (154a) where the mora μ_j is parsed by being associated to the obstruent.

(156) NLV, PARSE-μ, /luto+ en/

Candidate		NLV	PARSE-μ
(154b)	lut^{w}e:n	*!	
(154a)	√ lut:^{w}en		
	lut^{w}e<:>n		*!

Even though the preferred candidate in (156) satisfies both NLV and PARSE-μ, the distribution of geminates and nonmoraic vocoids is not particularly common cross-linguistically. For example, Luganda has both long vowels and geminates so satisfying PARSE-μ can conceivably lead to long vowels or geminates. The preference for geminates over long vowels in Ilokano can be accounted for by ranking NLV above NOCODA. Furthermore, PARSE-μ must be ranked above NOCODA as well since a geminate is preferred to an open syllable and an unparsed mora.

(157) a. NLV » NOCODA, /luto+ en/

Candidate	NLV	NOCODA
lu.t^{w}e:n	*!	*
√ lut.t^{w}en		**

b. PARSE-μ » NOCODA, /luto+en/

Candidate	PARSE-μ	NOCODA
lu.t^{w}e<:>n	*!	*
√ lut.t^{w}en		**

Luganda, in comparison, has the opposite ranking, i.e. NOCODA » NLV, so long vowels are preferred to geminates.

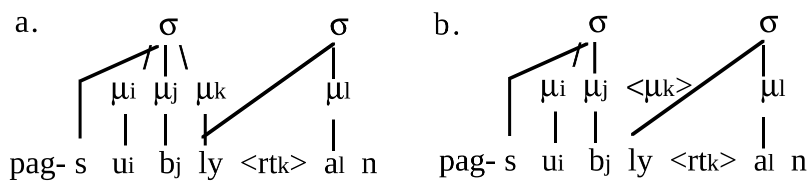
The source of the geminate, according to Hayes (1989), is compensatory lengthening, which is accomplished in the following way. The mora that is left unassociated by glide formation is linked to the preceding consonant thereby forming a geminate. Hayes notes that compensatory lengthening in Ilokano, like other cases of compensatory lengthening, preserves the number of moras. As already discussed, mora preservation in Optimality Theory is the product of the ranking of PARSE-μ with respect to other constraints. The one-to-one correspondence between underlying vowels and surface moras in Ilokano is the result of ranking PARSE-μ above NOCODA. In other words, NOCODA is violated to satisfy PARSE-μ and this moraic coda is the preferred surface form.

Hayes notes that there are two cases in which geminate consonants are not possible. One case involves the sonority of the consonant and the other case involves consonants in closed syllables. Examples of the latter case are given in (158).

(158) /sakdo/ [pag-sakd^{w}an] ‘place where water is fetched’
/subli/ [pag-subl^{y}an] ‘place that one returns to’

The candidate syllabification of /pag-subli+ an/ in (159a) that contains a geminate also has a trimoraic syllable. The moras are present due to satisfaction of different constraints: the mora μ_i is present by V-MORA, μ_j, by WXP, and μ_k by the rankings in (157). The preferred candidate, (159b) violates PARSE-μ, but has a bimoraic syllable.

(159) [pag.subl.l^{y}an] [pag.sub.l^{y}an]



The trimoraic syllable in (159a) violates BIMAX and by comparing (159a &b), BIMAX must dominate PARSE-μ.

(160) BIMAX » PARSE-μ, /subli+ an/

Candidate	BIMAX	PARSE-μ
(159a) √ subl^y<:>an		*
(159a) subl:^{y}an	*!	

Another possible moraic parse of /pag-subli +an/ that satisfies BIMAX is [pagsubl^{y}a:n] where there is a long vowel since all syllables in this candidate are bimoraic. This candidate actually best-satisfies the constraint ranking if NLV and PARSE-μ are not ranked with respect to each other. However, NLV and PARSE-μ do conflict since all vowels in Ilokano are monomoraic.

(161) NLV » PARSE-μ, /subli+ an/

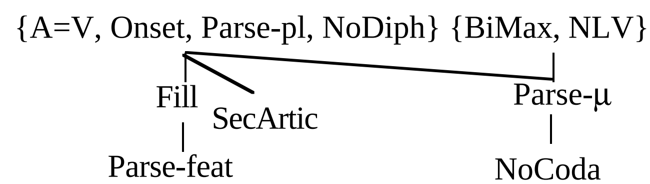
Candidate	NLV	PARSE-μ
√ subl^{y}a<:>n		*
subl^{y}a:n	*!	

To summarize, the following constraint rankings have been established in this section.

(162) PARSE-μ » NOCODA (157)
NLV » PARSE-μ (161)
BIMAX » PARSE-μ (160)
PARSE-PL » SECARTIC (155)
FILL » SECARTIC

Other rankings can be established as well. In particular, PARSE-μ can be shown to be dominated by FILL. This is evident from the candidate [pagsubli.Δan] where BIMAX and PARSE-μ are satisfied by violating FILL. The monosyllabic surface form indicates that FILL (and ONSET) dominate PARSE-μ. The rankings in (162) are added to (151) in (163a) and are illustrated in (163b&c).

(163) a.



b. ONSET, BIMAX, NLV » SECARTIC, PARSE-μ, /pag +subli+an/

Candidate	ONSET	BIMAX	NLV	SEC ARTIC	PARSE-μ
subl:^{y}an		*!		*	
√ sub.l^{y}<:>an				*	*
sub.l^{y}a:n			*!	*	
sub.li.an	*!				

c. ONSET, BIMAX, NLV » SECARTIC, PARSE-μ, /luto+ an/

Candidate	ONSET	BIMAX	NLV	SEC ARTIC	PARSE-μ
lu.to.an	*!				
lut^{w}<:>an				*	*!
√ lut^{w}:an				*	
lut^{w}a:n			*!	*	

In (163b) only one candidate satisfies the undominated constraints. Hence the violations of SECARTIC and PARSE-μ are irrelevant. In (163c), two candidates satisfy the undominated constraints and both tie with respect to SECARTIC violations. Therefore, the violation of PARSE-μ by [lut^{w}<:>an] is fatal.

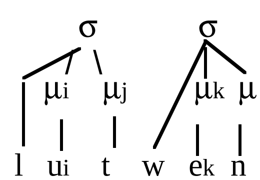
The occurrence of geminates, as mentioned, differs in frequency depending upon the sonority of the segment. Hayes's statement of frequency is repeated below.

obstruents:	usually geminate
nasals and liquids:	sporadically geminate
[r, ÷, w, y]:	never geminate

No attempt is made here to account for the relation between sonority and geminates, but the secondary articulation analysis of the vocoids does provide some insight. For example, [r, ÷, w, y] never geminate because these segments, being vocoid-like, cannot sustain a secondary articulation. Obstruents, on the other hand, occur as geminates because they can sustain a secondary articulation.

The question now turns to the absence of geminates. One requirement for a singleton consonant in the output, e.g. [$lut^{w}en$] (</luto +en/) is a violation of PARSE-μ since the mora coindexed with the high vocoid is left unparsed. However, this is not possible given that PARSE-μ dominates NOCODA. An alternative to the PARSE-μ violation is to propose that there is no mora in the representation in the first place. This alternative requires a V-MORA violation, which would occur when the high vocoid is parsed as a glide in the onset, provided that SYLL-SEG dominates V-MORA. Compare (154a) and (164).

(164) [lut.wen]



The source of the optimal geminate, therefore, stems from the variability of the parse of the high vocoid. If parsed as a secondary articulation, V-MORA is satisfied and the mora is parsed in accordance with the constraint ranking. If the high vocoid is parsed as a glide in the onset, V-MORA is violated and the consonant surfaces as a singleton in the coda.

According to Prince and Smolensky, variability in Optimality Theory arises from equal ranking of constraints. In Ilokano, it can be shown that V-MORA and SECARTIC are equal since both are dominated by the same set of constraints. The crucial ranking involves FILL, which directly dominates SECARTIC. It is evident that FILL dominates V-MORA since an epenthetic consonant ensures the vocoids have coindexed moras. Similarly, ONSET must dominate V-MORA as well since the glide is preferred to hiatus.[18]

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[18]Syllabifying these forms as […VC.GV…] rather than […V.C^{G}V…] is proposed by Hayes (1989). The variability of the geminate, according to Hayes, is the result of a Degemination Rule that maintains a moraic coda.

(165) a. ONSET » V-MORA, /luto+ en/

Candidate	ONSET	V-MORA
lu.to.en	*!	
√ lut.wen		*

b. FILL » V-MORA, /luto+ en/

Candidate	FILL	V-MORA
√ lut.wen		*
lu.to.Δen	*!	

Since V-MORA and SECARTIC are dominated by the same constraints and are not ranked with respect to each other, two outputs are acceptable. Notice that the output that violates both V-MORA and SECARTIC is less harmonic than an output that violates one or the other.

(166) ONSET, PARSE-PL » FILL » SECARTIC, V-MORA, /luto+ en/

Candidate	ONSET	PARSE-PL	FILL	SECARTIC	V-MORA
lu.to.en	*!				
√ lut.wen					*
√ lut^w:en				*	
lu.to<e>n		*!			
lu.t^{w}en				*!	*
bagi.Δan			*!		

The failure of [r, ÷, w, y] to surface as geminates, as mentioned before, follows from the inability of these segments to have secondary articulations. This means that the SECARTIC violation in these cases must compel a higher ranking constraint violation. Hence the only surface form of /karo+ an/, for example, is [kar.wan].

2.7 Conclusion

In Optimality Theory, the surface pattern of an underlying vowel sequence is a consequence of minimizing PARSE violations in accordance with the constraint hierarchy. PARSE violations are minimized by parsing as many phonological nodes as possible thus the high vowel~nonmoraic vocoid alternation is accounted for by parsing a high vocoid's place node as a secondary articulation. The high vocoid's root node cannot be parsed as this compels a violation of higher ranking constraints. For nonhigh vowels, minimizing PARSE violations requires leaving both the root node and place node unparsed in order to satisfy the constraint ranking, most notably {A}=V. In cases where mid vowels alternate with high nonmoraic counterparts, minimizing PARSE violations leaves only {A} unparsed.

Minimizing PARSE violations applies to moras as well. Given the ranking of PARSE-μ with respect to NLV, the surface vowel will be either long or short. Compensatory lengthening, therefore, is the minimization of PARSE-μ violations when PARSE-μ dominates NLV. With this ranking, best-satisfaction of the constraints includes parsing both moras at the expense of violating NLV. Geminates in Ilokano, which Hayes notes are the result of compensatory lengthening, maximally satisfy PARSE-μ by linking the mora to a consonant. In all cases, the ranking of PARSE-μ ensures that the relation between underlying vocoids and surface moras is as close as possible to a one-to-one relation.

The languages discussed in this chapter show variation in the surface form of underlying hiatus which is due to different rankings of the same constraints. For instance, nonhigh vowels in Luganda are left unparsed showing that ONSET dominates PARSE-PL, whereas in Kimatuumbi nonhigh vocoids are parsed with hiatus showing that PARSE-PL dominates ONSET. Given the number of constraints used here and the fact that any constraint can be dominated, there should a large number of possible surface forms of underlying vowels. Indeed, there are if languages with diphthongs, coalescence, and epenthesis are included. However, Optimality Theory makes interesting predictions concerning possible surface patterns of underlying vowel sequences in languages that have monophthongal vowels. The most illuminating way to view the predictions is by looking at the natural classes of vowels that exhibit different behaviours when in sequence. These classes are taken from the typological chart developed throughout the chapter and are summarized below.

(167)
1. all vowels behave alike (Yoruba)
2. high vowels become secondary articulations
nonhigh vowels are unparsed (Etsako, Luganda)
or hiatus (Kimatuumbi)
3. high and mid vowels become secondary articulations
low vowels are unparsed (Logo) or epenthesis (Ilokano)

What is intriguing in (167) is how the vowel system is partitioned, which is shown in (168) where the line separates the classes. Only the bipartite divisions in (168a &b) are observed whereas the tripartite division has not been observed.

```
(168)   a. i____u        b. i    u         c.* i____u
           e    o           e____o             e____o
                a                a                  a
```

(168a) is the partition found in Luganda, Kimatuumbi, and Etsako where high vowels behave differently than nonhigh vowels. (168b) is the partition found in Logo and Ilokano where low vowels behave differently from nonlow vowels.

(168c), where the three vowel heights behave differently, is predicted to be impossible because no constraint ranking can be established to account for this. Imagine a language L where NoDiph, Onset, Parse-feat, and {A}=V are undominated and the following phenomena and constraint violations for vowel sequences are observed.

(169)
a. a + V → a.ΔV — *Fill
b. e,o + V → V — *Parse
c. i,u + → $C^{y,w}V$ — *SecArtic

First consider the ranking necessary for (169a). It is evident here that Parse dominates Fill since the vowels are parsed heterosyllabically.

(170) Parse » Fill, /a +V/

Candidate	Parse	Fill
√ a.ΔV		*
<a>V	*!	

The secondary articulation in (169c) shows that SecArtic must be ranked below Parse. Furthermore, epenthesis in (169c) is less preferred than a secondary articulation so Fill must dominate SecArtic too.

(171) a. Parse » SecArtic, /Ci +V/

Candidate	Parse	SecArtic
√ C^yV		*
C<i>V	*!	

b. Fill » SecArtic, /Ci +V/

Candidate	Fill	SecArtic
√ Ci.ΔV	*!	
C^yV		*

The combined ranking of (170) and (171) is Parse » Fill » SecArtic, which means that the preferred candidate for a mid vowel in hiatus contains a Fill violation.

(172) Parse, {A}=V » Fill » SecArtic, /o +V/

Candidate	Parse	{A}=V	Fill	SecArtic
√ Ce.ΔV			*	
C<e>V	*!			
C^eV		*!		*

The only way mid vowels can be left unparsed is if there is some constraint C that is violated when Fill is violated. This is the strategy used elsewhere to account for the bipartite division shown in (168). In particular, violations of SecArtic compel violations of {A}=V. This strategy, however, is not possible in (169) because there is no constraint violation that is concomitant with FILL violations. In fact, it is impossible to imagine what this constraint could be. The same logic applies if FILL in (169) is replaced by any other constraint such as ONSET, for example. Again, there is no violation of a higher ranking constraint that is compelled by an ONSET violation. Therefore, mid vowels must violate the same constraint as low vowels.

The typological variation becomes more stringent when looking at languages where high vowels do not alternate with their nonmoraic counterparts. This is the case in Yoruba where all initial vowels in a sequence are left unparsed. The pattern found in Yoruba can be described another way: in languages without a high vowel~nonmoraic vocoid alternation, all vowels behave the same. This is easily demonstrated. First consider a language L' which exhibits three separate behaviours and the required constraint violations.

(173)	a.	a+ V $\rightarrow$	a.ΔV	*FILL
	b.	e/o + V $\rightarrow$	e/o.V	*ONSET
	c.	i/u + V $\rightarrow$	V	*PARSE

Language L' is impossible for reasons similar to those that ruled out L in (169). To account for (173a), ONSET must dominate FILL and to account for (173c) ONSET must dominate PARSE. However, PARSE must dominate FILL for (173a) and FILL must dominate PARSE for (173c). This ranking paradox cannot be resolved.

The more interesting case is language L" in (174) where there are only two phenomena to consider.

(174)	a.	a/e/o + V$\rightarrow$	a/e/o.V	*ONSET
	b.	i/u + V $\rightarrow$	V	*PARSE

This bipartite division is not possible because another ranking paradox ensues. To derive (174a), PARSE must dominate ONSET and to derive (174b) ONSET must dominate PARSE. The only way to derive both together is if the ONSET violation in (174b) compels a violation of a constraint ranked above PARSE. No such constraint exists; therefore, if there is no alternation for high vocoids then all vowels will behave alike.

The last typological observation to consider is the following markedness implication: if mid vowels alternate with their nonmoraic vocoid, then so must high vowels, but not vice versa. This observation is accounted for by the fact that a mid vowel~nonmoraic vocoid alternation requires a SECARTIC violation. Once SECARTIC is dominated by PARSE in a language, high vowels will alternate with their nonmoraic counterparts. Whether or not mid vowels alternate depends upon the ranking of PARSE-PL and PARSE-FEAT. This gives rise to two possible rankings.

(175)
a. PARSE-FEAT » PARSE-PL » SECARTIC
   ex. Luganda, Etsako
b. PARSE-PL » PARSE-FEAT, SECARTIC
   ex. Logo, Ilokano

In (175b), mid vowels alternate since the preferred candidate will contain a secondary articulation and leave {A} unparsed. Since only {A}=V can distinguish vowel quality, high vowels are always parsed as secondary articulations regardless of the ranking of PARSE-PL and PARSE-FEAT. In (175a), on the other hand, mid vowels are left unparsed and only high vowels have nonmoraic counterparts. Therefore, the domination of SECARTIC ensures that high vowels have a corresponding nonmoraic vocoid regardless of the behaviour of the mid vowels, but languages with alternating mid vowels must have alternating high vowels as well.

CHAPTER 3

METRICAL INFLUENCES ON SYLLABIFICATION

3.1 Introduction

The formation of prosodic constituents is always assumed to follow the prosodic hierarchy (Selkirk 1980, McCarthy and Prince 1986), that is, moras are grouped into syllables and syllables are grouped into feet. Each level of constituent construction follows the markedness conventions for that level. For example, syllabification should always produce syllables with onsets and foot formation (or metrification) should always produce preferred forms of feet. Since constituent construction starts with the mora and builds larger units as it makes its way up the prosodic hierarchy, it is called "bottom-up" construction (Prince and Smolensky 1993). One consequence of bottom-up constituent construction is that metrical structure should not affect syllabification because the former is built upon the latter. In general, this is true since foot structure forms a constituent of either two syllables or one heavy syllable.

Prince and Smolensky note that problems emerge for bottom-up construction when stress appears to influence syllabification. They discuss the Pacific language Tongan which shows an interesting conflict between stress placement and syllable structure markedness. Stress in Tongan is strictly penultimate and this requirement forces a long vowel to be syllabified heterosyllabically, e.g. [hu.ú.fi] (< /huu+fi/) 'open officially'. Bottom-up construction entails that the syllabification of /huu+ fi/ is [huu.fi] (where there are two syllables with onsets) which serves as the input for stress. Stress placement in Tongan can be characterized by a bimoraic trochee that must be placed at the right edge of the word. However, this foot is incompatible with the output of the syllabification. This is easy to see. To ensure maximal bimoraicity of the foot, the long vowel must be stressed, e.g. [{húu.}fi], but this means the final vowel is unfooted. The only way the rightmost mora can be footed while maintaining the output of syllabification is to create the undesirable heavy-light trochee. In the end, it is impossible to satisfy both syllable and metrical markedness. If syllabification must produce syllables with onsets, metrification cannot produce a bimoraic trochee. Alternatively, if metrification must produce a bimoraic trochee, syllabification cannot produce syllables with onsets. The only recourse in the bottom-up view is a resyllabification rule, i.e. a repair strategy, that splits the long vowel to ensure that the foot is a bimoraic trochee at the right edge of the word.

(1)	/huu+ fi/	→ huu.fi	→ {huu.fi}	→ hu.{u.fi}
		syllabification	metrification	resyllabification

In Tongan, therefore, constituent construction is "anti-bottom-up" since it appears that stress placement must be known prior to syllabification in violation of the prosodic hierarchy. In other words, syllabification is altered to satisfy the conditions of foot formation.

As Prince and Smolensky note, Optimality Theory is particularly well-suited to address the problems caused by the anti-bottom-up nature of Tongan constituent construction. In Optimality Theory, all possible syllabifications and metrifications are represented in the candidate set and are compared simultaneously for best-satisfaction of metrical and syllable structure constraints. Since potential outputs are compared, there is no procedure of syllabification followed by metrification. Tongan syllabification, therefore, has a straightforward account as a consequence of constraint interaction. According to Prince and Smolensky, foot placement at the right edge of the word dominates ONSET; hence the heterosyllabic parse of the long vowel is a consequence of violating ONSET to satisfy the conditions on metrical structure.

The influence of stress on syllabification is apparent in some descriptions of the distribution of high vocoids. In Spanish, for example, high vocoids are vowels when stressed, but they are glides when unstressed (Harris 1969, Cressey 1978, Morgan 1984, Carreira 1988, Dunlap 1991). This is another case of anti-bottom-up constituent construction since the surface form of the high vocoids depends upon its syllabic affiliation, but syllabification must be sensitive to stress placement. In this chapter, the distribution of vocoids in Lenakel and Spanish is discussed. Both languages exhibit a vowel/glide alternation which arises from simultaneously comparing moraic and nonmoraic parses of the high vocoid. Stress is shown to play a role through metrical constraints that ensure a moraic parse of the high vocoid when a nonmoraic parse is predicted by the interaction of the syllabification constraints. The metrical constraints are shown to directly conflict with syllabification constraints. The chapter begins with a discussion of Lenakel which establishes the interaction between metrical constraints and syllable structure constraints required to account for vocoid distribution. The chapter continues with a detailed analysis of the complex pattern of vocoid distribution, stress placement, and syllabification in Spanish. In brief, stress on the high vowel of a vowel sequence in Spanish is accompanied by hiatus, but the vowel sequence is syllabified as a diphthong when stress falls on the nonhigh vowel.

The occurrence of diphthongs in Lenakel and Spanish makes the syllabification of vowel sequences in these languages different from the patterns seen in the preceding chapter. Most importantly, NODIPH, as will be shown, is dominated and the constraints on nuclear sonority relations introduced in chapter 1 are relevant. They are SONRISE, which ensures a rise of sonority under a branching mora and SONFALL, which ensures a fall of sonority between two moras. These constraints (along with the other syllable structure constraints and the faithfulness constraints) interact with the constraints on metrical well-formedness.

3.2 Lenakel

Some basic characteristics of Lenakel vocoid distribution are analyzed independently of stress before turning to the influence of stress on syllabification. Lenakel exhibits the familiar complementary distribution of vowels and glides: a high vowel occurs when either preceded or followed by a consonant and a glide appears when adjacent to a vowel (Lynch 1975, 1978, Waksler 1990). This distribution of glides and vowels leads Lynch to conclude that glides are allophones of high vowels.[1]

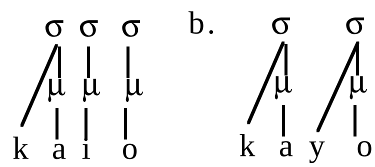
[1] There are two segmental alternations that appear in the surface forms: 1. stops are voiced intervocalically and 2. vowels are lax in closed syllables (Lynch 1975). These alternations are not discussed here.

(2)	a.	/n-iko/	[nigo]	‘boat’
		/kesi/	[k´si]	‘pawpaw’
		/suk/	[sUk]	‘to sow’
	b.	/uikar/	[wigar]	‘seed’
		/kaio/	[kayo]	‘tail-feather’
		/eua/	[ewa]	‘to vomit’

The data in (2) show that Lenakel adheres to the well-established pattern of high vowels in syllable nuclear position and glides in non-nuclear positions. The intervocalic and initial glides in (2b) can be accounted for by the interaction of SYLL-SEG, V-MORA and ONSET, as demonstrated in chapters 1 and 2. Consider the following syllabifications for /kaio/.

(3) [ka.i.o] [ka.yo]

a. b.



(3b) satisfies SYLL-SEG, but violates V-MORA and (3a) satisfies V-MORA, but violates ONSET twice. ONSET, therefore, dominates V-MORA.

(4) ONSET » V-MORA, /kaio/

Candidate	ONSET	V-MORA
ka.i.o.	*!	
√ ka.yo		*

Besides the intervocalic vocoids in (2b), Lenakel has pre- and postvocalic vocoids. The distribution of prevocalic vocoids, however, is complicated by the occurrence of prevocalic high vowels that are shown to be the result of constraint interactions involving metrical constraints. The discussion will proceed by establishing the interactions of the syllable structure constraints required to account for the distribution of postvocalic vocoids and some aspects of prevocalic vocoid distribution.

3.2.1 Lenakel Syllable Structure

The syllable in Lenakel is limited to a short vowel or diphthong that is preceded by a single consonant and followed by a single consonant. The only exceptions to the simplicity of the onset and the coda are word-initial and word-final sequences involving a high vocoid and a consonant. These exceptions are discussed below. To begin, consider the postvocalic vocoids in (5).

(5)	a.	/aulu/	[awlu]	‘to persuade’
		/akaikei/	[agaygey]	‘to enter’
	b.	/n+ maik/	[n¤mayk]	‘you swam’
		/noun/	[n≠wn]	‘fish poison’
		/euk/	[ewk]	‘to stamp’

The postvocalic vocoids in (5) are underlying vowels that are syllabified tautosyllabically with the preceding vowel. These vocoid sequences, therefore, are diphthongs that occur as a result of ranking NODIPH below other constraints, particularly PARSE and ONSET.

(6) a. ONSET » NODIPH, /aulu/

Candidate	ONSET	NODIPH
√ au.lu.		*
a.u.lu.	*!	

b. PARSE » NODIPH, /aulu/

Candidate	PARSE	NODIPH
√ au.lu.		*
a<u>.lu.	*!	

It is evident that these constraints conflict since ONSET is satisfied by creating a diphthong and conversely a bimoraic nucleus is avoided by a heterosyllabic parse of the vowels. Similarly, the tautosyllabic parse of the vocoids is avoided by leaving one vocoid unparsed. There is no way to satisfy all three constraints and so violations of NODIPH are compelled by satisfying ONSET and PARSE.

At this point, it is possible to combine the constraint rankings required for intervocalic and postvocalic vocoids. The distribution of vocoids in these positions involve the same set of constraints dominating V-MORA and NODIPH. By looking at (4b) and (6a), it is apparent that ONSET dominates both constraints and, furthermore, it should be clear that PARSE and FILL-C are undominated since underparsing and overparsing are less preferred. The only remaining ranking to be considered is between V-MORA and NODIPH. A dominance relation between these constraints leads to either a bimoraic diphthong (if V-MORA » NODIPH) or a monomoraic vowel followed by a nonmoraic vocoid, i.e. a glide, (if NODIPH » V-MORA). The two types of vocoid sequences are phonetically indistinguishable so at present it is assumed that all Lenakel vocoid sequences are bimoraic, although later it will be shown that word-final falling diphthongs consist of a vowel followed by a nonmoraic high vocoid. The ranking that determines the distribution of intervocalic and postvocalic high vocoids is given in (7).

(7)

{Parse, Fill-C, Onset}
|
V-Mora
|
NoDiph

This ranking is illustrated with the syllabifications of /kaio/ and /aulu/.

(8) a. {FILL-C, ONSET} » V-MORA » NODIPH, /kaio/

Candidate	FILL-C	ONSET	V-MORA	NODIPH
kai.o		*!		*
ka.Δi.Δo	*!*			
√ ka.yo			*	
ka.i.o		**!		

b. {FILL-C, ONSET} » V-MORA » NODIPH, /aulu/

Candidate	FILL-C	ONSET	V-MORA	NODIPH
√ au.lu				*
a.Δu.lu	*!			
aw.lu			*!	
a.u.lu		*!		

Although Lenakel does not have consonantal epenthesis, there is vowel epenthesis which interacts in interesting ways with the distribution of high vocoids. As previously mentioned, the only word-initial sequence is a consonant followed by a high vocoid, which must be a secondary articulation. Other word-initial clusters are separated by an epenthetic vowel.[2]

(9)
a. /n-kom/ [n¤kom] 'fire'
/rm-n/ [r¤mÖn] 'his father'
/t-r-rai/ [t¤r¤rai] 'he will write'
b. /suatu/ [s^{w}atu] 'road'
/kiukiu/ [k^{y}ukyu] 'to shake the body'

First, consider epenthesis in (9a) from which it is evident that the absence of onset clusters shows that NCO dominates FILL-V.

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[2]According to Lynch (1975), the epenthetic vowel alternates between [¤] and [Ö].

(10) NCO » FILL-V, /n-kom/

Candidate	NCO	FILL-V
nkom	*!	
√ nΔkom		*

The absence of an epenthetic vowel in (9b) shows that the high vocoid must be treated differently from other types of segments. Indeed, vocoids are unique in that they can appear as secondary articulations and so the word-initial sequences in (9b) can be accounted for by allowing these vocoids to be parsed as secondary articulations. The difference between sequences with high vocoids and other sequences is the result of FILL-V dominating SECARTIC.

(11) FILL-V » SECARTIC, /suatu/

Candidate	FILL-V	SECARTIC
√ s^watu		*
sΔwatu	*!	

Other candidate syllabifications can also account for the absence of epenthesis in (9b). One in particular is [sua.tu] where the vowel sequence is syllabified as a diphthong. In fact, this syllabification should be expected since NODIPH is dominated. However, the rising diphthong in [sua.tu] cannot be compared to the falling diphthong in [au.tu] since these diphthongs have different properties (Schane 1984b, Kaye 1989). The difference is that the former violates SONFALL because the first vocoid is less sonorous than the second. SONFALL is undominated in Lenakel and it crucially dominates SECARTIC.

(12) SONFALL » SECARTIC, /suatu/

Candidate	SONFALL	SECARTIC
√ s^watu		*
sua.tu	*!	

Given the ranking in (11), it seems that word-medial consonant^high vocoid clusters should surface as secondarily articulated consonants as well. However, there is evidence that the sequences in (13) surface as heterosyllabic clusters.

(13) /elue/ [el.we] 'to be lost'
/a√ien/ [a√.y´n] 'to be glad'

Support for the heterosyllabic parse in (13) comes from optional epenthesis that occurs between a stressed closed syllable and the following syllable. Interestingly, epenthesis also applies to consonant^high vocoid clusters.

(14) a. r¤málfa ~ r¤mál¤̲fa 'he was lazy'

	ramɛ;nda ~ ramɛ;n¤da	‘it is red’
b.	temálwa ~ temál¤wa	‘young man’
	neluyá√ya√ ~ neluyá√¤ya√	‘twig’
c.	Inlɛ;l¤√ ~ *In¤lɛ;l¤√	‘I have returned’
	adgábu ~ *ad¤gábu	‘to husk a coconut’

The nature of this optional epenthesis is not discussed here; it is only used to demonstrate that medial consonant^high vocoid clusters are syllabified heterosyllabically because the prevocoid consonant is patterning with coda consonants.[3] The heterosyllabic parse of these sequences shows that SECARTIC dominates NOCODA.

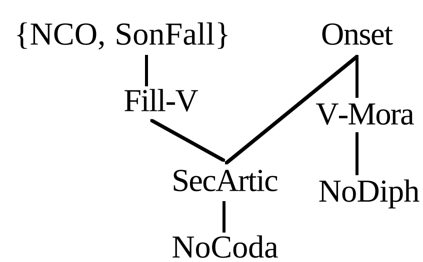
(15) SECARTIC » NOCODA, /elue/

Candidate	SECARTIC	NOCODA
√ el.we.		*
e.l^{w}e.	*!	

So far, only the properties of vocoid distribution based on syllabification have been discussed. The distribution of intervocalic and postvocalic vocoids follows from the ranking in (7) and some aspects of prevocalic vocoid distribution are a consequence of combining (11) and (15). The established syllable structure rankings are summarized in (16) and these rankings are sufficient to proceed to the analysis of stress and the interaction between stress and syllable structure.

(16) a. ONSET » NODIPH (6)
NCO » FILL-V (10)
FILL-V » SECARTIC (11)
SECARTIC » NOCODA (15)

b.



One ranking in (16b) that has not yet been established is ONSET dominating SECARTIC. This ranking, however, is evident from (9b) where the candidate [su.a.tu] with an ONSET violation must be less preferred than [s^{w}atu] with a SECARTIC violation. The hierarchy in

[3]Optional epenthesis appears to be the result of variation between a heavy-light and a light-light trochee.

(16b) is illustrated in (17) with an example of a word-initial and a word-medial consonant^high vocoid sequence.

(17) a. {FILL-C, ONSET} » SECARTIC » NOCODA, /suatu/

Candidate	FILL	ONSET	SECARTIC	NOCODA
√ s^{w}a.tu.			*	
su.Δa.tu.	*!			
su.a.tu.		*!		

b. {FILL-C, ONSET} » SECARTIC » NOCODA, /elue/

Candidate	FILL	ONSET	SECARTIC	NOCODA
e.l^{w}e.			*!	
√ el.we.				*
e.lu.Δe	*!			
el.u.e.		*!		

The SECARTIC violation in (17a) is inconsequential because only one candidate satisfies the undominated constraints. In (17b), two candidates satisfy the undominated constraints and so the SECARTIC violation is fatal. The ranking in (16b) ensures that word-initial and word-medial consonant^high vocoid sequences are syllabified differently. This ranking makes the form [kiukiu] in (9b) interesting because it is predicted to surface as [k^{y}uk.yu] with an initial secondarily articulated stop and a medial stop^glide cluster violating both SECARTIC and NOCODA. The alternative candidate [k^{y}u.k^{y}u] is nonoptimal because it violates SECARTIC twice which is less preferred to the single violation of SECARTIC in the preferred candidate. The violation of NOCODA in the preferred candidate, therefore, is not relevant.

The constraint ranking for Lenakel has been developed independently of the interaction with stress and at this point it is necessary to discuss Lenakel stress independently of syllabification.

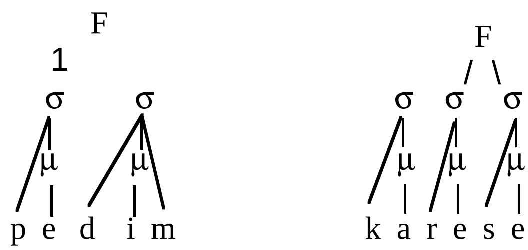
3.2.2 Lenakel Stress

Lynch reports that stress regularly falls on the penultimate syllable regardless of the weight of the final syllable be it a closed syllable or a diphthong.

(18)	a.	karése	'stick for plucking fruit'
		r¤móyo	'he hit me'
	b.	pédim	'all'
		abnábÖn	'fruitless'
	c.	k≠;lay	'sweet potato'
		kavévaw	'hat'

The only aspect of Lenakel stress that is of interest here is its quantity-insensitivity.[4] This quantity-insensitivity is attributed in part to the nonmoraic status of coda consonants, that is, all CVC syllables are light. Penultimate stress in words with final open or closed syllables follows from placing a trochee at the right edge of the word.

(19)



The appropriate foot for Lenakel appears to be a quantity-insensitive trochee (cf. Hammond 1986). This foot not only accounts for final open and closed syllables, but it also accounts for penultimate stress in the words with word-final diphthongs in (18c). However, the Lenakel foot is proposed to be maximally bimoraic rather than the quantity-insensitive trochee. This changes the analysis of stress assignment in words with final diphthongs, which will be shown later to require a more complex constraint interactions. For now the appropriate foot is the bimoraic trochee, which in (18a&b) is also disyllabic. In Optimality Theory, the foot is defined by the constraint FOOTFORM (Prince and Smolensky 1993) and any deviation from the proper foot-shape (in this case, the bimoraic trochee) constitutes a violation of FOOTFORM. Following Prince and Smolensky, FOOTFORM actually involves a number of constraints on foot structure. For instance, FOOTFORM includes FOOTBINARITY, which ensures feet are binary and RHTYPE, which ensures the foot is trochaic. For now these constraints are subsumed under FOOTFORM, although later it will be necessary to treat some of these constraints separately. The placement of the foot is constrained by ALIGN (McCarthy and Prince 1993a,b) or EDGEMOST (Prince and Smolensky 1993) which dictates that the right edge of the foot must coincide with the right edge of the word. The interaction between FOOTFORM and the syllable structure constraints (16) is shown to account for the pattern of vocoid distribution that relies on stress. This is demonstrated in the following section.

[4] Other aspects of Lenakel stress are discussed by Hammond (1986), Halle and Vergnaud (1987) and Idsardi (1992).

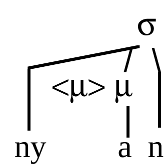
3.2.3 Metrification and Syllabification

The influence of stress on syllabification is apparent in (20a) where stressed prevocalic vocoids are parsed as vowels even though a nonmoraic parse of the vocoid is predicted by the constraint ranking in (16b). The occurrence of prevocalic high vowels in (20) is limited to a particular environment. According to Lynch (1977:p13) “in words of the form #CHV(C)#…the [glide formation] rules do not apply.” A most interesting aspect of the high vocoids in (20) noted by Lynch is “that when lexical items like these are preceded in the same phonological word by one or more syllables, the high vowel regularly becomes a glide.”

(20)	a.	ní.an.	*n^{y}an	‘day’	b.	l´n.yan.	‘at the time’
		tú.In.	*t^{w}In	‘the top of it’		l´d.wIn.	‘on top of it’
		lú.au.	*l^{w}au	‘ridge-pole’		t≠l.wau.	‘to the ridge-pole’
		ní.Uk.	*n^{y}Uk	‘grass skirt’		l´n.yUk.	‘on the grass skirt’

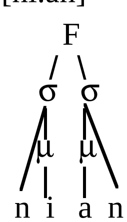
The presence of the high vowels in (20a) must be the result of satisfying a high ranking constraint which makes the predicted [n^{y}an] (</nian/), for example, nonoptimal. The problem created by the predicted surface form [n^{y}an] is evident from looking at its representation in (21).

(21) [n^{y}an]



(21) is monomoraic and so FOOTFORM, in particular FOOTBINARITY, is violated. The only way to satisfy FOOTFORM is to have a bimoraic parse for (20a) and the only possible bimoraic parse has both vocoids parsed as vowels.

(22) [ni.an]



An interesting consequence of the moraic parse of the vocoids in (20a) is vowel hiatus. The heterosyllabic parse of the vocoids in (20b) must be compared to a candidate with a tautosyllabic parse, i.e. [nian]. This candidate, however, violates SONFALL, which is undominated. In fact, SONFALL and FOOTFORM clearly conflict with ONSET, which must be dominated in Lenakel. Of particular interest here is the interaction between FOOTFORM and ONSET. Notice that ONSET is satisfied by the monomoraic parse in (21) and that FOOTFORM is satisfied by the heterosyllabic parse in (22). Hence, FOOTFORM, and SONFALL dominate ONSET. The absence of an epenthetic consonant means that FILL-C must dominate ONSET as well.

(23) a. FOOTFORM » ONSET, /nian/

Candidate	FOOTFORM	ONSET
(22) √ {ní.an}		*
(21) {nʸan}	*!	

b. SONFALL » ONSET, /nian/

Candidate	SONFALL	ONSET
(22) √ {ní.an}		*
(21) {nʸan}	*!	

c. FILL-C » ONSET, /nian/

Candidate	FILL-C	ONSET
(22) √ {ní.an}		*
{ní.Δan}	*!	

The dominance of FOOTFORM over ONSET is a case of the more general FOOTFORM » SYLLFORM that Prince and Smolensky propose to be responsible for the anti-bottom-up construction effect. Procedural constituent construction can only account for Lenakel syllabification by use of resyllabification rules. Procedural syllabification and metrification would entail that /nian/ would be syllabified as [nyan] to satisfy ONSET and this form would serve as the input for foot formation. The impossibility of building a bimoraic trochee would require vocalization of the high vocoid and a heterosyllabic parse of the vowels. The repair strategy, triggered by foot formation, would circumvent anti-bottom-up construction by allowing some syllabification after metrification. No such complication emerges in the Optimality Theoretic approach because the ONSET violation is the result of conflict with FOOTFORM. There is no need to assume that there is a level where ONSET is satisfied. In any circumstance other than underlying forms of the shape #CHVC#, ONSET violations are fatal. Therefore, ONSET will be satisfied when FOOTFORM does not exert any influence.

The relation between FOOTFORM and ONSET in Lenakel can be attributed to a word-minimality effect (McCarthy and Prince 1986, 1990a,b) since [nʸan] is monomoraic and so it is subminimal whereas the bimoraic [ni.an] satisfies minimality. As McCarthy and Prince (1993a) note, word-minimality follows from FOOTBINARITY, which is the relevant aspect of FOOTFORM in (22). The role of FOOTBINARITY (and word-minimality) is apparent from Lynch's description of the facts. The reason why the words in (20b) have nonmoraic vocoids is because these words are all disyllabic. Therefore, FOOTFORM is satisfied in all candidates and so an ONSET violation is fatal. Since FOOTFORM is not relevant in (20b), the nonmoraic vocoids occur as a result of the constraint ranking in (16).

(24) FOOTFORM » ONSET » SECARTIC » NOCODA, /le+ nian/

Candidate	FOOTFORM	ONSET	SECARTIC	NOCODA
lɛ.{ní.an.}		*!		
{lɛː.nʸan.}			*!	
√ {lɛːn.yan.}				*

The form [lú.au] in (20a) is interesting because there are a number of ways FOOTFORM can be satisfied at the expense of an ONSET violation, but the constraint ranking correctly predicts (25b) as the preferred candidate.

(25) a. lu.{á.u.} b. {lú.au.} c. {lʷá.u.}

(25a) is nonoptimal because it violates ONSET twice compared to the single violations of ONSET in (25b & c). (25c) violates SECARTIC and (25b) violates NODIPH, but both of these constraints are dominated by ONSET and are not ranked with respect to each other. However, the violation of SECARTIC must be accompanied by a violation of PARSE-RT (as discussed in chapter 2) and so (25c) is nonoptimal because it has two constraint violation below ONSET compared to the one violation in (25b).

(26) ONSET » SECARTIC, PARSE-RT, NODIPH /luau/

Candidate	ONSET	SECARTIC	PARSE-RT	NODIPH
lu.{á.u.}	**!			
√ {lú.au.}	*			*
{lʷá.u.}	*	*!	*	

To summarize, the interaction between FOOTFORM and ONSET demonstrates how metrical structure can influence syllabification. The demand to satisfy FOOTFORM compels a violation of the syllabification constraint ONSET, but in cases where FOOTFORM is satisfied by all candidates, an ONSET violation is nonoptimal. This interaction between FOOTFORM and ONSET in Lenakel is similar to their interaction in Tongan where in both cases the incompatibility between stress and syllabification markedness (which requires syllables to have onsets) is reflected in the ranking of FOOTFORM above ONSET. As noted by Prince and Smolensky, procedural syllabification based on satisfying markedness considerations would require that all syllables have an onsets. This, of course, is incompatible with stress placement and so a repair would be required. This problem does not exist in Optimality Theory because markedness considerations are satisfied unless under duress from higher ranking constraints as in (20a) where ONSET is violated to satisfy FOOTFORM. High vocoids, therefore, have the distribution expected by syllabification, that is, high vocoids are vowels when syllable peaks and nonmoraic vocoids occur as onsets or secondary articulations. The high vowels in (20a) are exceptions to this generalization that occur when the satisfaction of ONSET compels a violation of the higher ranking FOOTBINARITY.

There is another case of high vocoids appearing where a nonmoraic vocoid is predicted. According to Lynch, there are some words (approximately thirty-five) in which the high vocoid must be a vowel. Lynch marks these nonalternating high vowels with an accent.

(27)	/eiua/	[e.yú.a]	*[ey.wa]	'to tell a lie'
	/ekutuan/	[e.ku.tú.an]	*[e.kut.wan]	'cook'
	/nahua/	[na.hú.a]	*[nah.wa]	'pus'

The absence of nonmoraic vocoids in these words is not indicative of a phonemic distinction between vowels and glides (contra Waksler 1990). The function of the accent on the high vowels in (27) is to indicate that these vowels are stressed (Lynch p.c.). This diacritic is required independently of (27), for it is used throughout Lynch's work to mark exceptional stress, either antepenultimate stress, e.g. [sámaha] 'soreness of the throat' or final stress, e.g. [olmusmús] 'to slander'. In (27), stress is exceptional because it is falling on the penultimate vocoid which would be nonmoraic otherwise, i.e. [eyúa], *[éywa], [ekutúan], *[ekútwan].

The high vocoids in (27), like other cases of exceptional stress, must be diacritically marked to bear main stress. Since these high vowels must be stressed, it is quite natural why these vowels cannot surface as glides for this would violate Prince's (1983) Continuous Column Constraint (CCC) which states that prominence relations must be continuous, that is, no superordinate grid can be built unless there is an immediate subordinate grid. For a vowel to surface with main stress, it must have a continuous column of grids from the mora line to the foot line (Halle and Vergnaud's (1987) lines 0-2). A glide is nonmoraic so it cannot support a grid on the mora line and, as a result, a glide cannot have any superordinate grids. This is shown in (28) where the glide /w/ does not have a line 0 grid, but has grids on line 1 and line 2.

```
(28)     *  line 2          x
            line 1          x   x
            line 0     x        x
                       e yw     a
```

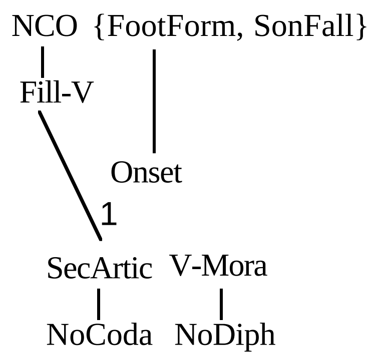
The CCC, properly speaking, is never violated and it can be considered part of GEN so there is no need to rank it. The hiatus in (27) follows from the nonoptimality of parsing a bimoraic rising diphthong which violates SONFALL and, as already established, SONFALL dominates ONSET.

(29) SONFALL » ONSET, /eiua/

Candidate	SONFALL	ONSET
e.{yúa.}	*!	
√ e.{yú.a.}		*

The constraint rankings in this section show that ONSET is dominated by FOOTFORM and SONFALL. These interactions are added to (16b) and shown in (30).

(30)



Prevocalic high vocoids are vowels when stressed because this parse simultaneously best-satisfies the metrical and syllabification constraints. One of the more interesting aspects of Lenakel is that underlying vocoids surface as vowels under duress to satisfy word-minimality via FOOTBINARITY. Unstressed prevocalic high vocoids are parsed nonmoraically when all candidates satisfy the metrical constraints and the interaction of the syllabification constraints decide best-satisfaction. The distribution of prevocalic high vocoids in Lenakel is demonstrated in (31). In (31a) the prevocalic vocoid surfaces as a vowel in hiatus since this is the only parse that satisfies the undominated constraints. In (31b), the ONSET and SECARTIC violations are less preferred than the NOCODA violation. Finally the SECARTIC violation in (31c) is preferred because NOCODA is irrelevant.

(31) a. SONFALL, FOOTFORM » ONSET » SECARTIC, /nian/

Candidate	SONFALL	FOOTFORM	ONSET	SECARTIC
{ní.an.}			*	
{nʸán.}		*!		*
√ {nían}	*!			

b. FOOTFORM » ONSET » SECARTIC » NOCODA, /le+ nian/

Candidate	FOOTFORM	ONSET	SECARTIC	NOCODA
lɛ.{ní.an.}		*!		
{lɛ;.nʸan.}			*!	
√ {lɛ;n.yan.}				*

c. FOOTFORM, SONFALL » ONSET » SECARTIC, /suatu/

Candidate	FOOTFORM	SONFALL	ONSET	SECARTIC
su.{a.tu}			*!	
√ {sʷa.tu}				*
{sua.tu}		*!		

The ranking in (30) has been established based on the distribution of prevocalic vocoids. Postvocalic vocoids exhibit different phenomena with respect to stress and epenthesis that are discussed in the following section.

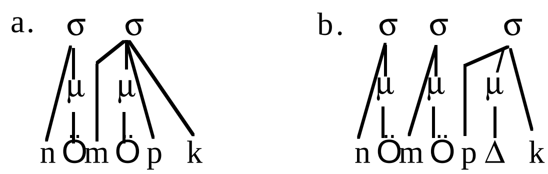
3.2.4 Postvocalic High Vocoids

In contrast to prevocalic vocoids, postvocalic vocoids are always parsed tautosyllabically with the preceding vowel to form a diphthong irrespective of stress. In other respects, postvocalic vocoids behave similarly to prevocalic ones. This is evident from epenthesis. As already mentioned above, the only postvocalic, word-final sequence found in Lenakel is a high vocoid followed by a consonant. In other words, word-final closed syllables can contain a diphthong. Other word-final consonant clusters are separated by an epenthetic vowel.

(32)	a.	/n+ maik/	[n¤mayk]	'you swam'
		/noun/	[n≠wn]	'fish poison'
		/euk/	[ewk]	'to stamp'
	b.	/r-Öm-Ö√n/	[r¤mÖ√Ön]	'he was afraid'
		/n-Öm-Öpk/	[n¤mÖpÖk]	'you look at it'
		/to-rm-n/	[tormÖn]	'to his father'

The absence of word-final consonant clusters indicates that Lenakel does not tolerate extrasyllabic segments. Since CVC syllables are light, the problem posed by the consonant clusters in (32b) is that two nonmoraic consonants cannot be parsed tautosyllabically. This follows from the necessary peripherality of the syllabic appendix (see Sherer 1993). Looking at the crucial candidates for /n-Öm-Öpk/ in (33), (33a) has both consonants in the same syllable whereas (33b) has an epenthetic vowel between the consonants.

(33)



The tautosyllabic sequence in (33a) violates the peripherality of nonmoraic consonants, which can be characterized by a constraint called PERIPH that clearly conflicts with FILL-V. (33a) violates the former and satisfies FILL-V and the reverse constraint satisfaction is true in (33b). Therefore, PERIPH dominates FILL-V and PARSE must dominate FILL-V as well since the word-final consonant is syllabified.

(34) PERIPH » FILL-V, /n+ Öm+ Öpk/

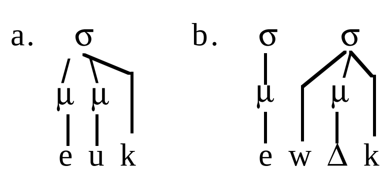
Candidate	PERIPH	FILL-V
(33a) n¤mÖpk	*!	
(33b) √ n¤mÖpΔk		*

PARSE » FILL-V, /n+ Öm+ Öpk/

Candidate	PARSE	FILL-V
n¤mÖp<k>	*!	
√ n¤mÖpΔk		*

The postdiphthongal consonants in (32a), unlike other word-final consonants, appear to be appendices since there is no epenthetic vowel. This is actually expected because the word-final consonant is preceded by a moraic vocoid so there is no PERIPH violation to compel a FILL-V violation. Since both candidate syllabifications in (35) satisfy PERIPH, the FILL-V violation in (35b) is fatal.

(35)



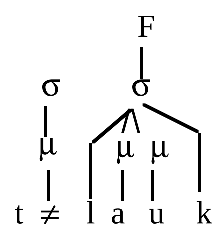
Word-final high vocoid^consonant sequences are similar to word-initial consonant^high vocoid sequences with respect to syllabification since neither sequence incurs FILL violations. This similar pattern occurs for different reasons: word-initial sequences satisfy FILL by violating SECARTIC and the word-final sequences satisfy FILL by faithfully parsing the underlying form.

The postvocalic vocoids, as mentioned, have a uniform distribution that is not affected by stress. These vocoids always appear as the nonpeak component of a falling diphthong. In short, the syllabification of falling diphthongs is not affected by metrical constraints, but word-final diphthongs that are followed by a consonant affect stress placement. In this case, stress falls on the final syllable (Lynch 1975).

(36)	elwáy√	‘to be hidden’
	t≠láwk	‘tomorrow’
	kÖmarɛ;wk	‘they stamped’

The words in (36) obviously do not have the disyllabic trochee seen elsewhere. Nonetheless, the foot required in (36) is the bimoraic trochee, placed on the word-final diphthong.

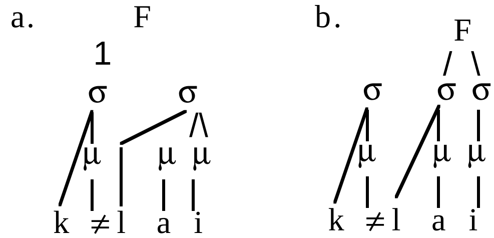
(37)



Comparing the forms in (36) to (18), the foot in Lenakel is a bimoraic trochee that is either disyllabic or a heavy syllable. It is shown below that the preferred foot is the disyllabic trochee, but under duress the foot is a monosyllabic bimoraic trochee. Lenakel, therefore, exhibits the Generalized Trochee (Prince 1980, Hayes 1991, Kager 1992). To see how the trochee type can vary, it is necessary to start with stress placement in words with word-final diphthongs and maintain the assumption that the trochee is disyllabic.

It was noted at the beginning of the discussion of Lenakel stress that word-final diphthongs have penultimate stress, e.g. [k≠;lay], [kavévaw]. Assuming penult stress in a word like [k≠;lay] is achieved by a disyllabic trochee, there are two candidates, shown in (38), that satisfy FOOTFORM.

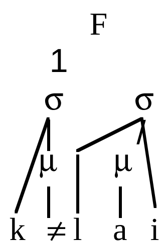
(38) [k≠.lai] [k≠.la.i]



Since both satisfy FOOTFORM, the ONSET violation in (38b) is fatal. However, (38a) is not considered to be the preferred candidate for reasons that will become clearer presently when words like those in (36) are discussed.

The foot in (38a) is nonoptimal because it violates the Weight-to-Stress Principle (WSP) (Prince 1990, Prince and Smolensky 1993) which states that if a syllable is heavy, then it is stressed. WSP is undominated in Lenakel even though the language is putatively quantity-insensitive. This means that the trochee must have one of two forms: either [σ σ] or [H]. To satisfy WSP a final diphthong must be monomoraic, which is the result of conflict between WSP and V-MORA. Compare (38a) to (39) where the final syllable is monomoraic and the word-final vocoid is linked to the syllable node.

(39) [k≠.lay]



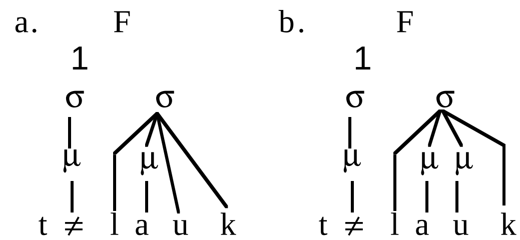
WSP can be included as part of FOOTFORM and so the ranking needed to account for penult stress for word-final diphthongs is established by combining the previously determined rankings FOOTFORM » ONSET, (23), and ONSET » V-MORA, (4b).

(40) FOOTFORM » ONSET » V-MORA, /k≠lai/

Candidate	FOOTFORM	ONSET	V-MORA
k≠.{ lái}	*!		
√ {k≠;.lay}			*
{k≠;.lai}	*!		
k≠.{ lá.i}		*	

In (40), any deviation from the disyllabic trochee is a FOOTFORM violation. This is necessary to make [k≠.{ lái}] a nonharmonic output. As mentioned above, the disyllabic trochee must be violated in (37). The compelling factor of this violation becomes apparent when looking at the candidate syllabification necessary to have a disyllabic, bimoraic foot.

(41)



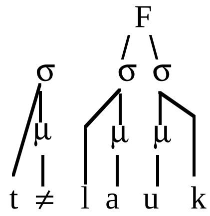
To satisfy WSP, the high vocoid must be nonmoraic and linked directly to the syllable node. The result of this, shown in (41a), is a PERIPH violation since two segments are extrasyllabic. The satisfaction of WSP and PERIPH compels the violation of FOOTFORM in (37). PERIPH actually conflicts with FOOTFORM as seen in (41b) where there is a monosyllabic, bimoraic foot and a single syllable appendix. Therefore, the final stress in words with final CVGC syllables is the result of ranking PERIPH above FOOTFORM, that is, the requirement on disyllabicity.

(42) PERIPH » FOOTFORM, /t≠lauk/

Candidate	PERIPH	FOOTFORM
(41a) {t≠;.la}uk	*!	
(41b) √ t≠.{ láu}k		*

Final CVGC syllables require the bimoraic trochee rather than the disyllabic one because satisfying disyllabicity and WSP compels a PERIPH violation. The only aspect of FOOTFORM that is violated is the preference for disyllabicity. Recall that FOOTFORM encompasses a number of constraints that now need to be separated. The fact that the foot must satisfy FOOTBINARITY and WSP means that these constraints are undominated. In fact, all that is left is that the candidates are evaluated for the type of trochee. Satisfaction of FOOTFORM is gradient where [σ σ] is preferred to [μμ]. The Generalized Trochee is characterized by the preference for the disyllabic trochee and only under duress is the bimoraic trochee preferred. The decomposition of FOOTFORM is necessitated by the syllabification in (43) where the disyllabic foot is satisfied by an ONSET violation.

(43) [t≠.la.uk]



(43) is actually predicted because FOOTFORM dominates ONSET, as shown by [ní.an]. However, there appears to be a ranking paradox because FOOTFORM (taken as a whole) must dominate ONSET in the case of prevocalic vocoids and ONSET must dominate FOOTFORM in the case of postvocalic ones. There is really is no paradox at all because only FTBINARITY (which can be either type of trochee) crucially dominates ONSET in [ní.an]. FOOTFORM is now the Generalized Trochee where the disyllabic foot is preferred to the heavy syllable foot. In (43), the preferred disyllabic trochee compels an ONSET violation. Therefore, the preferred candidate is (41b) which satisfies ONSET, but contains the less preferred trochee.

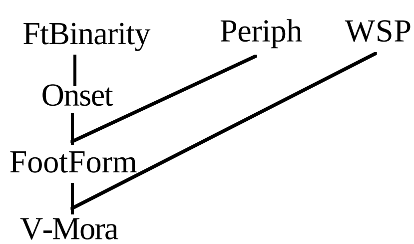
(44) FOOTFORM = [σ σ] > [H]

ONSET » FOOTFORM, /t≠lauk/

Candidate	ONSET	FOOTFORM
(43) t≠.{lá.u}k	*!	|σ σ|
(41b) √ t≠.{ láu}k		|H|

The uniform distribution of postvocalic vocoids as part of a diphthong is attributed to ranking some constraints above FOOTFORM, i.e. the Generalized Trochee, so the heavy syllable trochee is preferred under duress to satisfy ONSET and PERIPH. As for word-final diphthongs, FOOTFORM dominates V-MORA so the disyllabic trochee is more harmonic than stress on the word-final diphthong.[5] The ranking for the metrical constraints is shown in (45).

(45)



[5] The same ranking applies to penultimate diphthongs as well. In this case, the crucial candidates contain a H L trochee versus a L L trochee with a V-MORA violation.

This ranking is illustrated with the example [t≠lauk].

(46) WSP, PERIPH, ONSET » FOOTFORM » V-MORA, /t≠lauk/

Candidate	WSP	PERIPH	ONSET	FOOTFORM	V-MORA
{t≠;.la}w k		*!		|σ σ|	*
{t≠;.lau}k	*!			|σ σ|	
t≠.{lá.u}k			*!	|σ σ|	
√ t≠.{ láu}k				|H|	

The preference for the heavy syllable foot in (46) arises from violations of other constraints in candidates with the disyllabic trochee. No two candidates in this case are compared for trochee type. However, comparing different realizations of the trochee is relevant when evaluating candidates for word-final diphthongs.

(47) WSP, ONSET » FOOTFORM » V-MORA, /t≠lai/

Candidate	WSP	ONSET	FOOTFORM	V-MORA
{t≠;.lai}	*!			
√ {t≠;.lay}			|σ σ|	*
t≠.{lá.i}		*!	|σ σ|	
t≠.{ lái}			|H|!	

The two candidates that satisfy the undominated constraints must be compared for satisfaction of FOOTFORM and the candidate with the stressed, heavy syllable is less preferred to the candidate with the disyllabic trochee.

Ranking ONSET above FOOTFORM ensures the heterosyllabic parse of postvocalic high vocoids. In procedural terms, postvocalic vocoids are following bottom-up construction since they are not effected by stress. The interaction of stress and syllabification in Lenakel is quite intricate since stress can influence the syllabification of prevocalic vocoids, but otherwise stress has no effect. This intricacy is reflected in ranking ONSET below FTBINARITY and above FOOTFORM. Since FTBINARITY dominates ONSET, the analysis of prevocalic vocoids is not altered by the Generalized Trochee. This is shown in (48).

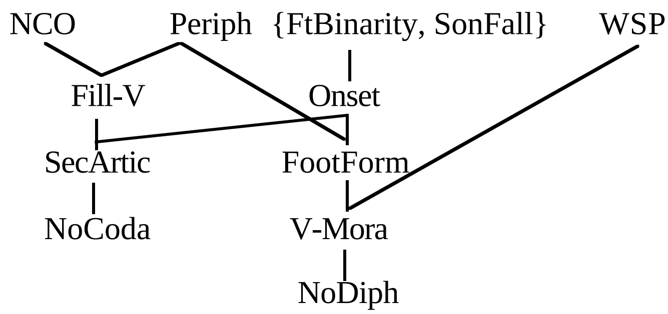
(48) SONFALL, FTBIN » ONSET » FOOTFORM, /nian/

Candidate	SONFALL	FTBIN	ONSET	FOOTFORM
{n^{y}án}		*!		
√ {ní.an}			*	|σ σ|
{nía}n	*!			|H|

The choice between trochee types is inconsequential since only [{ní.an}] satisfies the undominated constraints.

Placing ONSET between the metrical constraints captures the different behaviours of prevocalic and postvocalic high vocoids. For the latter, FTBIN and SONFALL are irrelevant so ONSET violations are fatal. For prevocalic vocoids, FTBIN is fatal for subminimal candidates, but it is irrelevant for supraminimal candidates. The metrical constraint hierarchy in (45) can be added to the hierarchy established for syllabification illustrating the interaction between metrical and syllabification constraints.

(49)



Lenakel, therefore, has only part of the FOOTFORM » SYLLFORM ranking Prince and Smolensky found in Tongan. The ranking FTBIN » ONSET » FOOTFORM in Lenakel accounts for the influence of metrical constraints on syllabification in a particular environment. The fact that the syllabification of a postvocalic vocoid is not influenced by metrification is a consequence of the Generalized Trochee, which in effect alters stress placement to ensure such vowel sequences are parsed tautosyllabically.

3.2.5 Underlying Glides

The constraint ranking accounts for the distribution of high vowels without requiring an underlying contrast for vowels and glides (cf. Waksler 1990). All nonmoraic vocoids have moraic counterparts and all moraic vocoids have nonmoraic counterparts. The only possible exception to this is (27), where high vocoids have to surface as high vowels, e.g. [eyua], *[eywa], and cannot have a nonmoraic counterpart. This exceptional behaviour, as discussed, is due to the CCC. Lenakel also seems to have nonmoraic vocoids where high vowels are predicted implying that these vocoids are glides without high vowel counterparts. This is the more interesting case because it implies an underlying vowel/glide contrast. These nonalternating glides, however, are shown to be either the residue of historical change or not to be vocoids at all. Therefore, these nonalternating glides lie outside the constraint interaction developed to account for the distribution of vocoids and cannot be part of the underlying sound system.

Cases of nonalternating glides are limited to a handful of exceptional lexical items. According to Lynch, verbs with an initial /a/ delete it when preceded by the plural marker /ai/, but a high vocoid that follows the root-initial /a/ does not always behave as expected.[6]

(50)	a.	/ai+ akar/	[aygar]		
		/ai+ atÖk/	[aytÖk]		
	b.	/ai+ ausito/	[ayusito]	*aywÖsito	'to tell a story'
	cf.		[n¤mausito]		'you told a story'
	c.	/ai +outa/	[aywÖda]	*ayuda	'to sit'
		/ai+ ouraur/	[aywÖrawr]	*ayurawr	'to be frightened'

Putting aside /a/-deletion, (50b) has the surface form predicted by the constraint ranking established thus far. The vocoid sequence /ai<a>uC…/ surfaces as [ayuC…] in accordance with ranking SYLL-SEG and ONSET above V-MORA. In (50c), on the other hand, the sequence /ai<o>uC…/ surfaces as [aywÖC…] where the labiovelar is followed by an epenthetic vowel rather than surfacing as a high round vowel. The labiovelar in (50c) is behaving like a consonant, whereas the labiovelar in (50b) is behaving like a [-consonantal] vocoid. The consonantal behaviour of /w/ in (50c) implies that this vocoid cannot correspond to an underlying [-cons] vocoid.

To provide an analysis of (50b&c), Lynch proposes that the underlying representations of (50c) must contain a high vocoid that is not vocalic, i.e. an underlying glide, whereas (50b) contains an underlying [-cons] vocoid. Lynch justifies this proposal by comparing Lenakel to NÖvhaal (a language that borders Lenakel) which has an initial /ak^{w}/ corresponding to the initial /ou/ of Lenakel.

(51)	<u>Lenakel</u>	<u>NÖhvaal</u>	
	owa√	ak^{w}a√	'to be open'
	outa	ak^{w}Öta	'to sit'
	ouraur	ak^{w}lak^{w}l	'to be frightened'

Lynch proposes that the consonantal behaviour of the labiovelars in (51) is derived from the lenition of the Proto-Oceanic labialized velar /*k^{w}/, which is clearly consonantal. Furthermore, Lynch proposes that the /ou/ sequence in (50c) was historically /ak^{w}/ which unifies the following exceptional behaviours: 1. they behave as /a/-initial verbs even though they are [o]-initial (see fn.5) and 2. the high vocoid cannot surface as a vowel. According to Lynch, the underlying forms of (50c) contain an initial /aW/ where /W/ is the residue of the labialized velar and the /a/ becomes [o] by a rounding rule that is triggered only by /W/. No attempt is made here to include Lynch's historical analysis of these forms. Such forms are clearly irregular and so they cannot be considered part of the distribution of high vocoids.

[6] There are two allomorphs of the plural marker: /ar/ and /ai/. The latter is used only for verbs with an initial /a/ or /ha/. The /o/-initial words in (50c) are exceptional insofar as they have the /ai/ plural marker.

3.2.5.1 The Phoneme /v/

The other case of an apparent nonalternating glide is transcribed as [v] which, according to Lynch (1975; p.91), is “a high central glide with varying amounts of bilabial articulation” which is transcribed as [¤÷] in the IPA. If [v] were derived from a vowel, the only reasonable choice is /¤/, which is the only central vowel. This correspondence is intriguing, as Lynch notes, because the two sounds exhibit a complementary distribution similar to vowels and glides.

(52)	¤bdI√	‘to be wet’	vat^h	‘to land’
	aps¤b¤s	‘strange’	nuvo	‘tree sp.’

Since [¤] never occurs adjacent to vowels, it seems reasonable to posit /¤ath/ as the underlying representation of [vat^h].

Lynch notes that there are a number of problems with deriving [v] from /¤/. Firstly, there is no alternation between [v] and [¤] even though there is complementary distribution. Secondly, [v] fails to form either secondarily articulated segments or word-final clusters as do the nonmoraic vocoids. Thirdly, Lenakel has [uv, iv, vu, vi] sequences but there are no lexical occurrences of [w¤, y¤, ¤w, ¤y]. The only time [¤] is adjacent to a high vocoid is when [¤] is epenthetic. One interesting problem emerges if [vu] and [uv] are derived from [¤u] and [u¤], respectively: there is no way to ensure that the [¤] (regardless of position) surfaces as a glide. Based on this evidence, Lynch concludes that [v] is not an allophone of a vowel.

Since there is no phonological evidence for a natural class of [v, w, y], the question of what [v] is still remains. [v] might be considered the bilabial fricative [β] and historically [v] does come from *p, which has become [f, p, p^W, w] in related languages. Lynch, however, hesitates to say [v] is underlyingly [β] because this would lead to an unnecessary voicing distinction for fricatives. As it stands, Lenakel has only /f, s/. In terms of features, [v] is clearly a [+consonantal] approximant and it is also [+sonorant] for it patterns with sonorants with respect to devoicing through coalescence with /h/.

(53)	/lahau/	[lahaw]	‘down’
	/n-Öm-hal-ho/	[nÖmΩalΩo]	‘you hit it’
	/a√h/	[a√Ω]	‘to spit’
	/vhin/	[vΩIn]	‘to turn’

The [v] of Lenakel appears to be best characterized as the voiced bilabial approximant /*v*/, which can contrast with the labiovelar approximant (Ladefoged 1968). The [v], therefore, like [r], is a [+cons] approximant without a corresponding vowel (cf. Kahn 1976).

Lenakel appears to have three sources for surface approximants, which are summarized in (54).

(54)	w	(</u/)	[-cons]
	y	(</i/)	[-cons]
	w	(<*k^W)	[+cons]
	v	(=/v/)	[+cons]

Of these four approximants, only two are attributed to an alternation with high vowels. These two are properly speaking the nonmoraic vocoids of Lenakel and so there is no need to posit an underlying distinction between vowels and glides, as proposed by Waksler (1990). The handful of labiovelar glides that do not correspond to an underlying high vocoid are the residue of historical lenition and rare enough to be considered exceptions.

<u>3.2.6 Previous Work On Lenakel</u>

The relation between stress and syllabification in Lenakel presents a challenge for any theory of procedural constituent construction. One tactic, previously mentioned, is to have resyllabification as a repair strategy that ensures satisfaction of the metrical constraints. Keeping a strict procedural approach that avoids the use of repairs and also denies the role of stress has been attempted by Waksler (1990) who proposes that high vocoid distribution is determined by feature-specification and a unification-theory based syllabification algorithm. Waksler notes that Lenakel appears to have three types of high vocoids: those that alternate between vowels and glides, those that must surface as glides, and those that must surface as vowels. The core of Waklser's proposal is that these three types of high vocoids must be distinguished underlyingly so that the syllabification algorithm can distinguish them. To do this, Waksler proposes that the vocoids have different specifications for [cons].

(55)	[øcons]:	alternates between vowels and glides
		e.g. [ní.an] ~ [lɛ;n.yan]
	[-cons]:	always vowels
		e.g. [e.yú.a] *[ey.wa]
	[+cons]:	always glides
		e.g. [aywÖda] *[ayuda]

The distinction between [-cons] and [+cons] vocoids allows for phonemic glide/vowel contrast, but the inclusion of [øcons] in this group is a departure from Steriade's (1984) proposal, discussed in chapter 2, which does not consider the possibility of [øcons] contrasting with other specifications for high vocoids.

Waksler's three-way distinction of [cons] is necessary for the unification-based syllabification. In short, syllabification involves building constituents through the licensing of phonological units. Following Zec (1988), Waksler proposes that certain segments are defined as mora licensers and others are defined as syllable licensers. Syllabification groups moras together into syllables based on the unification of the major class features. It is quite clear without going any further that unification is a bottom-up theory of constituent construction. As a result, there is no potential role for stress in accounting for the distribution of vocoids. The only working hypothesis that Waksler can use is that the vowel/glide alternation is determined only in terms of syllabification, that is, a vocoid is a vowel when it is a syllable peak otherwise it is a glide. The absence of any role for stress is expected in any procedural approach and, in fact, Deligiorgis (1988) explicitly excludes stress from having any role. Both Waksler (1990) and Deligiorgis (1988) maintain bottom-up construction by underspecifying the major class features of high vowels. This appears to them to be the only recourse in light of the alternative which is to admit resyllabification rules after metrical structure is built.

No such reliance on feature-specification is necessary in the Optimality Theoretic proposal advanced here. The alternation between vowels and nonmoraic vocoids is a consequence of simultaneously evaluating nonmoraic and moraic parses of high vocoids for best-satisfaction of both metrical and syllabification constraints. It is only in the case of satisfying word minimality (via FTBINARITY) that a prevocalic high vocoid best-satisfies the constraint ranking as a vowel rather than as a secondary articulation. Hence, there is no need to treat the alternating high vocoids differently from other vocoids. Similarly, the class of specified [-cons] vocoids proposed by Waksler is precisely the class of words that are exceptionally stressed. There is no doubt that these vocoids must be underlyingly marked in some way; however, using stress as a diacritic is preferable because it is required elsewhere and it eliminates the [øcons]/[-cons] contrast. The last class to consider is the [+cons] vocoids. As previously mentioned, these vocoids are the residue of *k^w and so it seems appropriate to say they are [+cons]. These segments are too sparse to make any real conclusions about an underlying vowel/glide contrasts. Clearly, if there were a real underlying contrast there would be a richer array of surface contrasts.

3.3 Spanish

Spanish displays an interaction between syllable structure and metrical structure that is more involved than in Lenakel. The difference is that in Spanish all high vocoids are affected by stress, not just the prevocalic ones. The distribution of high vocoids can be stated as follows: high vocoids are vowels when stressed and they are glides when unstressed, e.g. [dí.a] ‘day’, [dyá.ryo] ‘diary’, [a.ún] ‘even’, [áw.la] ‘classroom’ (Harris 1969, 1983, Morgan 1984, Carreira 1988, Roca 1988, 1991, Dunlap 1991). Stressed high vocoids in vowel sequences are also accompanied by hiatus. This is apparent in [dí.a] and [a.ún] where the stressed high vocoid is separated from the adjacent vowel by hiatus, but the unstressed high vocoids in [dyá.ryo] and [áw.la] are parsed tautosyllabically with the following vowel.

Spanish, like Lenakel and Tongan, exhibits anti-bottom-up construction since syllabification, that is the presence of hiatus, is determined by stress. This problem has not gone unnoticed in Spanish phonology and there have been attempts to reconcile vocoid distribution and anti-bottom-up construction. For example, proposals by Carreira (1988) and Roca (1991) involve resyllabification that applies after stress assignment. Carreira (1988) (following Steriade’s (1984) analysis of Romanian) proposes that syllabification precedes metrification in accordance with the prosodic hierarchy and there is a later resyllabification rule. This rule contracts two adjacent rimes provided that the first one is [+high] and unstressed. Contraction is shown in (56a) and illustrated in (56b).

```
(56)    a.  Contraction (Carreira 1988):
            O     R        R              O         R
            |     |        |      →       |        / \
            C  [+high]     V              C  [+high]  V
               [-stress]                     [-stress]

        b.                 /dia/          /mario/
            CV-Rule:       O R R          O R O R R
                           | | |          | | | | |
                           d i a          m a r i o

            stress:        O R R          O R O R R
                           | | |          | | | | |
                           d í a          m á r i o

            Contract:      n/a            O R O  R
                                          | | |  /\
                                          m á r i o
```

The stress on the high vocoid in [dí.a] blocks Contraction so the vowels are left in hiatus. The unstressed vocoid in [ma.rió] satisfies the structural description in (56a) and is resyllabified with the adjacent vowel.

An alternative to bottom-up construction is Dunlap's (1991) proposal in which syllabification is postponed until after stress assignment. Dunlap (following Poser's 1990 analysis of Japanese) proposes that Spanish stress is built on moras before the moras are grouped into syllables. Although this idea is at odds with the prosodic hierarchy, Dunlap justifies it on the grounds that Spanish stress is quantity-sensitive and so syllable structure is actually irrelevant at the time stress applies. After stress is placed on the appropriate mora, a syllabification algorithm, (57), links the stressed mora to a syllable, but an unstressed mora is adjoined to another vowel's syllable node. A contraction rule in Dunlap's proposal is unnecessary since syllabification is a matter of which moras can link to their own syllable node.

(57) Syllabification Algorithm (in part) (Dunlap 1991)

a. for any μ dominating [-high] vocoid, link μ to σ.

b. for any μ dominating a [+high] vocoid:

i. link to μ to σ if μ bears stress or

ii. adjoin μ to μ
|
σ

These proposals tackle the problem of anti-bottom-up construction by either maintaining strict bottom-up construction or by incorporating stress into syllabification. Both proposals require complications elsewhere in the grammar: for Carreira it is a resyllabification rule and for Dunlap it is a more complex syllabification algorithm. As already demonstrated, in the Optimality Theoretic approach, there are no issues of precedence among different levels of the prosodic hierarchy. The distribution of high vocoids follows from simultaneously best-satisfying the metrical and syllable structure constraints. Following Prince and Smolensky’s analysis of Tongan, the influence of stress on syllabification is the result of FOOTFORM » SYLLFORM.

The discussion of Spanish vocoid distribution is in three main sections. First, the ranking of syllable structure constraints is established (without reference to metrical structure) followed by the ranking of metrical structure constraints. The interaction of these two sets of constraints is then used to account for the distribution of high vocoids.

3.3.1 Spanish Syllable Structure

Spanish syllable structure allows a wide range of pre- and postvocalic vocoids which are considered to be part of rising and falling diphthongs (Harris 1969, 1983). Examples of falling diphthongs are given in (58).

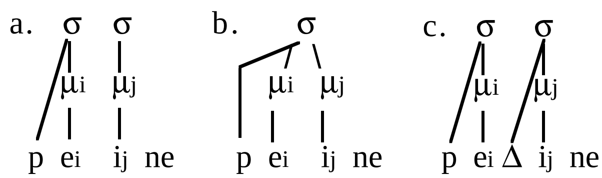
(58)

[fray]	‘friar’	[awto]	‘car’
[peyne]	‘comb’	[ewropeo]	‘Europe’
[oydor]	‘hearer’	[bow]	

According to Harris (1969), the nonsyllabic vocoids in (58) follow a general pattern of complementary distribution where a high vocoid following a vowel is a glide and a high vocoid between consonants is a vowel. Falling diphthongs are shown to be a tautosyllabically parsed vowel sequence, as in Lenakel. The terminology used to describe vowels and their nonmoraic counterparts fails here because the high vocoid component of a diphthong is moraic. The proper distinction is between a high vocoid that serves as the syllable peak and those that are anything but the peak, namely, secondary articulations or moraic components of a diphthong. Henceforth, high vowels that are not syllable peaks are referred to as nonpeak high vocoids.

The falling diphthongs in (58) show that NODIPH is dominated in Spanish and the constraints that dominate it are the ones that are violated by a heterosyllabic parse of these vowels, such as ONSET and FILL-C. These syllabifications are shown in (59). Note that these syllabifications are potentially affected by stress, but the present discussion ignores this.

(59) [pe.i.ne] [pei.ne] [pe.Δi.ne]



From (59), ONSET and FILL-C clearly dominate NODIPH since satisfaction of the first two compels a violation of the third. Furthermore, the underlying forms in (58) are faithfully parsed at the expense of violating NODIPH.

(60) a. ONSET » NODIPH, /peine/

Candidate	ONSET	NODIPH
pe.i.ne	*!	
√ pei.ne		*

b. FILL-C » NODIPH, /peine/

Candidate	FILL-C	NODIPH
pe.Δi.ne	*!	
√ pei.ne		*

c. PARSE-PL » NODIPH, /peine/

Candidate	PARSE-PL	NODIPH
√ pei.ne		*
p<e>i.ne	*!	

Another possible association of vowels to moras, other than the one-to-one associations in (59), is a two-to-one association which produces long vowels. Since long vowels do not occur in Spanish, NLV is undominated and it is not considered in any further rankings.

Ranking NODIPH below ONSET predicts that any sequence of vowels can form a diphthong. This is incorrect. Vowel sequences in which neither vowel is high surface with hiatus (Harris 1969, Cressey 1978, Morgan 1984).

(61)	[to.a.ya]	'towel'	*[toa.ya]
	[re.a.li.dad]	'reality'	*[rea.li.dad]
	[an.te.o.xo]	'spyglass'	*[an.teo.xo]

The correct generalization is that tautosyllabic vocoid sequences are permissible provided that the vocoids have a decrease in sonority in accordance with SONFALL. In Spanish SONFALL is undominated and, in fact, it must dominate ONSET since the vowels in (61) surface with hiatus. The presence of hiatus in (61) means that FILL-C and ONSET must interact with FILL-C dominating ONSET.

(62) a. SONFALL » ONSET, /realidad/

Candidate	SONFALL	ONSET
rea.li.dad.	*!	
√ re.a.li.dad.		*

b. FILL » ONSET, /realidad/

Candidate	FILL	ONSET
√ re.a.li.dad.		*
re.Δa.li.dad.	*!	

c. PARSE-PL » ONSET, /realidad/

Candidate	PARSE-PL	ONSET
r<e>a.li.dad.	*!	
√ re.a.li.dad.		*

SONFALL also accounts for the restriction against high vowels followed by glides, e.g. [uy, iy, uw, uy] (Harris 1983), because these vocoid sequences do not exhibit a decrease in sonority. Sequences of high vocoids, however, do occur but they contain a prevocalic glide, e.g. [wi, yu], which will be shown to be subject to different restrictions.

The foundation of the constraint hierarchy in Spanish can be formed from the two cases of vowel sequence examined so far. SONFALL, PARSE-PL, and FILL-C are undominated and dominate ONSET which in turn dominates NODIPH.

(63)

{SonFall, Parse-pl, Fill}
|
Onset
|
NoDiph

The constraint interactions have a form similar to ones seen before. In (64a), two candidates satisfy the undominated constraints and so the ONSET violation is fatal. In (64b), the NODIPH violation compels a violation of the higher ranking SONFALL and so the candidate with the ONSET violation is preferred since this candidate is the only one that satisfies the undominated constraints.

(64) a. {SonFall, Fill-C, Parse-pl} » Onset » NoDiph, /peine/

Candidate	SonFall	Fill-C	Parse	Onset	NoDiph
pe.i.ne.				*!	
√ pei.ne.					*
pe<i>.ne.			*!		
pe.Δi.ne.		*!			

b. {SonFall, Fill-C, Parse-pl} » Onset » NoDiph, /realidad/

Candidate	SonFall	Fill-C	Parse	Onset	NoDiph
re.Δa.li.dad		*!			
re<a>.li.dad			*!		
√ re.a.li.dad				*	
rea.li.dad	*!				*

Spanish also has prevocalic vocoids, which are also nonpeak vocoids (Harris 1969, 1983).[7]

(65)

[dyablo]	'devil'	[swavidad]	'softness'
[byen]	'well'	[fwe.ro]	'law'
[pyo.γo]	'louse'	[kwota]	'quota'

Prevocalic vocoids, like the postvocalic ones, are underlying vowels that are syllabified tautosyllabically with the following vowel. There are a number of questions pertaining to the nature of prevocalic vocoids in Spanish. The most important of these questions concerns their place in the syllable. Evidence that these vocoids are nuclear (hence part of a rising diphthong) comes from the stress system, which treats rising diphthongs as bimoraic. Harris (1983) notes that rising diphthongs, like falling diphthongs, act as heavy syllables. In particular, a penultimate rising diphthong is incompatible with antepenultimate stress just as a heavy penult is. For example, there are no words like *atápamba, *atápaiba, *atápauba, *atápiaba, and *atápuaba. On the other hand, there is also evidence to support a monomoraic representation of these sequences since rising diphthongs, unlike falling diphthongs, can occur in closed syllables (Harris 1983, Carreira 1988).

(66)

a. [mwer.te]	'death'	b.	*boyn.ta
[syes.ta]	'siesta'		*pawr.ta
[pwer.ta]	'door		*cewl.ta
[fyel.tro]	'felt'		
[byom.bo]	'folding screen'		

[7]A caveat is in order here. There is significant debate concerning the phonetics of prevocalic vocoids. It appears that dialects differ between syllabifying the vocoid as a nonpeak vocoid or as a vowel, e.g. [dya.blo] or [di.a.blo]. Hualde (1991) claims that the pronunciation of prevocalic vocoids is idiosyncratic in contrast to Harris's view. The transcriptions used here are taken from Harris's work and Dunlap (1991). Furthermore, all transcriptions and syllabifications used here are consistent with those provided by Castillo and Bond's University of Chicago Spanish Dictionary.

To account for this asymmetry between rising and falling diphthongs, consider (66b). These words are ill-formed because the falling diphthongs and the postdiphthongal consonants must all be moraic; hence these syllables exceed the bimoraic maximum on syllable weight.[8] To eliminate surface forms like (66b), BIMAX must be undominated and it must crucially dominate PARSE-PL. This ranking accounts for Harris's (1969, 1983) cluster simplification in (67b).

(67)	a.	/esculp+ ir/	[esculpir]	'to sculpt'
		/absorb+er/	[absorber]	'to absorb'
	b.	/esculp+ tura/	[escultura]	'sculpture'
		/absorb+to/	[absorto]	'absorbed'

Since BIMAX dominates PARSE-PL and PARSE-PL dominates ONSET, it is expected that underlying forms like /bointa/ should surface as [bo.in.ta] since hiatus is preferred to [boin.ta] and [boi<n>.ta]. Words of this form do exist although they are rare (Dunlap 1991).

(68)	[tran.se.ún.te]	'transient'
	[a.ín.de]	
	[ba.ra.ún.da]	'clamor'
	[ju.da.ís.mo]	'Judaism'

The CGVC syllables in (67a) are possible provided that they do not exceed the bimoraic maximum. It is assumed here that postvocalic consonants must be moraic through Weight-by-Position; hence, the high vocoid cannot be parsed with its mora. It must be parsed in the onset, (69a), or as a monomoraic rising diphthong, (69b). Following Harris (1983), the diphthongal representation in (69b) is correct.[9]

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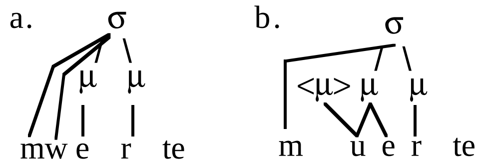
[8]Harris notes that there are three words which contain a falling diphthong in a closed syllable. There are vein.te, trein.te, and aun.que. Nonetheless, Harris claims that native speakers reject novel forms with these rimes.

[9]Rising diphthongs can arise by diphthongization which is not discussed here (see Harris 1985, Carreira 1991).

(69) [mwer.te] [muer.te]



The onset cluster in (69a) is ill-formed for the following reason. According to Harris, Spanish onsets contain at most two segments where the second segment must be consonantal. Furthermore, the consonants of the onset must maintain a minimal sonority distance. This means that classes that are adjacent on the sonority hierarchy cannot form onset clusters. The only possible combination that satisfies minimal sonority and "be consonantal" is an obstruent followed by a liquid, e.g. [preso], [plano], [globo], and [gris].[10] Harris's generalizations are assumed here so onset clusters can contain only [+cons] segments. Another possibility is that the high vocoids are realized as secondary articulations on the onset consonant. Evidence against this position comes from the lack of any phonotactic restriction on sequences of consonants and prevocalic vocoids. This implies that the segments belong to different constituents. With no evidence to the contrary, Harris's claim that prevocalic vocoids are nuclear and form part of a rising diphthong is maintained here.

The monomoraic diphthong in (69b) requires the domination of BRANCH-μ by ONSET and FILL-C thus allowing a heterosyllabic parse. (69b) also contains a PARSE-μ violation that follows from both vowels satisfying V-MORA. BRANCH-μ and PARSE-μ cannot be ranked with respect to each other because both are violated in the preferred candidate.

(70) a. FILL-C » {BRANCH-μ, PARSE-μ}, /muerte/

Candidate	FILL-C	BRANCH-μ	PARSE-μ
(69b) √ muer.te		*	*
(69a) mu.Δer.te	*!		

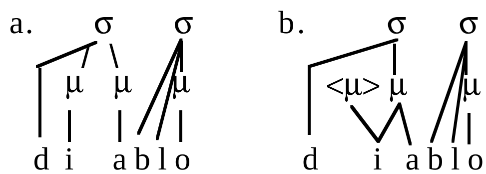
b. ONSET » {BRANCH-μ, PARSE-μ}, /muerte/

Candidate	ONSET	BRANCH-μ	PARSE-μ
(69a) √ muer.te		*	*
mu.er.te	*!		

[10]It is possible to make Harris's minimal sonority restriction follow from the interaction of constraints by using Zec's (1992) Weight-by-Position which assigns a mora to a consonant with the appropriate sonority. If a mora cannot be assigned, both consonants can appear in the onset. There are other more specific restrictions as well, namely, combinations of alveolars like *[dl], *[sr], and *[sl] are ill-formed onsets. These issues are germane to the present discussion.

Though the constraint rankings in (70) allow for the rising diphthongs, the representation of the diphthong itself deserves a closer inspection for it plays an important part in the analysis of alternations affecting vocoids. Looking at (66) again, the monomoraic diphthongs are necessitated by conformity to BIMAX. The question then turns to the status of the rising diphthongs in (65), which have the candidate syllabifications in (71) where (71a) violates NODIPH and SONFALL and (71b) violates BRANCH-μ and PARSE-μ.

(71) [dia.blo] [d<u>ia</u>.blo]



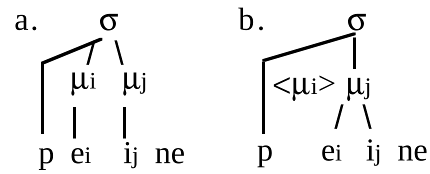
The bimoraic diphthong in (71a) violates SONFALL, which is undominated, so (71b) is preferred. In fact, the SONFALL violation in (71a) means that rising diphthongs are always monomoraic. This is predicted by the constraint ranking since it has already been established that ONSET dominates NODIPH, ONSET dominates BRANCH-μ, and SONFALL dominates ONSET. This gives the ranking SONFALL » ONSET » NODIPH, BRANCH-μ. A rising bimoraic diphthong violates the low ranking NODIPH, but since it compels a violation of SONFALL, the BRANCH-μ violation is always more harmonic. This is a very important result that has significant consequences for the distribution of vocoids in Spanish.

(72) SONFALL » ONSET » {NODIPH, BRANCH-μ, PARSE-μ}, /diablo/

Candidate		SON FALL	ONSET	NO DIPH	BRAN.-μ	PARSE-μ
(71a)	dia.blo	*!		*		
	di.a.blo		*!			
(71b) √	d<u>ia</u>.blo				*	*

Monomoraic diphthongs are limited to vocoid sequences that rise in sonority. Falling diphthongs are always bimoraic. The prohibition against falling sonority within a mora is characterized by SONRISE, which is undominated in Spanish. SONRISE crucially dominates NODIPH; this is apparent from (73) where the surface (73a) has a bimoraic diphthong.

(73) [pei.ne] [p<u>ei</u>.ne]

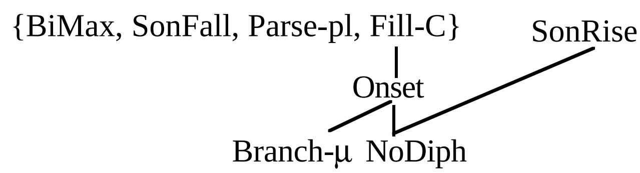


SONRISE does not conflict with ONSET since there is no surface form with hiatus that would violate SONRISE in another candidate.

The constraint rankings established so far account for the syllabification of vocoid sequence independently of stress. To summarize, postvocalic high vocoids are parsed tautosyllabically to form bimoraic falling diphthongs and prevocalic vocoids are parsed tautosyllabically as monomoraic rising diphthongs. The rankings are summarized in (74).

(74) a. BIMAX » BRANCH-μ
SECARTIC » BRANCH-μ
SONRISE » NODIPH

b.



The syllabification of vocoid sequences is illustrated in (75).

(75) a. SONFALL, FILL-C, PARSE » ONSET » NODIPH, BRANCH-μ, /diablo/

Candidate	SON FALL	FILL-C	PARSE	ONSET	NO DIPH	BRAN.-μ
dia.blo	*!				*	
di<a>.blo			*!			
di.Δa.blo		*!				
di.a.blo				*!		
√ dia.blo						*

b. SONRISE, FILL-C, PARSE » ONSET » NODIPH, BRANCH-μ, /peine/

Candidate	SON RISE	FILL-C	PARSE	ONSET	NO DIPH	BRAN.-μ
√ pei.ne					*	
pe<i>.ne			*!			
pe.Δi.ne		*!				
pe.i.ne				*!		
pei.ne	*!					*

c. SONRISE, SONFALL, PARSE » ONSET » NODIPH, BRANCH-μ, /realidad/

Candidate	SON RISE	SON FALL	PARSE	ONSET	NO DIPH	BRAN.-μ
rea.li.dad		*!			*	
re<a>.lidad			*!			
√ re.a.li.dad				*		
rea.li.dad	*!					*

Deriving all diphthongs from underlying sequences is a departure from Carreira's analysis which only derives rising diphthongs from vowel sequences through Contraction. The uniform treatment of pre- and postvocalic vocoids here has its origins in analyses by Roca (1988, 1991), who proposes that all vocoid sequences are initially syllabified heterosyllabically, and Dunlap (1991), who uses a syllabification algorithm to parse a postvocalic high vocoid as part of a diphthong. Roca's and Dunlap's proposals allow all vocoids to contribute weight since they are all being treated like vowels which, as will be shown, is crucial in the analysis of stress. The fact that all vocoids contribute weight is captured in the proposal made here by satisfaction of V-MORA which is undominated. The properties of the vocoids, namely syllabic affiliation and weight, are determined by constraint interaction.

The constraint hierarchy in (74b) suffices for the analysis of vocoid alternation in Spanish, but there are some other aspects of Spanish syllabification worth mentioning that can be accounted for by minor additions to (74b). For example, sequences of underlying mid vowels can alternate with rising diphthongs in certain speech styles and dialects (Harris 1969, Cressey 1978, Morgan 1984).

(76)	a.	[te.a.tro]	[tia.tro]	'theatre'
		[to.a.ya]	[tua.ya]	'towel'
	b.	te adoro	t[ia]doro	'I adore you'
		lo envlvió	[lue]nvolvió	'he wrapped it'

As with the alternation between mid vowels and secondary articulations in Logo discussed in chapter 2, the alternation between mid vowels and rising diphthongs in Spanish involves the parsing of the {A} feature of mid vowels. The alternation in (76) requires the ranking of PARSE-FEAT which conflicts with SONFALL and ONSET. By ranking PARSE-FEAT below SONFALL, the sonority requirements dictated by SONFALL are satisfied by leaving the {A} particle of the vowel unparsed and only the {I} or {U} particle is parsed. PARSE-FEAT is also ranked below ONSET since the preferred candidate contains a tautosyllabic sequence. Only dialects with this alternation have these rankings.

(77) a. SONFALL » PARSE-FEAT, /teatro/

Candidate	SONFALL	PARSE-FEAT
tea.tro	*!	
√ tia.tro		*

b. ONSET » PARSE-FEAT, /teatro/

Candidate	ONSET	PARSE-FEAT
te.a.tro	*!	
√ tia.tro		*

The constraint rankings in these dialects would also have PARSE-PL dominating PARSE-FEAT. In the dialects without the alternation in (76), PARSE-PL is undominated.

3.3.2 Spanish Metrical Structure

Harris (1983) observes that stress in Spanish nouns, adjectives, and adverbs falls on one of the last three syllables. Furthermore, the placement of stress is contrastive in a number of environments: 1. a word-final sequence of two light syllables, /…L L#/, can be stressed on the penult or antepenult, 2. a word-final sequence of a light syllable followed by a heavy syllable, /…L H#/, can be stressed on the penult or ultima, and 3. a word-final sequence of two heavy syllables can be stressed on the penult or the ultima, /…H H#/. There are also some words with stress on a final open syllable. Harris (1989) notes that three stress patterns (labelled Type A, B, C) emerge from the description above.[11]

[11] The final stress in Type C words is quite exceptional and is not discussed here. Also, secondary stress (see Roca 1986, Harris 1991) is not discussed.

In Type A: stress the penult if the final is light.
stress the final if heavy.
In Type B: stress the antepenult if the penult and final are light.
stress the penult if the final is heavy.
In Type C: stress the final syllable.

The contrasts in stress placement can be seen by comparing the three types of stress above and the weight of the final two syllables.

(78)

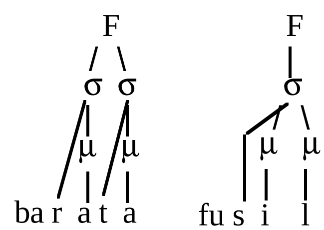
	Light^Light	Light^Heavy	Heavy^Light	Heavy^Heavy
Type A	baráta 'bargain'	fusíl 'gun'	canásta 'basket'	verdór
Type B	saβána 'bedsheet'	móβil 'mobile'	n/a	alcándor
Type C	kafé 'coffee'	n/a	hindú 'hindu'	n/a

The gap in the heavy^light column is due to a lack of contrast between Type A and Type B for this sequence (Harris 1989, Dunlap 1991). This gap is not accidental and is discussed below.

The final three syllables form the maximal expansion of what Harris (1989, 1992) calls the "stress window". What needs to be explained, according to Harris, is why there is never preantepenultimate stress and why the stress window shrinks under some conditions. In particular, a final heavy syllable limits the stress window to the ultima or penult and a heavy penult limits the stress window to just the penult.

In the Optimality Theoretic approach, the stress window is a consequence of the constraints on foot structure, namely, FOOTFORM and ALIGN (Prince and Smolensky 1993). The shape of the foot, characterized by FOOTFORM, is based on the Type A vocabulary which exhibits a rather well-known quantity-sensitive pattern. Dunlap (1991) notes that the equivalence of two light syllables to one heavy syllable means that the appropriate foot for Spanish is the moraic trochee (McCarthy and Prince 1986, Hayes 1987). Final heavy syllables, which are bimoraic, are stressed since both moras of the trochee are contained in one syllable. If both syllables are light, the trochee encompasses two syllables.

(79)

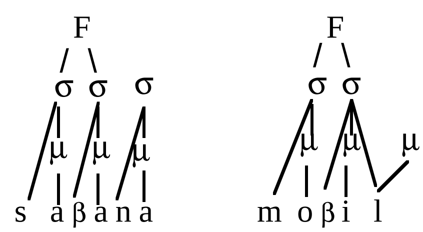


The quantity-sensitivity of stress in Spanish means that word-final consonants are moraic as in (79). This differs from Lenakel where word-final consonants are not moraic. Spanish and Lenakel differ with respect to the ranking of Weight-by-Position, which is undominated in Spanish.

The fact that the foot in Spanish is a bimoraic trochee leads to a natural account of the attenuation of the stress window by word-final heavy syllables. Type A vocabulary must satisfy ALIGN (McCarthy and Prince 1993a,b) which ensures the right edge of the foot coincides with the right edge of the word. This is seen in (79) where the right edge of the foot coincides with the rightmost mora. Since the foot is a bimoraic trochee, stress will fall on the lefthand branch of the foot which can be in the final syllable if it is heavy, as in [fusíl], or in the penult if the final is light, as in [ba.rá.ta].

The first constraint interactions for Spanish stress can now be established: the shape of the trochee is characterized by FOOTFORM, which in Spanish is the bimoraic trochee and penultimate stress is accounted for by satisfaction of FOOTFORM and ALIGN. Of course, the combination of ALIGN and FOOTFORM does not account for the antepenultimate stress in the Type B vocabulary. Type B stress, however, shows exactly the same quantity-sensitive pattern as Type A with the proviso that the final vowel or consonant is not included in the metrical parse.

(80)



The Type B vocabulary exhibits extrametricality (Harris 1983, 1989, 1992, Dunlap 1991), which in Optimality Theory is reconstructed by the constraint called NON-FINALITY (Prince and Smolensky 1993) that prohibits the foot from including the final mora.[12] Although NON-FINALITY in Type B ensures that the word-final mora is not parsed by the foot, the mora is parsed syllabically if possible. In the word [moβil] in (80), the final mora cannot be parsed syllabically as part of a heavy syllable because the result would be a light syllable followed by a heavy syllable, which violates FOOTFORM. Nonetheless, the segmental structure must be parsed and so the word-final consonant is parsed as part of a light, closed syllable. The situation is somewhat different for /saβana/ in (80). The word-final mora can be parsed syllabically and still remain metrically unparsed. In fact, the word-final mora must be parsed syllabically, otherwise the word-final vowel would be left unparsed. The Type A/Type B distinction, therefore, is a consequence of satisfying different constraint rankings. In Type A, ALIGN dominates NON-FINALITY and in Type B NON-FINALITY dominates ALIGN.

---

[12] A word-final mora is represented as linked to the final consonant, but it is not included in a higher level prosodic category to satisfy NON-FINALITY. This representation violates SYLL-SEG since the consonant is linked to the syllable node and it is linked to a mora. Therefore, WXP must dominate SYLL-SEG.

(81) Type A:

ALIGN » NON-FINALITY, /barata/

Candidate	ALIGN	NON-FINAL
{ba.ra}.ta	*!	
(79) √ ba.{ra.ta}		*

Type B:

NON-FINALITY » ALIGN, /sabana/

Candidate	NON-FINAL	ALIGN
(80) √ {sa.βa}.na		*
sa.{βa.na}	*!	

One last note, ALIGN violations must be minimal, that is, a candidate that violates ALIGN by being one mora from the right edge is preferred to a candidate that is farther away from the edge. This is illustrated with monólogo 'monologue' which has antepenult stress so it is Type B.

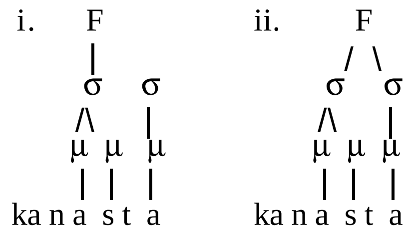
(82) NON-FINAL » ALIGN, /monologo/

Candidate	NON-FINAL	ALIGN
{mó.no.}lo.go		*!*
mo.no.{ló.go}	*!	
√ mo.{nó.lo.}go		*

The interaction of FOOTFORM, ALIGN, and NON-FINALITY provide a rather straightforward account of stress window phenomena. The maximal size of the window, according to Harris, is three syllables and this follows from the combination of FOOTFORM and NON-FINALITY which ensure stress falls no farther than the antepenultimate mora. Preantepenultimate stress is impossible because this entails two ALIGN violations which is always less harmonic than a single violation. This is illustrated in (82). The shrinking effect caused by heavy syllables follows from the maximum binarity of the foot. Heavy penults are incompatible with antepenultimate stress because in a word of the form L H L# the antepenultimate syllable actually contains the preantepenultimate mora. As before, the combination of FOOTFORM and NON-FINALITY never allows stress on the preantepenultimate mora.

A matter related to the effects of heavy penults on the stress window is the observation that closed penults fail to exhibit a contrast for stress placement. Such a contrast, in fact, cannot exist because a closed penultimate syllable is never light and so the combination of foot bimoraicity and foot non-finality will never allow stress to fall beyond the penult. If [kanasta], for example, were a Type B word, the dominance of NON-FINALITY would place stress on the heavy penult. If [kanasta] were a Type A word, satisfaction of ALIGN would compel a violation of FOOTFORM.

(83)



The absence of a contrast for penultimate closed syllables can be accounted for by allowing violations of ALIGN in Type A under pressure to satisfy FOOTFORM. Since ALIGN is dominated in both vocabulary types, a contrast for closed penults is neutralized. As a result, closed penults are always stressed.

(84) Type A
FOOTFORM » ALIGN » NON-FINALITY, /kanasta/

Candidate	FOOTFORM	ALIGN	NON-FINAL
i. √ ka.{nás}.ta		*	
ii. ka.{nás.ta}	*!		*

Type B
FOOTFORM , NON-FINALITY » ALIGN, /kanasta/

Candidate	FOOTFORM	NON-FINAL	ALIGN
i. √ ka.{nás}.ta			*
ii. ka.{nás.ta}	*!	*	

Note that ranking FOOTFORM above ALIGN does not alter the Type A/Type B distinction because this distinction relies on NON-FINALITY dominating ALIGN in Type B. The two vocabularies have the rankings in (85) and these rankings are illustrated in (86).

(85) Type A: FOOTFORM » ALIGN » NON-FINALITY
Type B: {FOOTFORM, NON-FINALITY} » ALIGN

(86) Type A: FOOTFORM » ALIGN » NON-FINAL, /podadera/

Candidate	FOOTFORM	ALIGN	NON-FINAL
√ po.da.{dé.ra.}			*
po.{dá.de.}ra.		*	
{pó.da.}de.ra.		**!	

Type A: FOOTFORM » ALIGN » NON-FINAL, /chaparon/

Candidate	FOOTFORM	ALIGN	NON-FINAL
cha.{pá.ron.}	*!		*
√ cha.pa.{rón.}			*
{chá.pa.}ron		**!	

Type B: FOOTFORM, NON-FINAL » ALIGN, /antilope/

Candidate	FOOTFORM	NON-FINAL	ALIGN
an.ti.{ló.pe.}		*!	
√ an.{tí.lo.}pe.			*
{án.}ti.lo.pe.			**!*
{án.ti.}lo.pe.	*!		**

Type B: FOOTFORM, NON-FINAL » ALIGN, /fusil/

Candidate	FOOTFORM	NON-FINAL	ALIGN
√ {fú.si}l			*
{fú.sil}	*!		
fu.{síl}		*!	

The constraint rankings in (85) predict that closed antepenultimate syllables do show a Type A/Type B contrast because the combination of FOOTFORM and ALIGN in Type A places stress on the penultimate syllable and the closed antepenultimate syllable is outside the stress window. On the other hand, a Type B word has stress on the antepenultimate mora which is in the antepenultimate syllable. This prediction is correct, e.g. [con.fú.so] 'confused', [cóm.pu.to] 'computation'. The word confuso belongs to Type A as is evident from the penultimate stress. The word computo, on the other hand, must belong to Type B. Stress in these words actually falls on the preantepenultimate mora and so a more complex interaction is required to get stress past the antepenultimate mora. The heavy antepenultimate must be footed in accordance with FOOTFORM which means that the penult is unfooted because footing the antepenult and the penult together is a heavy^light trochee. Therefore, words with stressed closed antepenults contain an ALIGN violation.

(87) FOOTFORM, NON-FINAL » ALIGN, /computo/

Candidate	FOOTFORM	NON-FINAL	ALIGN
{cóm. pu.}to.	*!		
com.{pú.to}		*!	
√ {cóm.} pu.to.			*

To summarize, contrastive stress in Spanish requires the partitioning of the vocabulary (Harris 1989, 1992). The difference between the vocabulary types, as shown in (85), is the ranking of ALIGN with respect to NON-FINALITY. Both vocabulary types share FOOTFORM which is the bimoraic trochee.

3.3.2.1 Previous Analyses of Spanish Stress

Spanish stress phenomena have received much attention in all phonological frameworks.[13] The analysis here relies on proposals made in many of these works. It is assumed here, following Harris (1992), that the domain of stress is the word (excluding clitics) rather than the derivational stem (see Otero 1986, Roca 1988). The literature on Spanish stress contains some debate concerning the status of the Spanish vocabulary types: Otero claims that Type B is the unmarked stress whereas Harris claims that Type A is unmarked and Type B is quite marginal. In either case, the different vocabularies must be distinguished, but marked versus unmarked stress patterns need not be important. Following Dunlap, all cases of penultimate mora stress are Type A and all cases of stress on the antepenultimate mora are Type B. This definition of the classes enlarges Type B because some cases of stressed penultimate syllables, which look like Type A, actually contain the antepenultimate mora.

The main concern of Spanish stress is the stress window. Harris (1992) accounts for the maximum size of the stress window by positing a binary foot and extrametricality. The constraint-based proposal here is similar insofar as the constraints FOOTFORM and NON-FINAL limit the size of the stress window. However, Harris, using Halle and Vergnaud's (1987) theory of stress, uses these devices quite differently. Harris's stress rules are given below.[14]

(88)
i. stressable elements are vowels.
ii. final vowel is extrametrical.
iii. stress the rightmost vowel.
iv. build a binary, left-headed constituent.

As stated in (ii), all words have extrametrical vowels. To account for the Type A/Type B distinction, Harris proposes that there are lexical exceptions to (iii). The application of the stress rules in (88) are shown in (89) where antepenultimate stress in democratico occurs because the morpheme ic, according to Harris, is an exception to (iii) and so stress placement occurs via (iv). Stress in republicano follows from (iii).

[13]In the SPE framework see Harris 1969, Hooper and Terrall 1976, in tree-based metrical theory see Harris 1983, Den Os and Kager 1986, Otero 1986, and in grid-based metrical theory, see Harris 1987, 1989, 1992, Roca 1986, 1988, 1991, Dunlap 1991.

[14]There are rules for stress on line 2 and tier conflation that are omitted here.

```
(89)    line 1                *                         (*   .)
        line 0      *   *   *   * <*>             *   *   *  * <*>
                   re  pu bli  ca no           de mo cra ti  co
```

The relative merits of Harris's proposal and the Optimality Theoretic proposal cannot be evaluated at this time because the proposals differ with respect to predictions for the syllabification of high vocoids. What is important at this point is the treatment of penultimate and antepenultimate stress. All theories of Spanish stress must mark this distinction. Harris has uniform extrametricality but two types of feet, (iii) and (iv), whereas Roca (1988, 1991) proposes uniform extrametricality, one type of stress placement, but certain words are marked for stress retraction onto the antepenultimate vowel. The proposal here, following Dunlap, has one type of foot but the vocabularies differ for satisfaction of ALIGN. Since Optimality Theory concerns constraints on outputs of underlying forms, any morpheme that carries the marking for Type B will ensure the domain of stress, i.e. the word, satisfies NON-FINALITY.

3.3.3 Stress and Syllabification

The generalization governing the distribution of vowels and nonpeak vocoids, as mentioned before, is that a vowel appears when stressed and a nonpeak vocoid appears when unstressed. Furthermore, vocoid distribution is also accompanied by the predictable distribution of vowel hiatus which is stated as follows: a stressed high vocoid is separated by hiatus from a nonhigh vowel and an unstressed high vocoid is tautosyllabic with the adjacent vowel. This distribution occurs in nearly every position in the stress window, as shown below. The contrast between stress and syllabification does not necessarily depend upon the position in the stress window, but it also depends on the Type A/Type B distinction.

(90)

	Postvocalic Vocoids		Prevocalic Vocoids	
	Type A	Type B	Type A	Type B
final:	[sa.mu.rái] [mil.déu] no hiatus	-	[po.li.sí.a] [a.ba.lú.o] hiatus	[ka.rí.sya] [té.nwe] no hiatus
penult:	[ko.ka.í.na] [fe.ú.ko] hiatus	[báy.le] [in.káw.to] no hiatus	[a.∂wá.na] [ro.syá.da] no hiatus	[mi.rí.a.∂a] [gla.dí.o.lo] hiatus
antepenult:	-	[o.le.í.fe.ro] [de.í.fi.co] hiatus	-	[pyé.la.go] [san.twá.rio] no hiatus

The penultimate position shows the most robust contrast for vocoid and hiatus distribution and the three gaps in (90) are discussed presently. In brief, the absence of postvocalic vocoids appearing with stress and hiatus in final position can be attributed to the fact that this would require Type C stress, e.g. [CV.CV.Ca.í]. In the antepenultimate position, prevocalic vocoids cannot occur with hiatus because stress can never fall on the high vowel. Postvocalic high vocoids do not appear as diphthongs in this position because the low vowel cannot be stressed although there are exceptions, e.g. [náu.ti.co]. These gaps in (90) occur because the vowel sequences are at the edge of the stress window where the constraint interaction neutralizes some differences.

The analysis of the distribution of high vocoids and hiatus begins with a discussion of the penultimate position and will then proceed with the discussion of the final and antepenult positions. In all positions, the distribution is accounted for by the interaction of the syllable structure constraints in (74b) and the metrical constraint hierarchy in (85).

3.3.3.1 The Penultimate Position

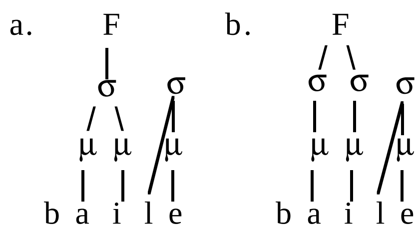
3.3.3.1.1 Postvocalic High Vocoids

The discussion of vowel sequences in the penultimate position begins with the contrast between hiatus and falling diphthongs shown in (91).

(91)	a. Type A		b. Type B	
	cocaína	[ko.ka.í.na]	baile	[bái.le]
	codeína	[ko.∂e.í.na]	aceite	[a.séi.te]
	paraíso	[pa.ra.í.so]	prosaico	[pro.sái.ko]
	creíble	[kre.í.ble]	aplauso	[a.pláu.so]
	feúco	[fe.ú.ko]	incauto	[in.káu.to]
	saúco	[sa.ú.ko]	trauma	[tráu.ma]

The falling diphthongs in (91b) are the result of a tautosyllabic parsing of the vowel sequence. The words in (91b) are stressed on the antepenultimate mora which means they belong to Type B. Hence, the final mora is not footed in accordance with NON-FINALITY and so the moraic trochee is placed on the vowel sequence. This means that there are the two syllabifications in (92) which satisfy the metrical constraints but differ with respect to syllabification. (92a) has a diphthong and (92b) has a heterosyllabic parse of the vowels.

(92)



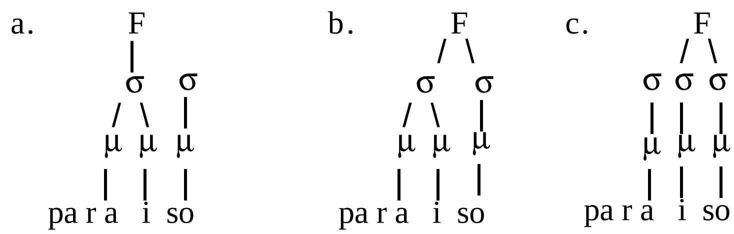
It has already been determined that ONSET dominates NODIPH so (92a) is preferred.

(93) ONSET » NODIPH , /baile/

Candidate	ONSET	NODIPH
(92b) {ba.i.}le	*!	
(92a) √ {bai.}le		*

The situation is different with respect to the Type A vocabulary where vowel sequences surface with hiatus. The Type A words must satisfy ALIGN and so the bimoraic foot can only encompass one mora from two vowel sequence. The Type A words in (91a) also have the two candidate syllabifications in which one violates ONSET, (94c), and the other violates NODIPH, (94a &b). However, the Type A words must also satisfy ALIGN as well so there is another candidate, (94b), to consider where the trochee is a heavy^light foot and the vowel sequence is parsed tautosyllabically as a diphthong.

(94)



(94b) satisfies both ONSET and ALIGN, but the heavy^light trochee violates FOOTFORM, which is undominated. This leaves only (94a) and (94c) which shows that there is a conflict between ALIGN and ONSET. To preserve the bimoraicity of the trochee in (94c), ONSET must be violated and ALIGN is violated in (94a) in order to ensure all syllables have onsets. Therefore, an argument can be made for ranking ALIGN above ONSET. Since FOOTFORM dominates ALIGN and ONSET dominates NODIPH, the ranking of ALIGN above ONSET illuminates the relation between the metrical and the syllabification constraints. This is shown in (95b).

(95) a. ALIGN » ONSET, /paraiso/

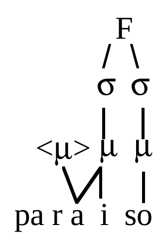
Candidate		ALIGN	ONSET
(94a)	pa.{rai.}so.	*!	
(94c) √	pa.ra.{i.so.}		*

b. FOOTFORM » ALIGN » ONSET » NODIPH, /paraiso/

Candidate		FOOT-FORM	ALIGN	ONSET	NODIPH
(94b)	pa.{rai.so.}	*!			*
(94a)	pa.{rai.}so.		*!		*
(94c) √	pa.ra.{i.so.}			*	

The ranking in (95b) is another case of Prince and Smolensky's FOOTFORM dominating SYLLFORM. Violations of the lower ranked syllable structure constraint NODIPH compels a violation of the higher ranked metrical constraints. The candidate with the ONSET violation, therefore, best-satisfies the constraint ranking because it is the only candidate that satisfies the metrical constraints. The only way to satisfy ALIGN, FOOTFORM, and ONSET is by parsing the vowel sequence as a monomoraic diphthong as shown in (96).

(96)



The diphthong in (96), however, violates SONRISE, which has been shown to dominate NODIPH. From (96), it can be established that SONRISE dominates ONSET as well.

(97) SONRISE » ONSET, /paraiso/

Candidate		SONRISE	ONSET
(96)	pa.{rai.so.}	*!	
(94c) √	pa.ra.{i.so.}		*

The constraint ranking in (95b) is a significant step towards understanding the relation between stress and vocoid distribution. When stress falls on the high vocoid, the combination of ALIGN and FOOTFORM in Type A entails an ONSET violation in the preferred candidate since a NODIPH violation compels a violation of the higher ranking metrical constraints. Since NON-FINALITY is undominated in Type B (and ALIGN is violated), the nonhigh vocoid is stressed and the metrical constraints are satisfied. As a result, the ONSET violation is fatal. This is shown in (98).

(98) Type A:

FOOTFORM » ALIGN » ONSET » NODIPH, /paraiso/

Candidate		FOOT-FORM	ALIGN	ONSET	NODIPH
(94b)	pa.{rai.so.}	*!			*
(94a)	pa.{rai.}so.		*!		*
(94c) √	pa.ra.{i.so.}			*	

Type B:

FOOTFORM » ALIGN » ONSET » NODIPH, /baile/

Candidate		FOOT-FORM	ALIGN	ONSET	NODIPH
	{bái.le}	*!			*
√	{bái.}le		*		*
	{bá.i.}le		*	*!	

The conflict between ALIGN and ONSET is the particular form of FOOTFORM » SYLLFORM that bridges the metrical and the syllable structure constraints as shown in (95b). This constraint interaction directly accounts for the conditions under which hiatus occurs. In other words, ONSET violations are most harmonic under the duress of satisfying FOOTFORM. Procedural bottom-up construction is faced with the problem of syllable markedness which requires all syllables to have onsets which means that all vowel sequences are parsed as diphthongs and a repair applies or syllabification is suspended until after stress assignment. The conditions of hiatus in Spanish are similar to Tongan, e.g. [hu.{ú.fi}] (</huu+fi/) which is also the result of ALIGN dominating ONSET (Prince and Smolensky 1993). Prince and Smolensky note that a tautosyllabic parse of the long vowel, i.e., the absence of the influence of stress on syllabification, is possible if NON-FINALITY is undominated since this would ensure the trochee falls on the two moras of the long vowel. This claim is verified in Spanish where there is both the tautosyllabic parse and the heterosyllabic parse of vowel sequences depending upon whether NON-FINALITY or ALIGN is higher ranking.

3.3.3.1.2 Prevocalic High Vocoids

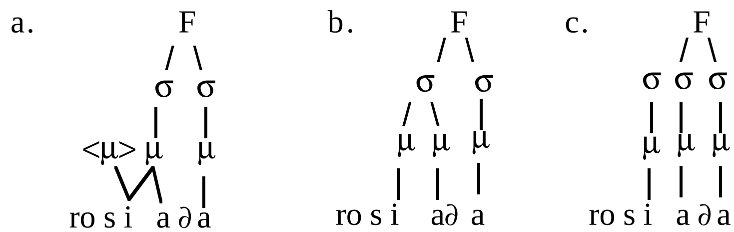
One of the more interesting features of the Spanish stress window phenomenon is that penultimate rising diphthongs do not allow antepenultimate stress. This is actually unexpected since rising diphthongs must be monomoraic making a light penult. This means that the combination of a light penult and NON-FINALITY in Type B should allow antepenultimate stress. The problem of the interaction of rising diphthongs and stress should be addressed from a different angle. As observed by Dunlap (1991), there actually is antepenultimate stress in the Type B words in (99b) since the antepenultimate mora is stressed. The appropriate question to ask is why are the vowel sequences in (99b) heterosyllabic, but tautosyllabic in (99a).

(99) a. Type A

a. Type A		**b. Type B**	
aduana	[a.∂wá.na]	miríada	[mi.rí.a.∂a]
rociada	[ro.syá.∂a]	gladíolo	[gla.dí.o.lo]
piano	[pyá.no]	etíope	[e.tí.o.pe]
peruano	[pe.rwá.no]	driada	[drí.a.∂a]
miedo	[myé.∂o]	podátra	[po.∂í.a.tra]
viruela	[bi.rwé.la]	período	[pe.rí.o.∂o]

The difference between penult and antepenult stress is again attributed to the Type A/Type B distinction. In (99a), the metrical foot must satisfy ALIGN; hence the strong branch of the foot falls on the penultimate vocoid. This leads to three possible outputs for /rosia∂a/, for example.

(100) [ro.{siá.∂a}] [ro.{siá.∂a}] [ro.si.{á.∂a}]



(100b), where the diphthong is bimoraic, violates FOOTFORM because the trochee exceeds bimoraicity. (100a) and (100c) satisfy FOOTFORM, but (100a) violates BRANCH-μ and PARSE-μ and (100c) violates ONSET. It has already been established that ONSET dominates BRANCH-μ, so (100a) is the preferred candidate.

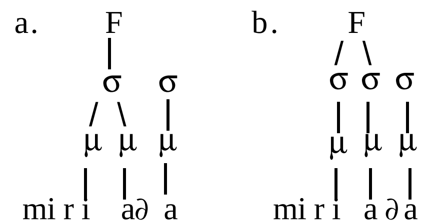
(101) FOOTFORM » ONSET » BRANCH-μ, /rosia∂a/

Candidate	FOOTFORM	ONSET	BRANCH-μ
(100a) √ ro{sia.∂a}			*
(100b) ro{sia.∂a}	*!		
(100c) ro.si.{a.∂a}		*!	

The Type A vocabulary has an interesting contrast for a penultimate vocoid sequence: postvocalic vocoids are parsed heterosyllabically, but prevocalic vocoids are parsed tautosyllabically. This difference centres upon SONRISE. Recall that tautosyllabic parses of postvocalic vocoids in Type A are nonoptimal due to violations of SONRISE as in (96). Type A rising diphthongs in (99) satisfy SONRISE; hence they can be parsed monomoraically.

The effect of rising diphthongs on the stress window is not evident in (100a) because the foot must be aligned to the right edge of the word so stress will never occur past the penult. The more interesting cases are those in (99b). These words actually have antepenultimate stress, but what is interesting is that these words have hiatus rather than diphthongs. Harris's observation about rising diphthongs in the stress window concerns syllabification as much as it does stress. The question should be rephrased in the following way: why is the syllabification [mi.rí.a.∂a] not *[mí.ria.∂a] or *[mi.ría.∂a]? Part of the answer to this question is provided by the constraint ranking established so far. Consider the syllabifications of /miriada/ in (102). Both syllabifications satisfy FOOTFORM and NON-FINALITY, but (102a) has a bimoraic rising diphthong in violation of SONFALL and (102b) has an ONSET violation.

(102) [mi.{ria.∂a}] [mi.{ri.a.}∂a]



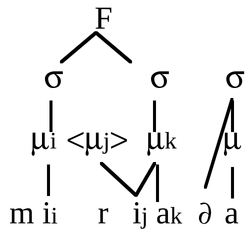
The fact that penultimate vowel sequences surface with hiatus is accounted for by the previously established ranking of SONFALL above ONSET.

(103) SONFALL » ONSET, /miria∂a/

Candidate	SONFALL	ONSET
(102a) mi.{ria.}.∂a	*!	
(102b) √ mi.{ri.a.}∂a		*

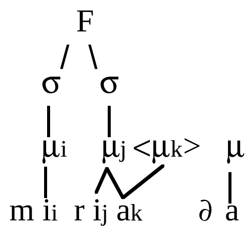
The mandatory hiatus for these penultimate vowel sequences means that the antepenultimate syllable (or more appropriately, the antepenultimate mora) is stressed, as expected in Type B words. The question why stress never falls to the left of a penultimate rising diphthong, i.e. *[mí.ria.∂a], is connected to the size of the stress window. Since all vocoids satisfy V-MORA, stress to the left of a penultimate rising diphthong means that the preantepenultimate mora is stressed. The only way to achieve preantepenultimate stress is to leave one mora unparsed, as shown in (104).

(104)



(104) is an interesting candidate because the unparsed mora is required since ONSET dominates BRANCH-μ and PARSE-μ. Therefore, (104) is more harmonic than (102b) with its ONSET violation. However, the foot in (104) is peculiar because there is a foot-internal unparsed mora. Notice that (104) cannot be improved by leaving μ_k unparsed.

(105)



(105) violates ALIGN since the foot does not coincide with the rightmost mora while respecting NON-FINALITY. It has already been shown that ALIGN dominates ONSET; hence (102b) is preferred.[15]

(106) ALIGN » ONSET, /miria∂a/

Candidate	ALIGN	ONSET
(105) {mí.r<u>ia</u>.<:>}.∂a	**!	
(102b) √ mi.{rí.a.}∂a	*	*

To evaluate the optimality of (104), violations of PARSE-μ must be subject to positional restrictions. This is similar to the positional restrictions on PARSE-PL violations discussed in chapter 2. (100a), the preferred candidate for stressed penultimate rising

---

[15]Another candidate worth considering in [mí.rʸa.∂a] where SECARTIC is violated. SECARTIC is assumed to be undominated in Spanish but the current discussion requires its reconsideration. This candidate is not harmonic because it has the same moraic representation as (104). Recall from chapter 2 that V-MORA is satisfied by a secondary articulation so SECARTIC violations are accompanied by PARSE-μ violations. Therefore, there is still an unparsed mora between the strong and the weak branch of the foot.

diphthongs has an unparsed mora to the left of the trochee. If the unparsed mora occurs to the right of the trochee, as in (105), the higher ranking ALIGN is violated. The foot-internal unparsed mora in (104) must also violate a higher ranking constraint.

(107)	a.	<μ>	{μ	μ}		#	(100a)
	*b.	{μ	<μ>	μ}		#	(104)
	*c.	{μ	μ}		<μ>	#	(105)

The peculiarity of the foot in (107b) (which is exemplified in (104)) is that it skips a mora in the parse. This lack of contiguity is less preferred to a parse where there are no foot-internal unparsed moras. The constraint against foot-internal, unparsed moras can be simply stated as an adjacency requirement on the two branches of the foot (McCarthy & Prince 1990b).

(108) Foot Contiguity (FOOT-CONT)
Foot branches parse adjacent metrical units.

Like other constraints on foot well-formedness, FOOT-CONT conflicts with and dominates ONSET.

(109) FOOT-CONT » ONSET, /miria∂a/

Candidate		FOOT-CONT	ONSET
(104)	{mi.ria.<:>}.∂a	*!	
(102b) √	mi.{ri.a.}∂a		*

The interaction between metrical constraints and the syllable structure constraints provides an answer to the problem of rising diphthongs in the stress window. The observation, as Harris states it, is that rising diphthongs are incompatible with antepenultimate stress. Harris is referring to the antepenultimate syllable which contains the preantepenultimate mora. Hence, stress is not expected to occur in this position. The lightness of rising diphthongs follows from the constraint ranking which appears to make preantepenult stress possible, but the PARSE-μ violation compels a violation of FOOT-CONT. Rising diphthongs in Type B cases receive antepenultimate stress, as expected, and stress on this mora must satisfy SONFALL which compels an ONSET violation.

The constraint rankings established in this section places the metrical constraints above the syllabification constraints, particularly ONSET, which dominates the other syllable structure constraints.

(110) ALIGN » ONSET (95)
FOOTFORM » ONSET (95)
FOOT-CONT » ONSET (109)

The distribution of stressed high vocoids accompanied by hiatus and tautosyllabically unstressed high vocoids are accounted for by these rankings. Hiatus occurs in the surface form because the candidate with the ONSET violation best-satisfies the constraint ranking. Any candidate with a tautosyllabic parse of the vowel sequence compels a violation of a higher ranking metrical constraint. This is illustrated below for both pre- and postvocalic high vocoids.

(111) a. Type A:
FOOTFORM » ALIGN » ONSET » NODIPH, /paraiso/

Candidate	FOOT-FORM	ALIGN	ONSET	NODIPH
(94b) pa.{rái.so.}	*!			*
(94a) pa.{rái.}so.		*!		*
(94c) √ pa.ra.{í.so.}			*	

b. Type B:
FOOTFORM » ONSET » NODIPH , /baile/

Candidate	FOOTFORM	ONSET	NODIPH
{bái.le}	*!		*
(92b) {bá.i.}le		*!	
(92a) √ {bái.}le			*

c. Type A:
FOOTFORM » ONSET» BRANCH-μ, /rosiaða/

Candidate	FOOTFORM	ONSET	BRANCH-μ
(100a) √ ro{s<u>iá</u>.ða}			*
(100b) ro{siá.ða}	*!		
(100c) ro.si.{á.ða}		*!	

d. Type B
SONFALL, FOOT-CONT » ONSET » BRANCH-μ, /miriaða/

Candidate	SON FALL	FOOT-CONT	ONSET	BRANCH -μ
(104) {mí.r<u>ia</u><:>}ða		*!		*
(102a) mi.{ría.}.ða	*!			
(102b) √ mi.{rí.a.}ða			*	

The distribution of high vocoids crucially depends upon the ranking of ONSET below FOOTFORM and ALIGN. This ranking illustrates the interaction between metrical and syllable structure constraints through constraint conflict. The ranking FOOTFORM » ALIGN

» ONSET requires syllables to have onsets except when compelled by the satisfaction of the higher ranking metrical constraints. This constraint interaction accounts for Hualde's (1991) observation that words like [Cá.i.CV.] (where there is stress on the low vowel and hiatus) do not occur. This surface form, as shown in (92) and (111), is always less harmonic than [Cái.CV.] since all candidates satisfy the metrical constraints and so an ONSET violation is fatal. Constraint conflict directly captures the relation between metrical and syllable structure constraints. Since metrical constraints dominate the syllable structure constraints, the satisfaction of the former can compel surface violations of the latter. When metrical constraints are not relevant, violations of the syllable structure constraints are fatal.

A consequence of the analysis proposed here is that rising diphthongs in Spanish are always optimally monomoraic. If the low vowel of a rising diphthong is stressed, the diphthong must be monomoraic to satisfy FOOTFORM. A bimoraic diphthong would create a heavy^light trochee. If the high vowel is stressed, the vowel sequence is parsed heterosyllabically to satisfy SONFALL. Even though the constraints interact to ensure monomoraic rising diphthongs, these nuclei are incompatible with stress to their left. This is what leads Harris and others to propose that these diphthongs are heavy. These diphthongs have the effect of heavy nuclei in the stress window because V-MORA is satisfied. Both vocoids have coindexed moras although one mora is unparsed. Stress to the left of a rising diphthong is nonoptimal because the unparsed mora compels a FOOT-CONT or an ALIGN violation.

The penultimate position exhibits the complete set of contrast for vocoid and hiatus distribution. The constraint ranking developed in this section is used to account for the similar patterns found in the final and the antepenultimate positions.

3.3.3.2 The Final Position

3.3.3.2.1 Prevocalic Vocoids

Another of Harris's generalizations is that final rising diphthongs attenuate the stress window by allowing only penultimate stress, e.g. [ka.rí.sya] not *[ká.ri.sya]. Again, antepenultimate stress should be possible if word-final monomoraic rising diphthongs are possible. However, word-final rising diphthongs, like penultimate ones, are light, but must also satisfy V-MORA. Words with final rising diphthongs, therefore, have stress on the penultimate syllable, but this syllable contains the antepenultimate mora. The words in (112b) then are Type B which contrast with cases where stress is placed on the penultimate mora which are Type A.

(112) a. Type A

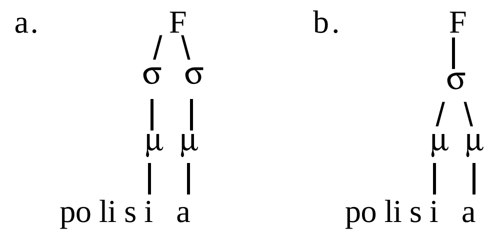
policía	[po.li.sí.a]
avalúo	[a.βa.lú.o]
lanío	[la.ní.o]
grafía	[gra.fí.a]
legacía	[le.ga.sí.a]

b. Type B

caricia	[ka.rí.sya]
tenuo	[té.nwo]
vario	[bá.ryo]
agrafia	[a.ɣrá.fya]
gracia	[grá.sya]

Vowel hiatus in the Type A vocabulary occurs for the same reasons established during the discussion (99b). Since ALIGN is high ranking, the foot must coincide with the word-final vowel and the strong branch of the foot falls on the high vocoid. The two candidates that must be compared are the tautosyllabic parse (113b), which violates SONFALL, and the heterosyllabic parse (113a), which violates ONSET.

(113) [po.li.{si.a}] [po.li.{sia}]



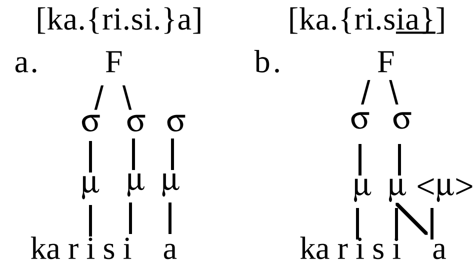
(113a) with the ONSET violation is preferred since this candidate does not violate SONFALL, which, as established, dominates ONSET.

(114) SONFALL » ONSET, /polisia/

Candidate	SONFALL	ONSET
po.li.{sía}	*!	
√ po.li.{sí.a}		*

The word-final rising diphthongs in (112b) must be monomoraic otherwise stress would not fall on the penultimate syllable. In order for a diphthong to occur word-finally, a mora must be left unparsed without violating FOOT-CONT. This is only possible in Type B vocabulary where the foot must satisfy NON-FINALITY. (115) shows two candidates that satisfy NON-FINALITY, but (115a) violates ONSET and (115b) violates BRANCH-μ.

(115)



Both candidates in (115) tie for NON-FINALITY and ALIGN; hence the ONSET violation in (115a) is fatal.

(116) NON-FINAL » ALIGN » ONSET » BRANCH-μ, /karisia/

Candidate	NON-FINAL	ALIGN	ONSET	BRANCH-μ
(115a) ka.{ri.si.}a		*	*!	
(115b) √ ka.{ri.sia}<:>		*		*

The distribution of prevocalic vocoids and hiatus in final position is accounted for by the constraint ranking established for the distribution in the penultimate position. In both cases, hiatus occurs because a tautosyllabic parse, i.e., violating NODIPH, compels a SONFALL violation; hence, the candidate with the ONSET violation is preferred. This only occurs with stressed high vocoids because only when the high vocoid is stressed must both vowels of the vowel sequence be moraic. Tautosyllabic parse of the prevocalic vocoid occurs when the high vocoid is unstressed because FOOTFORM, ONSET and SONFALL, which dominate BRANCH-μ, ensure a monomoraic parse.

Vowel sequences in word-final position can be followed by a word-final consonant. These final VVC sequences also exhibit a hiatus contrast which is the result of stressing the penultimate or antepenultimate mora.

(117) a. Type A

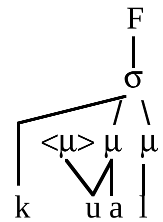
cual	[kwál]
miel	[myél]
buen	[bwén]
pues	[pwés]
bien	[byén]

b. Type B

flúor	[flú.or]
crúor	[krú.or]
aríol	[a.rí.ol]

The Type A words must satisfy ALIGN and so the bimoraic trochee includes the nonhigh vowel and the final consonant.

(118) [kual]



The unparsed mora in (118) is licit because it violates neither NON-FINALITY nor FOOT-CONTIGUITY and the high vocoid is parsed as a nonpeak vocoid because ONSET dominates BRANCH-μ.

(119) ONSET » BRANCH-μ, /kual/

Candidate	ONSET	BRANCH-μ
ku.ál	*!	
(118) √ kual		*

Since the Type B words in (117b) must satisfy NON-FINALITY, the foot is placed on the vowel sequence. As has already been shown, a prevocalic high vocoid cannot be tautosyllabic in this environment. Therefore, the vowel sequence appears with hiatus.

(120) SONFALL » ONSET » NODIPH, /ariol/

Candidate	SONFALL	ONSET	NODIPH
a.{rí.o}l		*!	
√ a.{río}l	*!		*

The effects of penult and final rising diphthongs on the stress window have a single cause. Rising diphthongs satisfy V-MORA, but they are parsed monomoraically. Stress to the left of a penultimate rising diphthong means stressing the preantepenultimate mora which is impossible because the combination of FOOTFORM, NON-FINALITY, and ALIGN allows stress on the antepenultimate mora at most. It is the effect of this same combination at work when the rising diphthong occurs in the final position. In this case, the antepenultimate mora is in the penultimate syllable.

3.3.3.2.2 Postvocalic Vocoids

According to Dunlap (1991), five hundred or so words (many of which are loanwords) have a word-final falling diphthong. Interestingly, they all have final stress (Harris 1983, 1989, 1992).

(121) [sa.mu.rái] ‘samurai’
[mil.déu] ‘mildew’
[ka.rái] ‘tortoise shell’

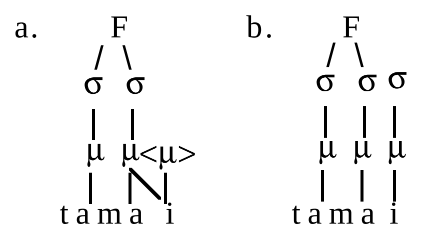
The word-final, falling diphthongs in (121) indicate that these words must be Type A because the penultimate mora is stressed. This produces [ka.rai] and [ka.ra.i] as the crucial candidates for /karai/ with the latter is less preferred due to the violation of ONSET.

(122) ONSET » NODIPH, /karai/

Candidate	ONSET	NODIPH
ka.{ra.i}	*!	
√ ka.{rai}		*

Postvocalic vocoids in final position do not show a contrast for hiatus. This is expected since hiatus is concomitant with stress on the high vocoid and stressing a word-final high vocoid is unlikely given the rarity of Type C stress. Word-final postvocalic vocoid sequences also show another interesting neutralization: stress cannot fall to the left of a word-final diphthong (Harris 1992). In other words, stress cannot fall on the antepenultimate mora which means there is no Type A/Type B contrast. Two possible Type B representations for a nonsense word like /tamai/ are shown in (123), but neither representation surfaces.

(123) [{ta.mai}] [{ta.ma.}i]



(123a) satisfies NON-FINALITY, but violates the undominated SONRISE. (123b), on the other hand, violates ONSET which is dominated by SONRISE. Therefore, the appropriate output for a Type B postvocalic vocoid in final position is (123b).

(124) SONRISE » ONSET » BRANCH-μ, /tamai/

Candidate	SONRISE	ONSET	BRANCH-μ
√ {tá.ma.}i		*	
{ta.mai}	*!		*

It is unknown why forms like (123b) do not exist and there seems to be no way to neutralize the Type A/Type B distinction with respect to final falling diphthongs. However, there are words with sequences of nonhigh vowels that are Type B. This is particularly common with adjectives like [fé.re.o], for example. Antepenultimate stress occurs as a result of satisfying Non-finality and the Onset violation is compelled by the satisfaction of SonRise.

(125) SonRise » Onset » Branch-μ, /fereo/

Candidate	SonRise	Onset	Branch-μ
√ {fé.re.}o		*	
{fé.reo}	*!		*

Although word-final postvocalic vocoids do not show a Type A/Type B contrast, there is a contrast for postvocalic vocoids in final position when followed by a consonant.

(126)

a. Type A		b. Type B	
raiz	[ra.ís]	seis	[sé.is]
maiz	[ma.ís]	gneis	[néis]
laud	[la.úð]		
aún	[a.ún]		

The hiatus in (126a) comes from satisfying FootForm and SonRise. A tautosyllabic parse of the vocoids would create a trimoraic foot or a monomoraic rising diphthong. The tautosyllabic parses in (126b) follow from satisfying Non-finality and Onset.

3.3.3.3 The Antepenultimate Position

The contrasts for stress and syllabification that are found in other positions are neutralized in the antepenultimate position. This is not unexpected since the antepenultimate position is at the limit of the stress window. The contrasts for prevocalic vocoids in the penultimate and final position, for example, do not occur in the antepenultimate position. As noted by Dunlap, prevocalic vocoids always appear tautosyllabically with the following vowel.

(127)

a.		b.
acuático	[a.kuá.ti.ko]	*a.cú.a.ti.co
biótico	[bió.ti.ko]	*bí.o.ti.co
piélago	[pié.la.go]	
santuário	[san.tuá.rio]	

The lack of contrast in the antepenultimate position is actually predicted because the source of contrast in other positions involves stress on either the penultimate or antepenultimate vocoid. For a contrast to exist in the antepenultimate position, stress must fall on the antepenultimate or the preantepenultimate mora. However, there is no way the combination of FOOTFORM and NON-FINALITY can put stress on the preantepenultimate mora. The only way a candidate can do this is to violate ALIGN twice, which is less preferred than a candidate that violates it once. Therefore, only tautosyllabic parses are possible antepenultimately. The words in (127) must be Type B because stress falls on the antepenultimate mora. The tautosyllabic parse of the vowel sequence follows from ONSET dominating BRANCH-μ.

(128) NON-FINAL » ALIGN » ONSET » BRANCH-μ, /biotiko/

Candidate	NON-FIN	ALIGN	ONSET	BRANCH-μ
bi.{ó.ti.}ko		*	*!	
√ {bió.ti.}ko		*		*
{bí.o}.ti.ko		**!	*	

A Type A word with an antepenultimate rising diphthong has stress on the penultimate mora. The vowel sequence is actually to the left of main stress in this case and so the metrical constraints are irrelevant. Therefore, the prevocalic vocoid is parsed as a rising diphthong in accordance with the syllable structure hierarchy.

In the antepenultimate position, postvocalic vocoids do show some contrast between falling diphthongs and hiatus.

(129)

a.	nautica	[náu.ti.ka]	b.	proteínica	[pro.te.í.ni.ka]
	clausula	[cláu.su.la]		deípara	[de.í.pa.ra]
	naufrago	[náu.fra.go]		oleífero	[o.le.í.fe.ro]
	aurea	[áu.re.a]		deífico	[de.í.fi.ko]

The stress and syllabification in (129b) is predicted by the constraint ranking. The antepenultimate stress is the result of FOOTFORM and NON-FINALITY and once again, hiatus is a consequence of an ONSET violation compelled by satisfying FOOTFORM and SONRISE.

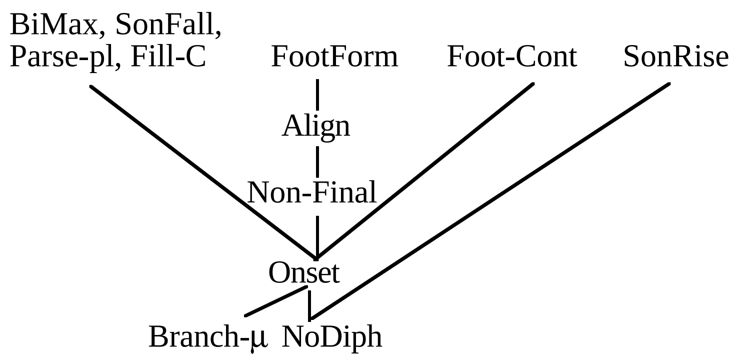
(130) FOOTFORM » ALIGN » ONSET » NODIPH, /deifiko/

Candidate	FOOTFORM	ALIGN	ONSET	NODIPH
{déi.fi.}ko	*!	*		*
{déi.}fi.ko		**!		*
√ de.{í.fi.}ko		*	*	

The words in (129a) are puzzling because the stress falls on the preantepenultimate vocoid which is actually outside the stress window and so they are not predicted by the constraint hierarchy. Although, there are other cases of preantepenultimate mora stress such as [ré.gi.men] and [ín.te.rin], for example, preantepenultimate stress is sufficiently rare that it may be considered exceptional. Furthermore, only the sequence [au] is stressed this way in antepenultimate position (Dunlap 1991). These words, therefore, are exceptional in that the falling diphthongs do not appear to be derived, but rather they must be lexically marked as diphthongs (cf. Harris 1992).

In summary, the distribution and the behaviour of high vocoids in the stress window is accounted for by the interaction of metrical and syllable structure constraints. The crucial rankings involve the metrical constraints which all conflict with ONSET. This is shown in the hierarchy below.

(131)



For Type B: FootForm, Non-Final » Align

The distribution of high vocoids as vowels when stressed and as nonpeak vocoids when unstressed, and the distribution of hiatus are accounted for by (131). The tautosyllabic parse of unstressed high vocoids follows from ONSET dominating NODIPH and BRANCH-μ thus making diphthongs more harmonic than two monophthongal nuclei. Hiatus is associated with stressed high vocoids because the NODIPH or BRANCH-μ violation in the tautosyllabic parse compels a violation of a higher ranking metrical constraint. The candidate with the ONSET violation, therefore, is preferred. A summary of the distribution of vocoids and hiatus is set out in (132) using candidates of pre- and postvocalic high vocoids in the penultimate position and their constraint violations.

(132) Prevocalic High Vocoids

Case I (=101) [ro.{siá.∂a}]

	H. {V'. CV.}	ONSET
√	{HV'. CV.}	BRANCH-μ
	{HV . CV.}	FOOTFORM, SONFALL

Case II (=103) [mi.{rí.a.}∂a]

√	{H'. V.}	ONSET
	{HV.}	NODIPH

Postvocalic High Vocoids

Case I (=98a) [pa.ra.{í.so}]

√	V. {H'. CV.}	ONSET
	{VH'. CV.}	BRANCH-μ, SONRISE
	{VH'. CV.}	FOOTFORM

Case II (=93) [{bái}.le]

√	{V'H.}	NODIPH
	{V'. H.}	ONSET

In Case I, where the weak branch of the foot falls to the right of the penultimate vowel sequence, the ONSET violation is most harmonic for a postvocalic vocoid because a violation of the lower ranking BRANCH-μ compels a SONRISE violation. Since SONRISE is not relevant for prevocalic vocoids in Case I, the BRANCH-μ violation is most harmonic. In Case II, where the bimoraic foot falls on the vowel sequence, the tautosyllabic parse (via a NODIPH violation) is preferred for postvocalic vocoids. However, a tautosyllabic parse of a prevocalic vocoid compels a SONFALL violation. Therefore, the candidate with the ONSET violation is preferred.

One consequence of the ranking in (131) worth repeating is that rising diphthongs are always monomoraic. If a rising diphthong is on the strong or weak branch of the foot, e.g. [{diá.blo}] and [ka.{rí.sia}], it must be monomoraic to satisfy FOOTFORM and SONFALL. If a rising diphthong is unstressed, it is monomoraic because SONFALL is undominated, e.g. [ka.sua.{lí.da}d]. In fact, all vowel sequences outside the stress window are predicted to have a tautosyllabic parse. Without the influence of stress, the optimal parse satisfies ONSET and SONFALL. Hence, postvocalic vocoids are parsed as bimoraic diphthongs and prevocalic vocoids are parsed as monomoraic rising diphthongs. This is shown in (133).

(133) a. SONFALL » ONSET » BRANCH-M, /kasualidad/

Candidate	SONFALL	ONSET	BRANCH-μ
ka.su.a.{lí.da}d		*!	
√ ka.sua.{lí.da}d			*
ka.sua{lí.da}d	*!		

b. ONSET » NODIPH, /ausente/

Candidate	ONSET	NODIPH
a.u.{sén}.te.	*!	
√ au.{sén}.te.		*

The heaviness effect of rising diphthongs in the stress window follows from satisfying V-MORA. Since each vocoid has a coindexed mora and one of these moras is unparsed, stress to the left of a rising diphthong compels a violation of either ALIGN or FOOT-CONT.

The distribution of high vocoids follows from conflict between the metrical constraints and the syllable structure constraints. Since the syllable structure constraints are dominated by the metrical constraints, surface violations of the former are compelled by satisfaction of the latter. Violations of the syllable structure constraints are fatal when all candidates tie for satisfaction of the metrical constraints.

One vocoid sequence which has not yet been discussed is two high vocoids. According to Nunez-Cedeño (1985), tautosyllabic high vocoid sequences cannot have stress on the first of the two vocoids, stress only occurs on the second vocoid.

(134)

viúda	*víuda
miseriúca	*miseríuca
buítre	*búitre
fortuíto	*fortúito

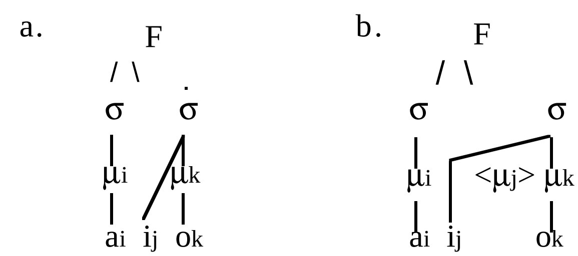
Nunez-Cedeño's observation points to an interesting property of diphthongs in Spanish irrespective of the Type A/Type B distinction. A sequence of two high vocoids must be analyzed as a monomoraic rising diphthong because this is the only way that a tautosyllabic vowel sequence can have stress on the second vowel. Stress on the first vocoid of a tautosyllabic sequence can only occur when the sequence is bimoraic. This means that Spanish does not tolerate bimoraic diphthongs where both vocoids are equal in sonority. The relevant constraint here is SONFALL which must be stated so that a bimoraic vocoid sequence must have a fall in sonority, but SONRISE, on the other hand, only prohibits an {A} particle in the first vowel thus allowing the possibility of two high vocoids forming a rising diphthong.[16]

[16] As mentioned in chapter 1, the sonority requirement in SONFALL can be stated as a scalar constraint.

3.4 Intervocalic Glides

The distribution of intervocalic and word-initial glides in Spanish, as in other languages, involves V-MORA, SYLL-SEG, and ONSET. In chapter 2, the ranking of these constraints was used to account for the distribution of vowel length following glides in the onset. In Luganda, onset glides do not contribute weight so only short vowels follow intervocalic glides. This is attributed to the ranking SYLL-SEG, ONSET » V-MORA. Long vowels in Kimatuumbi arise from the ranking V-MORA, ONSET » SYLL-SEG which ensures the intervocalic glide contributes a mora. The question of which ranking occurs in Spanish is interesting because Spanish does not have long vowels and so the two rankings above (together with V-MORA » PARSE-μ) lead to identical surface forms. The two candidates that these rankings produce are shown in (135).

(135)



SYLL-SEG, ONSET » V-MORA   V-MORA, ONSET » SYLL-SEG

In a language without long vowels, the choice between the representations in (136) seems trivial. For example, during the discussion of Lenakel it is assumed that (135a), which violates V-MORA, is preferred. However, the matter is not trivial in Spanish because unparsed moras play a crucial role in the analysis of stress. On the assumption that (135a) is the preferred representation, ONSET must dominate V-MORA. This is shown in (136).

(136) SYLL-SEG » V-MORA, /aio/

Candidate	SYLL-SEG	V-MORA
(135a) √ a.yo		*
(135b) a.yo<:>	*!	

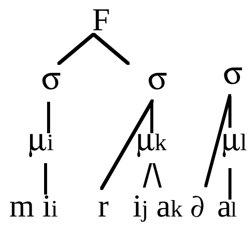
ONSET » V-MORA, /aio/

Candidate	ONSET	V-MORA
(135a) √ a.yo		*
(135b) a.i.o	*!	

Ranking ONSET above V-MORA, however, creates problems elsewhere in the phonology. In particular, it predicts that the penultimate rising diphthongs in section 3.3.3.1.2 can have a V-MORA violation to satisfy ONSET. Recall that in the discussion of forms like [mi.rí.a.∂a], antepenultimate stress is impossible because the violation of PARSE-μ compels a violation of the higher ranking FOOT-CONT. If ONSET dominates V-MORA, then FOOT-

CONT can be satisfied by violating V-MORA. This means that (137), where there is no μ_j for the vocoid /i_j/, is preferred over [mi.rí.a.∂a], which has an ONSET violation.

(137) [{mi.ria.}∂a]



The preference for (137) is illustrated in (138).

(138) FOOT-CONT » ONSET » V-MORA » BRANCH-μ, /miria∂a/

Candidate	FOOT-CONT	ONSET	V-MORA	BRANCH-μ
√ *{mí.ria.}∂a			*	*
mi.{rí.a.}∂a		*!		
{mí.ria<:>}∂a	*!			*

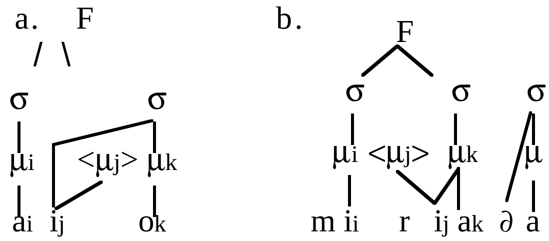
The ranking in (138) cannot be correct because V-MORA must be undominated to account for the effect of rising diphthongs in the stress window. Therefore, (135b) is the preferred representation for intervocalic glides in Spanish. This presents a problem as well because in (135b) FOOT-CONT is violated. If V-MORA dominates ONSET, the preferred candidate would be penultimate stress as in [a.í.o].

(139) {FOOT-CONT, V-MORA} » ONSET, /aio/

Candidate	FOOT-CONT	V-MORA	ONSET
(135a) {á.yo}		*!	
(135b) {á.yo}<:>	*!		
√ *a.{í.o}			*

Since the ranking in (139) is already established, (135b) (or something like it) must be correct. However, FOOT-CONT cannot be violated. To do this, FOOT-CONT must distinguish between unparsed moras that are associated to a nonpeak high vowels, (140b), and an unparsed mora that is associated with a glide in the onset, (140a). The two representations in question are shown below.

(140)



The difference between the representations in (140) is clear enough although it is unclear how to formalize the way FOOT-CONT can distinguish them. One possibility is that the unparsed mora in (140b) is visible to FOOT-CONT through its link to μ_j, but the unparsed mora in (140a) is not visible because it is not linked to any other mora.

3.5 Evidence for Phonemic Glides

The constraint hierarchy in (131) accounts for the distribution of nonpeak high vocoids through constraint interactions that lead to tautosyllabic parses of vowel sequences. This implies that all nonpeak vocoids correspond to underlying high vowels and an underlying vowel/glide contrast is not necessary. However, the existence of a contrast for the syllabification of high vocoids can be considered evidence for an underlying vowel/glide contrast (see Harris 1969, 1992, Cressey 1978, Morgan 1984, Hualde 1991). The analysis here follows Dunlap's claim that the contrast is the result of the Type A/Type B distinction rather than an underlying vowel/glide contrast. There are other potential sources of evidence for underlying glides that must be considered. As Dunlap shows, these potential sources of underlying glides can also be accounted for by the Type A/Type B distinction.

So far, the discussion of Spanish has ignored verb stress, which, according to Harris (1969) provides the strongest evidence for underlying glides. Harris notes that present tense verbs always have penultimate stress and the only way that the words in (141a) can have penultimate stress is if the high vocoid in final position does not contribute weight. These words can be compared to (141b) where the high vowel of the final sequence is stressed.

(141)	a.	cám.byo.	b.	am.plí.o.
		cám.byas.		am.plí.as.
		frá.gwo.		con.ti.nú.o.
		frá.gwas.		con.ti.nú.as.
		a.ca.rí.cya		

Harris (1969, 1987, 1992) claims that the only way by which the high vocoids in (141a) can fail to contribute weight is if they are glides. This means that the underlying form of the root of [a.ca.rí.cya] is /acricy/ with a final glide and penultimate stress is subsequently applied to the suffixed form. The proposed glide-final representation of the verbs in (141a) is similar to Liberman and Prince’s (1977) analysis of final high vocoids in English. By calling the final high vocoid in a word like industry a glide, it is not visible to stress placement and so stress can fall on the initial syllable. However, Hayes’s (1980) extrametricality makes this proposal unnecessary since the final high vocoid is just an extrametrical vowel. The same can be done for Spanish verbs so, following Dunlap, the verbs in (141) exhibit a Type A/Type B contrast. The verbs in (141a) are Type B with stress on the antepenultimate mora and the verbs in (141b) are Type A with stress on the penultimate mora.

An underlying vowel/glide distinction, therefore, is unnecessary because the contrast between stress placement and syllabification is accounted for by the Type A/Type B distinction which is based on the ranking of NON-FINALITY. It is worthwhile to pursue the question of underlying glides in Spanish because an underlying vowel/glide distinction is required in Harris’ (1992) analysis of stress which has uniform extrametricality. However, the combination of a vowel/glide contrast and a Type A/Type B contrast leaves some problems unresolved and makes a number of incorrect predictions. The basics of Harris’ stress analysis is repeated below.

(142)
i. stressable elements are vowels.
ii. a final vowel is extrametrical.
iii. place stress as far to the right as possible.
iv. build binary constituents.

The difference between Type A and Type B, recall, is that the latter are exceptions to (iii) and are stressed by (iv). Harris does not address the issue of hiatus and stress and so it is assumed that high vowels are stressable and glides are not. To make sure a sequence of vowels is parsed heterosyllabically in this approach, there must be constraint stating that no tautosyllabic vowel sequences are permitted. This means that all diphthongs consist of a nonhigh vocoid plus a consonantal glide. The contrast for stress and syllabification in the penult position appears to follow from the stress rule.

```
(143)              *             *
            pa ra i s<o>      bay l<e>
```

The high vocoid in [pa.ra.í.so] is a vowel and it is stressed by (iii), but the high vocoid in [bay.le] is a glide and so the low vowel is the rightmost stressable vowel. The same argument can be used to account for the contrast in the antepenultimate position.

```
(144)        (*    .)              (*  .)
            naw.fra.g<o>   pro.te.i.ni.c<a>
```

Both words must be Type B because they are stressed by (iv). If it assumed that the labiovelar in [nawfrago] is a glide, stress will fall on the low vowel. The combination of an underlying vowel/glide distinction and Type A/Type B, therefore, appears to account for the contrast in antepenultimate position that cannot be accounted for otherwise.

Turning now to the final position, the behaviour of falling diphthongs is not better understood with an underlying vowel/glide contrast. Recall that stress must fall on a word-final diphthong, e.g. [ka.rái]. If a word-final high vocoid is a glide, it should still be possible for stress to fall on the penultimate syllable as it does with other word-final consonants, e.g. [móβil]. It appears that all word-final vocoids are vowels, but this is an odd distribution. Moreover, it must be the case that word-final high vowels are incompatible with Type B. The problem of stress on final diphthongs remains unsolved.

The combination of an underlying vowel/glide distinction and a Type A/Type B distinction is particularly problematic when applied to prevocalic high vocoids. Consider stress assignment in final position.

(145)
*   *
po.li.si. <a>   ka.ri. sy<a>

Both forms in (145) have stress on the penultimate syllable because this syllable contains the rightmost stressable vowel. Once again, this contrast appears attributable to an underlying vowel/glide contrast.

Harris actually does not account for the stress contrast in (145) by the method mentioned above. In fact, the contrast cannot be accounted for this way because it fails to account for the effect of rising diphthongs on the stress window. If the final syllable of [karisya] is a glide, there is no way to block antepenultimate stress because the combination of a glide and Type B stress can create *[ká.ri.sya]. Harris accounts for the behaviour of final rising diphthongs by proposing that the high vocoid is [+cons], but it is also moraic. The stress rule (iii) cannot assign main stress to the high vocoid because it is not the peak of the syllable. Harris posits a rule that shifts stress to the penultimate syllable in this case.

(146)
*   *
μ μ μ<μ>   μ μ μ<μ>
ka.ri. sy<a> → ka.ri. sy<a>

It is crucial in Harris's account that [+cons] glides are moraic otherwise there is no way to account for their tautosyllabic parse with the following vowel and their effect on stress. However, there is no mechanism in this approach to assign moras to these glides.

Positing underlying glides only partially aids the account of preantepenultimate stress in words like [náu.fra.go] since only labiovelars in this position behave like glides. An underlying vowel/glide contrast, as Dunlap notes, predicts that palatal glides should appear in this position, but they do not. In the final position, underlying glides force the addition of stress shift which is unnecessary in the analysis here. The effects on the stress window of prevocalic vocoids follows from the constraint ranking and the Type A/Type B distinction. The strongest evidence for an underlying vowel/glide contrast is the verbs in (141). However, these stress patterns can be accounted for, as proposed by Dunlap, by a Type A/Type B distinction in verbs. Hence all surface vocoids correspond to underlying [-cons] vocoids.

3.6 Conclusion

In both Lenakel and Spanish, the distribution of high vocoids crucially refers to stress. The reference to stress in the distribution of high vocoids is problematic in procedural approaches to constituent construction because the locus of stress must be known prior to syllabification. This means metrification appears to precede syllabification, which is what Prince and Smolensky call anti-bottom-up construction. Any attempt to maintain bottom-up construction forces complication elsewhere in the grammar. For example, Waksler's (1990) analysis of Lenakel requires ternary specification for [cons] and Carreira's (1988) analysis of Spanish requires resyllabification after metrification. In the Optimality Theoretic approach, the role of stress in the distribution of high vocoids is accounted for by simultaneously satisfying both metrical and syllable structure constraints. The anti-bottom-up nature of Spanish and Lenakel is the result of conflict between these constraints. In general, the interaction of the syllable structure constraints can force a high vocoid to be parsed as a nonpeak vocoid. However, this parse might violate a higher ranking metrical constraint so the moraic parse of the vocoid, which satisfies the metrical constraints, is more harmonic.

In Lenakel, prevocalic high vocoids are parsed as nonpeak vocoids except when such a parse compels a violation of the metrical constraint FTBINARITY. In Spanish, where the distribution of high vocoids directly refers to stress the relevant undominated constraint is FOOTFORM, which ensures the bimoraicity of the foot at the expense of violating syllable structure constraints, particularly ONSET. Both Lenakel and Spanish clearly exhibit the anti-bottom-up construction problem in procedural approaches. In Optimality Theory, the metrical constraints directly conflict with the syllable structure constraints and in the face of this conflict the metrical constraints are satisfied. This conflict and the ranking FOOTFORM » SYLLFORM ensures that violations of syllable structure constraints are more harmonic than violations of metrical constraints.

Lenakel and Spanish also exhibit instances of other types of interactions between metrical and syllable structure constraints. In Lenakel, for example, postvocalic high vocoids are always parsed tautosyllabically. This parse crucially depends upon ONSET dominating NODIPH and the absence of any metrical influence. In fact, the syllable structure constraints influence stress assignment since the foot is a bimoraic trochee rather than a disyllabic trochee under pressure to preserve the tautosyllabic parse. The conflict between FOOTFORM and SYLLFORM is resolved by altering the shape of the trochee, which is captured in the ranking by ONSET dominating FOOTFORM. Vocoid distribution in Lenakel has both metrical constraints influencing syllable structure and vice versa. This is revealed in the ranking FTBINARITY » ONSET » FOOTFORM.

Metrical constraints and syllable structure constraints need not interact at all. In Tongan, as Prince and Smolensky note, hiatus within long vowels occurs because ALIGN dominates ONSET. However, in another language, the integrity of the vowel can be maintained if ALIGN is dominated thus allowing the foot to be placed on the long vowel, that is, [{CVV}.CV] is preferred to [CV.{V.CV}]. This occurs to a small extent in Spanish where in Type B NON-FINALITY dominates ALIGN. Penultimate vowel^high vowel sequences, therefore, are always parsed as diphthongs a the expense of ALIGN. This ranking in Type B has the spirit of bottom-up construction because stress placement is being manipulated to maintain syllable structure, i.e., stress occurs farther to the left to ensure vowels are parsed tautosyllabically. A language in which NON-FINALITY is undominated throughout its lexicon and has ranking ONSET » {NODIPH, NLV} would mimic bottom-up construction.

CHAPTER 4

OTHER SOURCES OF GLIDES

4.1 Introduction

In the previous chapters, two main sources for nonmoraic vocoids were considered. Chapter 2 discusses nonmoraic vocoids arising from underlying vowel sequences and chapter 4 discusses nonpeak vocoids arising through interaction with stress. There are, however, other sources of glides. In particular, a glide homorganic to a high vowel can occur between a high vowel and a nonhigh vowel or glides can be present in underlying representation. These two sources of glides have received varying degrees of attention in the previous chapters. Homorganic glides were explicitly excluded from the analysis in chapter 2 whereas underlying glides were discussed in chapter 3. The purpose of this discussion was to marginalize the role of underlying glides (in the case of Lenakel) and to deny their existence (in the case of Spanish).

Homorganic glides, in procedural terms, arise as a result of spreading the place of articulation from a high vowel to the onset of the following syllable in response to preventing vowel hiatus. As will be shown in the Optimality Theoretic approach in this chapter, the linking of a high vocoid to a following onset best satisfies ONSET and other conflicting constraints. There are, of course, many ways to satisfy ONSET so whatever constraint interaction accounts for homorganic glides must be ranked with respect to other constraints.

The discussions of underlying glides in chapter 3 show that in these languages there is no strong evidence to support an underlying vowel/glide distinction and the distribution of high vocoids is determined by the established constraint hierarchies. However, there are languages that display surface phenomena that can only be accounted for by positing an underlying vowel/glide distinction. In this chapter, two cases of underlying glides are discussed. First, postvocalic vocoids in Ilokano and Ponapean have different distributions that can only be the result of an underlying distinction for high vocoids. Second, Berber dialects have a distribution of high vocoids that must be accounted for by positing underlying glides. Moreover, Berber glides can be moraic giving rise to a glide/vowel alternation traditionally called Glide Vocalization. It is shown here that vocalized glides are the result of simultaneously comparing a moraic glide and a nonmoraic glide for constraint satisfaction. A vocalized glide serves as a syllabic nucleus when the moraic parse of the glide best satisfies the constraint ranking.

4.2 Homorganic Glides and Epenthetic Consonants

The discussion of underlying vowel sequences in chapter 2 shows how constraint interaction can account for the ways in which languages can maintain surface monophthongal vowels by the nonmoraic parse of high vocoids. One possible way of maintaining surface monophthongs, which has not yet been discussed, is consonant epenthesis, which forces a vowel sequence to surface heterosyllabically. Intervocalic epenthesis can have two forms: 1. a default consonant or 2. a glide homorganic to the initial high vowel of the sequence. This latter type, often called Glide Formation or Glide Insertion, is the focus of the following section.

Both types of epenthesis arise in order to satisfy ONSET, and consonant epenthesis, as proposed by Prince and Smolensky, occurs at the expense of a FILL violation. Although an epenthetic consonant is a consequence of a FILL violation, a homorganic glide cannot be. The difference stems from the definition of FILL which, according to Prince and Smolensky, requires the parsing of an empty position that has its features supplied by default. Homorganic glides appear to be similar since the features of the high vocoid can be phonetically interpreted as the features for the empty position, but this cannot be correct since it leads to ambiguity. Consider the candidate parses for a sequence like /…CiaCV…/ and the violated constraints.

(1)	a.	Cia.CV	*NODIPH
	b.	Ci.∆a.CV.	*FILL
	c.	Ci.a.CV.	*ONSET

In a language without hiatus or diphthongs, (1a &c) are not harmonic because they violate undominated constraints. The preferred candidate is (1b), but the problem with this candidate is that the form of epenthesis is not determined because there is no way of knowing whether the empty position is to be interpreted with default features or with features from the preceding vowel. Therefore, consonantal epenthesis and homorganic glide epenthesis must be distinguished by constraint ranking.

Epenthetic segments of any kind can appear whenever there is vowel hiatus. The two environments that are of particular interest are morpheme internally and at morpheme junctures. In suffixation in Lardil (Prince and Smolensky 1993) and Axininca Campa (McCarthy and Prince 1993a, b), consonantal epenthesis crucially involves the alignment of syllable boundaries and morphological boundaries. For example, in Axininca Campa, an epenthetic [t] appears between a vowel-final stem and a vowel-initial suffix.

(2)	/noN- pisi- i/	[nompisiti]	‘I will sleep’
	/noN- piyo- i/	[nompiyoti]	‘I will heap’
	/iN- koma- i/	[iŋkomati]	

As McCarthy and Prince argue, the epenthetic consonant arises as a result of a FILL violation which is compelled in order to satisfy ONSET. Furthermore, McCarthy and Prince show that ALIGN-R (that is, the right edge of the stem must coincide with a syllable boundary) must dominate FILL as well. This is evident from the fact that Axininca Campa has diphthongs morpheme-internally, but tautosyllabic parses of vocoid sequences are not possible across morpheme boundaries.

(3) a. ONSET » FILL, /iN-koma-i/

Candidate	ONSET	FILL
+ iŋkoma.|]Δi		*
iŋkoma.|]i	*!	

b. ALIGN-R » FILL, /iN-koma-i/

Candidate	ALIGN-R	FILL
+ iŋ.ko.ma.|]Δi		*
iŋ.ko.ma|i]	*!	

Homorganic glide epenthesis is similar to consonantal epenthesis insofar as ONSET must be satisfied. The two types of epenthesis often occur in complementary distribution, which is shown here to follow from constraint interaction. Two aspects of homorganic glides and consonantal epenthesis are discussed here: 1. the distribution with respect to morphology and, 2., the phonologically determined distribution based on the height of the first vowel in the sequence. The phonological distribution is discussed first before turning to the interaction with morphology.

An example of homorganic glides and epenthetic consonants in complementary distribution is found in Kalinga (a Philippine language). In this language, stem-final high vowels and vowel-initial suffixes are separated by a homorganic glide. Stem-final low vowels, however, are followed by a glottal stop (Geiser 1970).

(4)

a.	/dangli+ an/	[dangliyan]	‘to bevel’
	/dabbi+ on/	[dabbiyan]	‘to construct’
b.	/?adagu+an/	[?adaguwan]	‘to have pity’
	/punu+on/	[punuwon]	‘to fill’
c.	/?ala+an/	[?ala?an]	‘to do’
	/piya+on/	[piya?on]	‘to like’

The distribution of the epenthetic segment is a result of the constraint ranking that is best-satisfied differently depending on the height of the stem-final vowel. The epenthetic glottal stop following the low vowel in (4c) shows that FILL is crucially dominated by ONSET.

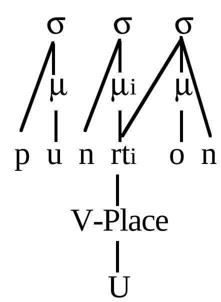
(5) ONSET » FILL, /piya+on/

Candidate	ONSET	FILL
+ pi.ya.|]Δon.		*
pi.ya.|]on.	*!	

It is impossible to determine whether ALIGN has a role in Kalinga as it does in Axininca Campa because the candidate from (5) that violates ALIGN, e.g. [pi.ya|an.], has a long vowel which does not occur in Kalinga. The fatally violated constraint is NLV, which is undominated. Nevertheless, the preferred candidate in (5) has the right edge of the stem aligned with a syllable boundary.

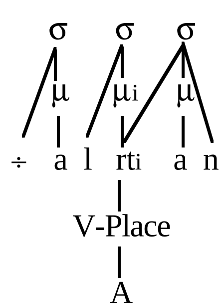
The homorganic glides in (4a& b) require a more complex constraint interaction than glottal stop epenthesis. Following McCarthy and Prince's (1993b) analysis of English flapping, homorganic glides are the result of the stem-final vowel being parsed ambisyllabically to serve as the peak of one syllable and as the onset of the following one. This is shown in (6) with the syllabification on [punuwon].

(6) [punuwon]



The ambisyllabic parse of the high vocoid satisfies both ONSET and FILL, but it violates SYLL-SEG because the high vocoid is linked to a syllable node and it has a coindexed mora. This will be discussed presently. Returning to the low vowels, the presence of a glottal stop follows from the fact that low vowels cannot have the ambisyllabic parse shown in (6). Such a parse would involve a {A}=V violation since the link from the root node to the syllable entails a nonmoraic {A} particle. This is shown in (7).

(7) [?a.la.a^an]



The glottal stop in (4c) follows from the interaction of FILL and {A}=V where the latter dominates the former. Therefore, the distribution of homorganic glides and epenthetic consonants in (4) is a consequence of {A}=V and ONSET dominating FILL. This is shown in (8).

(8) a. {A}=V, ONSET » FILL, /punu+ on/

Candidate	{A}=V	ONSET	FILL
+ pu.nu.won			
pu.nu.Δon			*
pu.nu.on		*!	

b. {A}=V, ONSET » FILL, /?ala+an/

Candidate	{A}=V	ONSET	FILL
?a.la.a^an	*!		
+ ?a.la.Δan			*
?a.la.an		*!	

The complementary distribution of consonantal epenthesis and homorganic glides follows from the violation of {A}=V that is compelled by the ambisyllabic parse of {A} in (7). Since {A}=V is irrelevant for high vowels, the ambisyllabic parse satisfies all constraints.

The constraint interactions in (8) that account for homorganic glides are similar to the interactions proposed in chapter 2 for the distribution of nonmoraic vocoids and elision. In chapter 2, nonmoraic vocoids surface as secondary articulations in violation of SECARTIC. Nonhigh vowels cannot surface as secondary articulations because the SECARTIC violation is accompanied by a violation of the undominated {A}=V. As a result, nonhigh vowels best satisfy the constraint hierarchy with a violation of some other constraint, which is PARSE in the case of elision.

McCarthy and Prince (1993b) and Cohn (1989) show that homorganic glides and consonantal epenthesis can be in complementary distribution in different morphological environments. This is seen in Malay where a glottal stop not only occurs in a phonologically defined environment, i.e., when the first vowel is low, but it also appears between all prefixes and stems. Homorganic glides occur after high vowels within morphemes and between stems and suffixes (Durand 1987).

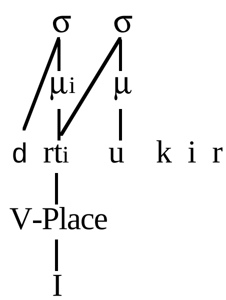
(9)	a.	/tiap/	[tiyap]	‘every’
		/buah/	[buwah]	‘fruit’
	b.	/bantu+an/	[bantuwan]	‘aid, relief’
		/uji+ an/	[ujiyan]	‘test’
	cf.	/mengula+ i/	[me+gula?i]	‘to cause to sweeten’
	c.	/di+ ukir/	[di?ukir]	‘to carve’
		/di+ ankat/	[di?ankat]	‘to lift’

The presence of glottal stop in (9c) is a consequence of the interaction between ALIGN-L (rt, σ) and FILL (McCarthy and Prince 1993b, Cohn 1989). As shown in (10), the candidate syllabification that satisfies ALIGN-L, (10a), violates the undominated ONSET. This leaves the candidate that satisfies ONSET with an epenthetic glottal stop, (10b), and (10c) where a homorganic glide satisfies ONSET.

(10) a. di.[|u.kir *ONSET
b. di.[Δ|u.kir *FILL, ALIGN-L
c. di.[y|u.kir *ALIGN-L

For the FILL violation to be the most harmonic parse, McCarthy and Prince (1993b) propose that ambisyllabic parses violate ALIGN. This is evident in (11) where the root node of the prefix's vowel is also the root node of the onset of the stem.

(11) [diyukir]



Furthermore, McCarthy and Prince propose that ALIGN violations are gradient, that is, it is more harmonic to violate ALIGN with an empty position than to violate it with a segment from the preceding morpheme. The constraint ranking established by McCarthy and Prince for epenthesis between a prefix and root is given in (12).

(12) ONSET » ALIGN-L » FILL, /di+ ukir/

<table>
<tr><th>Candidate</th><th>ONSET</th><th>ALIGN-L</th><th>FILL</th></tr>
<tr><td>di.[|u.kir.</td><td>*!</td><td></td><td></td></tr>
<tr><td>+ di.[Δ|u.kir.</td><td></td><td>|Δ|</td><td>*</td></tr>
<tr><td>di.[y|u.kir</td><td></td><td>|i|!</td><td></td></tr>
</table>

The situation is different morpheme-internally where ALIGN-L is irrelevant. As shown in (13), the homorganic glide is a faithful parse.

(13) ONSET » ALIGN-L » FILL, /tiap/

<table>
<tr><th>Candidate</th><th>ONSET</th><th>ALIGN-L</th><th>FILL</th></tr>
<tr><td>ti.ap.</td><td>*!</td><td></td><td></td></tr>
<tr><td>ti.Δap.</td><td></td><td></td><td>*!</td></tr>
<tr><td>+ ti.yap.</td><td></td><td></td><td></td></tr>
</table>

ALIGN-L is, of course, irrelevant between the stem and the suffix, but the alignment of the right edge of the root and a syllable (which is ALIGN-R) can be relevant. However, all three candidates in (14) satisfy ALIGN-R since the morpheme edge and the syllable edge coincide. Once again, the homorganic glide is preferred since it satisfies both ONSET and FILL.

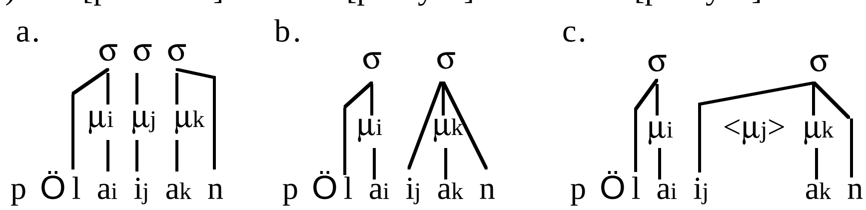
(14) ONSET » FILL, /bantu+ an/

Candidate	ONSET	FILL
ban.tu|]. an.	*!	
ban.tu|].Δan.		*!
+ ban.tu|].wan.		

There are many more candidates to consider in addition to those in (14), which all share a moraic parse of the stem-final vowel. Most importantly, ONSET and FILL can be satisfied by a nonmoraic parse of the high vocoid, e.g. [ban.]t^{W}|an]]. This parse, however, violates SECARTIC, which is undominated in Malay, and it also violates ALIGN-R since the last two segments of the stem are syllabified with the suffix. Therefore, the preferred candidate must contain a moraic parse of the high vocoid.

Ambisyllabicity, so far, is represented as the faithful parse since all other moraic and nonmoraic parses of a high vocoid lead to a violation of a high ranking constraint. Homorganic glides, of course, are only one way to resolve underlying hiatus, which must be evaluated with respect to other ways such as secondary articulations. Hence, there must be a way to evaluate the optimality of homorganic glides compared to other potential parses of high vocoids. Homorganic glides require a moraic parse of the high vocoid plus a link from the vocoid's root node to the following syllable node. This representation, shown in (6), violates SYLL-SEG. Based on the constraint interactions required to account for intervocalic glides, a SYLL-SEG violation actually predicts that homorganic glides should not be possible. This follows from the syllabification of intervocalic glides which require a V-MORA violation under the duress of satisfying ONSET and SYLL-SEG. This is illustrated with candidate syllabifications of the Malay word [p&layan] 'waitress'.[1]

(15) [p&la.i.an] [p&layan] [p&layan]



The preferred candidate is (15b), where there is no mora coindexed with the glide in the onset. The appropriate constraint ranking is shown in (16).

[1]The underlying form is /peN+ laian/. The deletion of the nasal is not relevant so it is omitted.

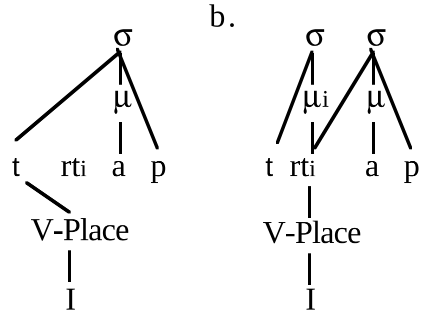
(16) ONSET, SYLL-SEG » V-MORA, /p&nlayan/

Candidate	ONSET	SYLL-SEG	V-MORA
(15a) p&la.i.an.	*!		
(15b) + p&la.yan.			*
(15c) p&la.yan.<:>		*!	

The ranking in (16) predicts that a violation of V-MORA is preferred to the SYLL-SEG violation that occurs with homorganic glides. This means that the nonmoraic vocoid in (17a) is more harmonic than (17b) since in the former there is no mora coindexed with the root node of the high vocoid.

(17) [t^{y}ap] [tiyap]

a. b.



To ensure the correct distribution of homorganic glides and intervocalic high vocoids, all nonmoraic parses of the high vocoid must involve a violation of a higher ranking constraint, particularly SECARTIC and NCO. As a result, the surface form has the high vocoid parsed moraically. Furthermore, SYLL-SEG and ONSET must be ranked with respect to each other since homorganic glide epenthesis, as in (17b), violates the latter and satisfies the former.

(18) a. ONSET » SYLL-SEG, /tiap/

Candidate	ONSET	SYLL-SEG
ti.ap.	*!	
+ ti.yap.		*

b. SECARTIC » SYLL-SEG, /tiap/

Candidate	SECARTIC	SYLL-SEG
t^{y}ap.	*!	
+ ti.yap.		*

The rankings in (18) do not effect the distribution of intervocalic vocoids because the relation between ONSET and SYLL-SEG does not alter the output of (16). This is seen by comparing homorganic glides and intervocalic vocoids.

(19) a. SECARTIC, ONSET » SYLL-SEG » V-MORA, /tiap/

Candidate	SECARTIC	ONSET	SYLL-SEG	V-MORA
ti.ap		*!		
t^{y}ap.	*!			*
+ ti.yap.			*	

b. SECARTIC, ONSET » SYLL-SEG » V-MORA, /p&nlaian/

Candidate	SECARTIC	ONSET	SYLL-SEG	V-MORA
p&.la.i.an		*!		
+p&.la.yan				*

The V-MORA violation compels a SECARTIC violation in (19a), but in the case of the intervocalic vocoid in (19b) SECARTIC is irrelevant so the candidate with the V-MORA violation is preferred.

One candidate not mentioned above involves parsing the high vocoid as the onset, for example, [p&r.sat.wan]. This syllabification violates V-MORA, but satisfies SECARTIC and so based on (19) it should be preferred. The relevant constraint here is ALIGN-R. (20) shows the candidate nonmoraic parses where the vocoid is syllabified as either a secondary articulation or as an onset. The nonmoraic parses of the glide in (20b& c) compel a de-alignment of the right edge of the stem and the syllable. Only the homorganic glide in (20a) has the stem aligned with the syllable boundary.

(20) a. p&r.satu|].wan
b. p&r.sat.]w|an]
c. p&r.sa.]t^w|an]

The violations of ALIGN-R in (20b &c) are fatal and conflict with SYLL-SEG. Since ALIGN-R must dominate SYLL-SEG, it dominates V-MORA too and so a nonmoraic parse (via a V-MORA violation) compels a violation of a higher ranking constraint. This leaves the homorganic glide as the optimal parse.

(21) a. ALIGN-R » SYLL-SEG, /p&rsatu +an/

Candidate	ALIGN-R	SYLL-SEG
p&r.sat.]w|an]	*!	
+ p&r.satu|].wan		*
p&r.sa.]t^{W}|an]	*!	

b. ALIGN-R » SYLL-SEG » V-MORA, /p&rsatu +an/

Candidate	ALIGN-R	SYLL-SEG	V-MORA
p&r.sat.]w|an]	*!		*
+ p&r.satu|].wan		*	
p&r.sa.]t^{W}|an]	*!		

The last interaction to consider is FILL and SYLL-SEG. It has already been shown that ONSET dominates FILL and ONSET dominates SYLL-SEG. FILL must dominate SYLL-SEG too since homorganic glides are preferred to consonantal epenthesis.

(22) FILL » SYLL-SEG, /tiap/

Candidate	FILL	SYLL-SEG
+ ti.yap.		*
ti.Δap.	*!	

The glottal stop following the low vowel in (9c) follows from the fact that {A}=V dominates FILL. This produces the combined ranking {A}=V » FILL » SYLL-SEG that accounts for the phonologically conditioned distribution of homorganic glides and glottal stop. The glottal stop occurs because low vowels cannot have homorganic glides due to the {A}=V violation that is compelled by the SYLL-SEG violation. The ranking of ALIGN-L accounts for the morphologically conditioned distribution.

(23) a. {A}=V » FILL » SYLL-SEG, /tiap/

Candidate	{A}=V	FILL	SYLL-SEG
+ ti.yap.			*
ti.Δap.		*!	

b. {A}=V » FILL » SYLL-SEG, /mengula+i/

Candidate	{A}=V	FILL	SYLL-SEG
+ men.gu.la.Δi.		*	
men.gu.la.a^i	*!		*

c. ALIGN-L » FILL » SYLL-SEG, /di+ ukir/

Candidate	ALIGN-L	FILL	SYLL-SEG
di.[|yu.kir.	|i|!		*
di.[|Δu.kir.	|Δ|	*	

To summarize, the distribution of homorganic glides is similar to the distribution of other nonmoraic vocoids because both phenomena have the same basic constraint interaction. The constraints SECARTIC for nonmoraic vocoids and SYLL-SEG for homorganic glides are dominated by some constraint, such as ONSET or FILL, for example, which in turn is dominated by {A}=V. For a high vocoid, {A}=V is irrelevant so the constraint hierarchy is best-satisfied by a nonmoraic parse that violates SECARTIC or SYLL-SEG. For a nonhigh vocoid, an {A}=V violation means the candidate with the nonmoraic vocoid is less harmonic and so the constraint hierarchy is best-satisfied by some other candidate.

Languages with homorganic glides and secondary articulations arising from underlying hiatus differ crucially in the ranking of SYLL-SEG and SECARTIC. In languages with homorganic glides, SECARTIC must dominate SYLL-SEG thus rendering all nonmoraic parses less harmonic and, as shown in chapter 2, languages with secondary articulations in the same environment must have SYLL-SEG dominating SECARTIC. The complementarity of the rankings implies that homorganic glides and secondary articulations are incompatible in the same language. However, this is not true. Constraint interaction predicts that a language can have secondary articulations within morphemes, but homorganic glides at morpheme boundaries. This follows from the ranking of ALIGN with respect to SYLL-SEG and SECARTIC.

Assume a language L that has secondary articulations from underlying vowel sequences. This means that SECARTIC must be dominated by SYLL-SEG. As previously discussed, secondary articulations are de-aligning; therefore, ranking ALIGN above SYLL-SEG produces a difference within and between morphemes as shown in (24).

(24) a. Morpheme-internal:
ONSET, ALIGN » SYLL-SEG » SECARTIC, /diar/

Candidate	ONSET	ALIGN	SYLL-SEG	SECARTIC
di.ar.	*!			
+ d^yar.				*
di.yar.			*!	

b. Morpheme juncture:
ONSET, ALIGN » SYLL-SEG » SECARTIC, /di+ ar/

Candidate	ONSET	ALIGN	SYLL-SEG	SECARTIC
di|].ar.	*!			
d^y|ar]		*!		*
+ di|].yar.			*	

In the morpheme-internal case, (24a), the candidate with the SECARTIC violation is preferred, but at a morpheme boundary, (24b), the ALIGN violation makes the candidate with the SECARTIC violation less harmonic than the candidate with the SYLL-SEG violation. Hence, a language can have both homorganic glides and secondary articulations from underlying vowel sequences.

Interestingly, constraint interaction predicts that the reverse is not true: if a language has secondary articulations at boundaries it cannot have homorganic glides morpheme internally. The reasoning is as follows. For a language to have secondary articulations between a stem and a suffix, SYLL-SEG must dominate SECARTIC since homorganic glides are less harmonic. ALIGN must be dominated by SYLL-SEG as well since a secondary articulation at a boundary violates both ALIGN and SECARTIC. This is shown in (25).

(25) ONSET, SYLL-SEG » ALIGN, SECARTIC, /di+ ar/

Candidate	ONSET	SYLL-SEG	ALIGN	SECARTIC
di|].ar	*!			
+ d^y|ar]			*	*
di|].yar		*!		

Since ALIGN is irrelevant morpheme-internally, the ranking in (25) will produce nonmoraic vocoids in both environments.

(26) ONSET, SYLL-SEG » ALIGN, SECARTIC, /diar/

Candidate	ONSET	SYLL-SEG	ALIGN	SECARTIC
di.ar	*!			
+ d^yar				*
di.yar		*!		

Therefore, a language with secondary articulations at morpheme boundaries must have secondary articulations morpheme internally. This is the case in Ilokano, e.g. [p^{y}ek], [bagg^{y}en] (</bagi+ en]). The full extent of the effect of morphology on the distribution of nonmoraic vocoids is not known, but the role of ALIGN makes some interesting predictions.

4.2.1 Other Examples of Homorganic Glide Distribution

Malay exhibits what can be called the unmarked pattern of homorganic glide distribution, that is, high vowels are followed by homorganic glides, but low vowels are not. The relevant constraint is {A}=V which is violated when a low vowel violates SYLL-SEG. The distribution of homorganic glides, therefore, is similar to the distribution of other nonmoraic high vocoids. Homorganic glides also seem to be subject to the same typological variations as other nonmoraic vocoids. For example, the glide counterpart of a mid vowel is high and languages with glides following mid vowels must also have glides following high vowels. This is the same pattern found with nonmoraic counterparts of mid vowels.

In this section the typology of homorganic glide distribution is shown to follow from different rankings of the same constraints. In brief, the typology of glide distribution resembles the typology of nonmoraic vocoid distribution because all vocoid distribution relies on {A}=V which is the only constraint that can distinguish vowel quality. The constraint rankings required for glide counterparts of mid vowels is established based on Dutch. The section ends with an analysis of West Greenlandic Eskimo which has a more restricted distribution of glides.

The discussion of Dutch begins by first looking at the rankings required for syllabifying vowel sequences in which the first vowel is /a, i, u/. As shown in (27), high vowels are followed by glides, but the low vowel is not (Zonneveld 1978, Booij 1993).

(27)	/hindu + ism&/	[hinduwism&]	‘hinduism’
	/dri+ &/	[drij&]	‘three’
	/kni + &/	[knij&]	‘knee’
	/al.g&.bra:+ is/	[al.g&.bra:.is]	‘algebraic’
	/pro.za:+ is/	[pro.za:.is]	‘prosaic’

Dutch differs from Malay in that the low vowel is followed by hiatus. The constraint ranking for Dutch, therefore, is similar to Malay except that ONSET violations are preferred to FILL violations. The two crucial rankings are ONSET must dominate SYLL-SEG to account for homorganic glides and {A}=V must dominate ONSET to account for hiatus. FILL must dominate ONSET and SYLL-SEG since epenthesis is never harmonic.

(28) a. ONSET » SYLL-SEG, /dri+ &/

Candidate	ONSET	SYLL-SEG
dri.&	*!	
+ dri.y&		*

b. FILL » SYLL-SEG, /dri+ &/

Candidate	FILL	SYLL-SEG
dri.Δ&	*!	
+ dri.y&		*

c. {A}=V » ONSET, /proza:+ is/

Candidate	{A}=V	ONSET
+ pro.za:.is.		*
pro.za:.a^is.	*!	

d. FILL » ONSET, /proza:+ is/

Candidate	FILL	ONSET
pro.za:.Δis.	*!	
+ pro.za:.is.		*

The combined ranking ensures that a SYLL-SEG violation with a low vowel compels a violation of the higher ranking {A}=V; hence the candidate with the ONSET violation is preferred.

(29) a. FILL, {A}=V » ONSET » SYLL-SEG, /dri+ &/

Candidate	FILL	{A}=V	ONSET	SYLL-SEG
dri.Δ&.	*!			
dri.&.			*!	
+ driy&.				*

b. FILL, {A}=V » ONSET » SYLL-SEG, /proza+ is/

Candidate	FILL	{A}=V	ONSET	SYLL-SEG
pro.za.Δis.	*!			
+ pro.za.is.			*	
pro.za.a^is		*!		*

Mid vowels in Dutch, as mentioned, are followed by high glides.

(30) [re:y&] 'roe'
[ze:y&] 'sea'
[egowism&] 'egoism'
[exo:w&] 'to echo'

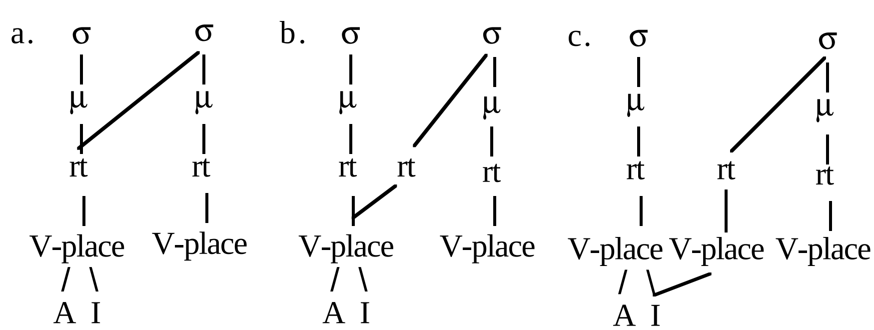
As in the case of mid vowels alternating with high nonmoraic counterparts discussed in chapter 2, the high glides in (30) are the result of parsing only the {I} or {U} particle of the mid vowel in the onset. This in fact follows from the constraint ranking in (29) since the high ranking {A}=V forces the {A} particle to remain outside the onset. The parse of the {I} or {U} particle ensures the satisfaction of ONSET.

(31) {{A}=V, FILL} » ONSET » SYLL-SEG, /re +&/

Candidate	{A}=V	FILL	ONSET	SYLL-SEG
re.e?&.	*!			*
re.&.			*!	
re.Δ&.		*!		
+ re.y&.				

The glide in (31) does not violate SYLL-SEG because, as shown in (32c), only the particle {I} is multiply-linked. This representation must be preferred because a multiply-linked root node, (32a), violates SYLL-SEG and {A}=V and a multiply-linked place node, (32b), also violates {A}=V.

(32) [ee?V] [ee?V] [eyV]



The representations in (32) differ with respect to the amount of structure associated with the onset position. (32a) has the least amount since all of the onset's nodes come from the preceding vowel. (32c) has the most structure since the onset has its own place and root nodes and in (32b) the onset has only its own root node. The more enriched structure given to the onset in (32c) is dictated by satisfaction of {A}=V.

Given that (32c) is most harmonic for mid vowels in Dutch, the homorganic glides following high vowels conceivably have the same representation rather than (32a) or (32b). However, (32b &c), when compared to (32a), have unnecessary structure to accomplish the same end, which is to link the {I} or {U} particle to the onset. (32b& c), therefore, are less harmonic than (32a) since the former violate McCarthy and Prince's (1993a) *STRUC which minimizes structure. *STRUC is relevant when all else is equal, so the glides following high vowels have the representation in (32a). In the case of mid vowels all else is not equal because the simpler structure compels a {A}=V violation. This is demonstrated with a comparison of high and mid vowels in (33).

(33) a. {A}=V » ONSET » SYLL-SEG, *STRUC, /re +&/

Candidate	{A}=V	ONSET	SYLL-SEG	*STRUC
(32a) re.e? &.	*!		*	
re.&.		*!		
(32c) + re.y&.				*

b. {A}=V » ONSET » SYLL-SEG, *STRUC, /dri +&/

Candidate	{A}=V	ONSET	SYLL-SEG	*STRUC
(32a)+ dri.y&.			*	
dri.&.		*!		
(32c) dri.y&.			*	*!

The similarity between glide counterparts of mid vowels and nonmoraic counterparts of mid vowels discussed in chapter 2 can now be accounted for. It is shown in chapter 2 that no constraint ranking allows a language to have only mid vowels alternating with high nonmoraic vocoids. The reason for this, given in chapter 2, is that nonmoraic vocoids require a SECARTIC violation and there is no way to limit SECARTIC violations to mid vowels. The only way to distinguish vowel quality is with {A}=V and this constraint is always satisfied by a high vocoid. Glide counterparts of mid vowels exhibit the same distribution, but for slightly different reasons. The relevant constraint that allows for epenthetic glides is SYLL-SEG, which does not interact with {A}=V since the high glide counterparts of mid vowels do not violate SYLL-SEG. Now consider a language where mid vowels are followed by glides, but high vowels are not. In such a language, SYLL-SEG must dominate ONSET or FILL. This accounts for the absence of homorganic glides.

(34) SYLL-SEG » ONSET, /i+ a/

Candidate	SYLL-SEG	ONSET

+	i.a		*
	i.ya	*!	

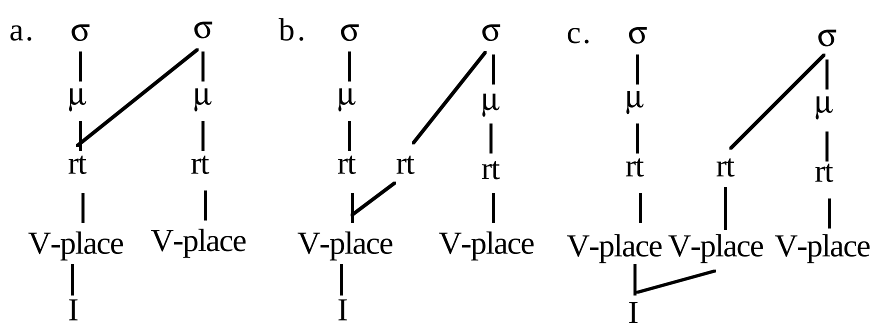
Allowing mid vowels to have high glide counterparts requires a *STRUC violation, which would be dominated by ONSET.

(35) SYLL-SEG » ONSET » *STRUC, /e+ a/

Candidate		SYLL-SEG	ONSET	*STRUC
(32a)	e.e^a	*!		
	e.a		*!	
(32c) +	e.ya			*

The ranking of *STRUC in (35), however, cannot prohibit high vowels in this language from having homorganic glides. Consider the candidate syllabifications in (36) where the onset has increasing amounts of its own structure.

(36) [iyV] [iyV] [iyV]



(36a), where there is minimal structure, violates SYLL-SEG, but (36b &c) satisfy SYLL-SEG at the expense of *STRUC. Therefore, the high vowel can have a homorganic glide. The only difference is that the onset has its own root and place nodes.

(37) SYLL-SEG » ONSET » *STRUC, /i+ a/

Candidate		SYLL-SEG	ONSET	*STRUC
(36a)	i.ya	*!		
	i.a		*!	
(36c) +	i.ya			*

To get high vowels to surface in hiatus entails a ranking paradox because ONSET must dominate *STRUC and vice versa. Therefore, any language with glides following mid vowels has homorganic glides after high vowels.

*STRUC is also relevant in the account of glides following front round vowels in Dutch. Zonneveld (1978) notes a rather curious fact that the glide counterpart of the vowel [ü] is [w] and the counterpart of [&] is [y].

(38)	a.	rüwin&	‘ruin’
		paraplüw&	‘umbrella’
	b.	smöy&	‘juicy’
		röy&	‘dog’

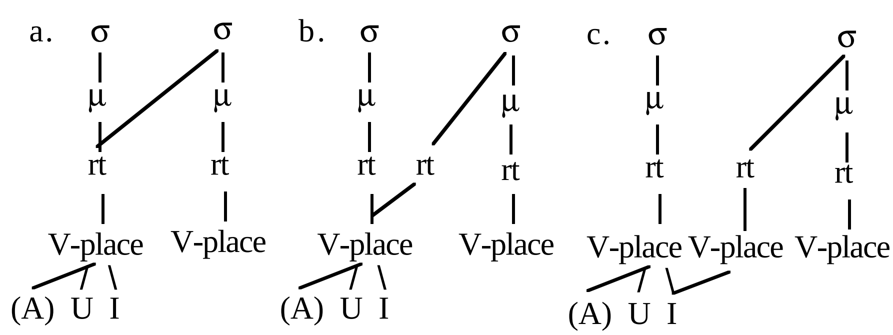
Part of the explanation for this curious behaviour lies in the feature representation of these vowels.

(39)	vowel	glide counterpart
	ü = {I, U}	w = {U}
	ö = {I, A, U}	y = {I}

The fact that [&] corresponds with a high glide is not surprising because {A} cannot be parsed nonmoraically. However, if {A}=V were the only constraint involved here, [ü] and [&] should neutralize and surface as [w/] since {I} and {U} can be nonmoraic.

The absence of [w/] in Dutch can be related to its markedness. The constraint that prohibits [w/] ensures that a linked root node structure, like (40a), or a linked place node structure, like (40b), for [&] or [ü] is less harmonic since both linkings parse both the combination {I, U}.

(40) [üü?V] or [ëë?V]   [üü?V] or [ëë?V]   [üyV] or [ëyV]



The only possible ambisyllabic linking is (40c) where a single feature is linked. The feature that happens to be linked is {I} for [&] and {U} for [ü]. The choice of features appears to be arbitrary.[2] The constraint interaction is shown in (34), where the constraint prohibiting [w/] is called {ü}=V.

(41) {ü}=V, {A}=V » ONSET » SYLL-SEG, *STRUC, /rö+ &/

Candidate	{ü}=V	{A}=V	ONSET	SYLL-SEG	*STRUC
rö.&.			*!		
(40a) rö.ö^&.	*!	*		*	
(40c) + röy&.					*
(40b) rö.ö^&.	*!	*			*

Since the three representations in (36) are produced by GEN, these representations are evaluated for constraint satisfaction in every language. *STRUC ensures the simplest structure, (36a), is most harmonic. However, the more complex structure given to the onset is compelled by satisfying higher ranking constraints, namely {ü}=V and {A}=V. Therefore, glides homorganic to high vowels have the representation in (36a), but the glide following mid vowels (and front round vowels in Dutch) have the representations in (32c) and (40c). In a language like French that has [w/], e.g.[glüw/ã] 'sticky', SYLL-SEG dominates {ü}=V. This allows (40a &b) as possible representations and *STRUC dictates that (40a) is preferred.

Glide epenthesis has a more restrictive distribution in West Greenlandic Eskimo (Rischel 1974, Darden 1982, Murasugi 1991). High vowels are accompanied by homorganic glides only when followed by a nonidentical vowel, but similar vowels surface as long vowels. Before turning to the case of long high vowels, consider the environment in which homorganic glides appear.

(42)	a.	/ulu+ a /	[uluwa]	'his house'
		/ajuqi+ uvaq/	[ajuqiyuvaq]	
	b.	/pi+ araq/	[piyaraq]	'young of animal'
		/taku+ i+uk/	[takuwiyuuk]	'did you see him'
	c.	/nuna+a/	[nunaa]	

The constraint ranking that accounts for the glides and long vowels in (42) is similar to the rankings seen before. ONSET must dominate SYLL-SEG which must dominate V-MORA to account for the difference between homorganic glides and glides as onsets. The low vowel in (42c) is not followed by an epenthetic consonant or hiatus as seen in Dutch and Malay, but rather two low vowels form a long vowel. This means that ONSET and FILL must dominate NLV. All the rankings required for the syllabification of vowel sequences in (42) are shown in (43).

---

[2] Zonneveld notes that the nonsyllabic counterpart of [ü] varies between [y] and [w], particularly when [ü] is stressed.

(43) a. FILL » SYLL-SEG , /ulu +a/

Candidate	FILL	SYLL-SEG
+ ulu.wa		*
ulu.Δa	*!	

b. ONSET » SYLL-SEG, /ulu +a/

Candidate	ONSET	SYLL-SEG
ulu.a	*!	
+ ulu.wa		*

c. FILL » NLV, /nuna+ a/

Candidate	FILL	NLV
nuna.Δa	*!	
+ nunaa		*

d. ONSET » NLV, /nuna+ a/

Candidate	ONSET	NLV
+ nunaa		*
nuna.a	*!	

The long low vowel surfaces as a result of the now familiar interaction between {A}=V and SYLL-SEG where a violation of the latter compels a violation of the former.

(44) {A}=V, ONSET » NLV, SYLL-SEG, /nuna+ a/

Candidate	{A}=V	ONSET	NLV	SYLL-SEG
nu.na.a?a	*!			*
+ nu.naa.			*	
nu.na.a		*!		

Furthermore, low vowels form long vowels when followed by any vowel, not only when followed by another low vowel.

(45) a. /sava+ innaq/ [savaannaq]
b. /una+ uvaq/ [nunaavaq]

The long vowels in (45) satisfy FILL, ONSET, and NODIPH, which are undominated.[3] These long monophthongs show that NODIPH dominates NLV and PARSE.

[3]Rischel notes that there are some word-final diphthongs. These can be accounted for by ranking ALIGN-R(Prwd, σ) above NODIPH.

(46) NODIPH » NLV, PARSE, /nuna+ uvaq/

Candidate	NODIPH	NLV	PARSE
nu.nau.vaq.	*!		
+ nu.na:<u>.vaq.		*	*

High vowels, of course, are followed by homorganic glides rather than forming long vowels; therefore, NLV must dominate SYLL-SEG.

(47) NLV, PARSE » SYLL-SEG, /ulu +a/

Candidate	NLV	PARSE	SYLL-SEG
+ u.lu.wa.			*
u.lu:<a>.	*!	*	

So far, West Greenlandic Eskimo has the same distribution of homorganic glides found elsewhere. The only difference is in the behaviour of low vowels which surface as long vowels. This follows from NLV violations compelled by the satisfaction of ONSET, FILL, and NODIPH. The constraint ranking developed so far accounts for the different surface forms of /a+i/ sequences and /i+a/ sequences.

(48) a. NODIPH, ONSET, {A}=V » NLV » SYLL-SEG, /ulu +a/

Candidate	NODIPH	ONSET	{A}=V	NLV	SYLL-SEG
u.lua.	*!				
u.lu.a.		*!			
+ u.lu.wa.					*
u.lu:<a>.				*!	

b. NODIPH, ONSET, {A}=V » NLV » SYLL-SEG, /nuna+ uvaq/

Candidate	NODIPH	ONSET	{A}=V	NLV	SYLL-SEG
..na.iv..		*!			
..nai.va..	*!				
..na.a?i.va..			*!		*
+ ..na:<i>.v..				*	

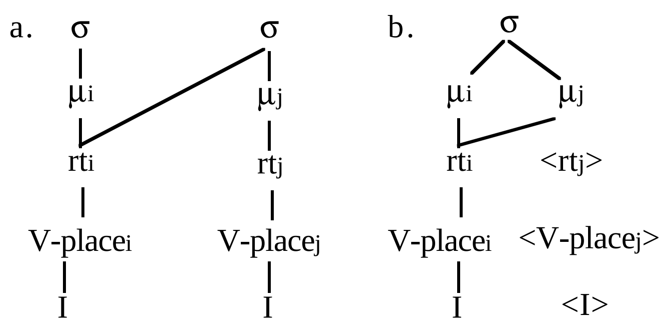
The asymmetry between sequences with an initial low vowel and an initial high vowel, as seen in other languages, is due to {A}=V which is not relevant for high vowels. Hence, the candidate with the SYLL-SEG violation in (48a) is preferred and the NLV violation is fatal. For the initial low vowel in (48b), the candidate with the NLV violation is preferred.

The examples in (49) show that there is a gap in the distribution of homorganic high glides. A high vowel followed by an identical high vowel is parsed as a long vowel.

(49) /tali+i/ [tali:] 'their arms'
/u+u/ [u:] (reported, no data given)

The generalization here is that the glide cannot be homorganic to both vowels. The crucial candidate syllabifications involved are shown in (50). In (50a), there is a homorganic glide in violation of SYLL-SEG and in (50b) there is a long vowel in violation of NLV.

(50) [iyi] [i:]



Since NLV dominates SYLL-SEG, (50a) should be preferred. However, (50a) also violates McCarthy's (1986) OCP because there are adjacent identical vowels. The OCP is satisfied in(50b) where there is a long vowel. Therefore, the OCP dominates NLV.

(51) OCP » NLV, /tali+ i/

Candidate	OCP	NLV
(50a) taliyi	*!	
(50b) + tali:<i>		*

The OCP must dominate PARSE as well since the latter is not ranked with respect to NLV and the OCP also dominates SYLL-SEG since SYLL-SEG is dominated by NLV. The OCP and SYLL-SEG exhibit the same interaction as {A}=V and SYLL-SEG. When both vowels are identical, a SYLL-SEG violation compels an OCP violation. This is shown in (52).

(52) OCP » NLV » SYLL-SEG, /tali+i/

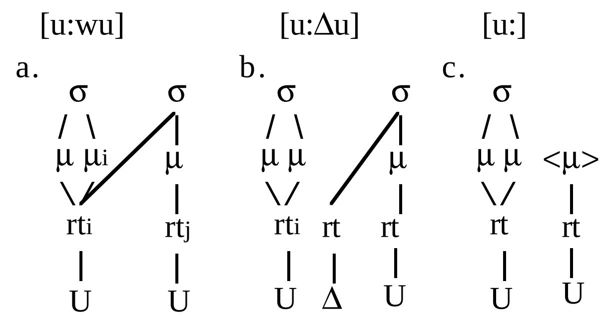
Candidate	OCP	NLV	SYLL-SEG
(50b) + tali:<i>		*	*
(50a) taliyi	*!		*

Underlying sequences of long vowels followed by a short vowel show a more complex distribution of homorganic glides. In particular, a short vowel followed by an identical long vowel shows some variation for the type of epenthetic glide.

(53)	a.	/qii+ iarppa/	[qiiwiarppa]	‘he removes his white hair’
		/puu+ uciga/	[puuyuciga]	‘my bag’
	b.	/puwijurppa + aasiit/	[puwijurppayaasiit]	‘that's the old story’
		/qallunaa+ uwuq/	[qallunaawuwuq]	
		/naa+ i/	[naawi]	‘his stomach’

In (53a), the epenthetic glide is dissimilar to the preceding vowel and when the vowel is /aa/, as in (53b), there are two possibilities: 1. an epenthetic labiovelar glide and 2. an epenthetic palatal glide. The sequences of similar vowels in (53a) do not become long monophthongs as they do when both vowels are short. As Murasugi (1991) notes, the relevant constraint here must ensure the number of surface moras in (53) is equal to the number of underlying moras and that the bimoraic maximum is satisfied. Parsing a long monophthong from the vowel sequences in (53a), therefore, would require a violation of PARSE-μ. The interaction of PARSE-μ and the other constraints is evident in the candidate syllabifications in (54). In (54a), SYLL-SEG and the OCP are violated, FILL is violated in (54b), and PARSE-μ is violated in (54c).

(54)



The correct surface form for (53) is (54b) where there is a FILL violation because the epenthetic glide is not homorganic to the preceding vowel.[4] The FILL violation, however, is only optimal under duress to satisfy PARSE-μ and the OCP. As already established, FILL dominates NLV and (54) shows that the OCP and PARSE-μ must dominate FILL.

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[4]A minor problem emerges here due to the definition of FILL. The features for FILL violations are default features provided by the interpretative component (Prince and Smolensky 1993). This static view of the default features is inapplicable in West Greenlandic since the features are conditioned by the OCP. Therefore, the OCP must be relevant in the default component.

(55) a. PARSE-μ» FILL, /u:+ u/

Candidate		PARSE-μ	FILL
(54c)	u: <:>	*!	
(54b)	+ u:.Δu		*

b. OCP » FILL, /ii + i/

Candidate		OCP	FILL
(54a)	u:.wu	*!	
(54b)	+ u:.Δu		*

The combination of (52) and (55) chooses the FILL violation as the preferred candidate from (54).

(56) OCP, PARSE-μ » FILL » NLV » SYLL-SEG, /u:+u/

Candidate		OCP	PARSE-μ	FILL	NLV	SYLL-SEG
(54a)	u:.wu.	*!			*	*
(54c)	u: <:>		*!		*	
(54b)	+ u:.Δu			*	*	

The /aa+ a/ sequences in (53b) appear to show that there is free variation for glide epenthesis. This would mean that either glide can be used when FILL is violated, regardless of the OCP. However, Rischel (1974) notes that there are two ways to predict which glide is used in hiatus. First, when the suffix is derivational or inflectional, the labiovelar glide is used and the palatal glide is used when the suffix is a clitic. The choice of glide, therefore, is clearly related to morphological domain. Second, some roots historically contain a diphthong and the glide in hiatus corresponds to the high component of the diphthong. For example, /aaq/ 'sleeve' becomes [aaya]. The intervocalic palatal glide can be accounted for if the synchronic underlying representation is the reconstructed form *aiq. The only conclusion that can be drawn from (53b) is that the choice of glide is subject to morphological domain and historical residue. Most importantly, there is no free variation and the only restriction of the epenthetic vowel is conformity to the OCP.

In summary, the distribution of homorganic glides in West Greenlandic Eskimo is similar to distributions found in other languages. The distribution is affected by the role of the OCP which compels long vowels when the vowels in hiatus are identical. The complete constraint ranking established for West Greenlandic Eskimo is given in (57).

(57) ONSET, NODIPH, OCP, {A}=V, PARSE-μ »
FILL » NLV, PARSE » SYLL-SEG

The surface forms of different underlying vowel sequences are shown in (58).

(58) a. ONSET, {A}=V » NLV » SYLL-SEG, /ulu+ a/

Candidate	Onset	{A}=V	NLV	SYLL-SEG
u.lu.a.	*!			
+ u.lu.wa.				*
u.lu:<a>.			*!	

b. ONSET, {A}=V » NLV » SYLL-SEG, /nuna+ a/

Candidate	Onset	{A}=V	NLV	SYLL-SEG
nu.na.a.	*!			
nu.na.a?a		*!		*
+ nuna:<a>			*	

c. OCP » FILL » NLV » SYLL-SEG, /…u+ u…/

Candidate	OCP	FILL	NLV	SYLL-SEG
…u.wu…	*!			*
+ …u:…			*	
…u.Δu…		*!		

d. OCP, PARSE-μ » FILL » NLV » SYLL-SEG, /…u:+ u…/

Candidate	OCP	PARSE-μ	FILL	NLV	SYLL-SEG
…u:.wu…	*!				*
…u:<:><u>…		*!		*	
+ …u:.Δu…			*		

The homorganic glides in (58a) are a consequence of the SYLL-SEG violation, but the SYLL-SEG violations in (58b, c &d) involve a violation of a higher ranking constraint. Hence, the surface forms in these cases contain a long vowel or an epenthetic consonant.

Some of the constraints in the analysis proposed here are used quite differently by Murasugi (1991) who accounts for the surface form of underlying hiatus using an economy based approach (cf. Chomsky 1991). This approach uses the constraints ONSET, OCP, NODIPH, BIMAX among others. Derivations involve processes such as linking, delinking, and inserting. Glide Formation is the result of the most economical linking which is the one that links the root node of the vowel to the following syllable node. All other derivations either increase the number of constraint violations or the length of the derivation. According to Murasugi, the only time a longer derivation is preferred is when all shorter derivations increase the number of constraint violations.

Murasugi’s economy-based model requires all constraints to be satisfied and to minimize the number of steps in the derivation. This differs significantly from the Optimality Theoretic approach adopted here. Since candidate outputs are compared for constraint satisfaction, the number of steps in the derivation is irrelevant. Furthermore, Murasugi’s proposal is similar to other repair strategy proposals in which all constraints are satisfied at some level of representation. To do this necessitates violating constraints so that it can be satisfied later. For epenthetic glides, the violated constraint is ONSET and the repair is to spread to form an onset. In the Optimality Theoretic approach the conflict between ONSET and SYLL-SEG directly captures the relation between the constraints.

4.3 Consonantal Glides

As mentioned in the introduction to this chapter, the analyses of vocoid distribution so far have not required an underlying vowel/glide contrast. This is not to say that such a contrast cannot exist; in fact, it is shown in this section that an underlying contrast is the only way to account for some aspects of high vocoid distribution in some languages.

The difference between underlying vowels and glides is in their specification for the feature [consonantal] (Hyman 1985, Waksler 1990), where glides are [+consonantal] and vowels are [-consonantal]. Given the C-Place/V-Place distinction in Clements and Hume's (1993) feature-geometry, it is worthwhile asking whether or not consonantal glides must have C-Place features. This question, as interesting as it is, is not germane to the present discussion. Nevertheless, glides exhibit certain behaviours that indicate that they have a V-Place node. It is assumed, therefore, that consonantal glides have a [+cons] root node dominating a V-Place node. The contrast between vowels and glides is shown in (59).

(59)	high vowel: /i/	glide: /y/
	[-cons]	[+cons]
	|	|
	V-Place	V-Place
	|	|
	I	I

The contrasting specification in (59) entails different behaviour with respect to constraint satisfaction. Most important is that a consonantal glide, being [+cons], does not interact with V-MORA so it should behave like other consonants.

In this section, a number of phenomena are discussed that show that an underlying vowel/glide contrast is necessary. First, postvocalic glides in Ilokano show a contrast with respect to syllabification that can only be accounted for by the presence of underlying glides. Second, Ponapean has a number of homophonous words ending with a high vocoid that show different patterns in reduplication. Some high vocoids pattern like consonants and others pattern like vowels. Lastly, the distribution of high vocoids in Berber is shown, following Guerrsel (1986), to not only require an underlying vowel/glide contrast, but also the underlying glides alternate with surface vowels.

4.3.1 Ilokano Diphthongs

In chapter 2, the distribution of prevocalic vocoids in Ilokano is discussed at length, but there is no mention of the distribution of postvocalic vocoids. Recall that prevocalic vocoids surface as secondary articulations as a consequence of satisfying ONSET, FILL and NODIPH. High vocoids are specified as [-cons] since this specification is necessary to account for the distribution of geminates and secondary articulations, e.g. [bagg^{y}en] (< /bagi +en/). The geminate occurs because the mora coindexed with the high vocoid is parsed by being linked to the stop. The high vocoid must be [-cons] because V-MORA must be satisfied for there to be a mora in the representation.

Although prevocalic high vocoids surface as their nonmoraic counterparts, Hayes and Abad (1989) note that postvocalic vocoids behave differently with respect to glottal stop distribution in the same morphological domain. This is shown in (60). In (60a) postvocalic high vocoids are separated from the preceding vowel by a glottal stop, whereas the postvocalic vocoids in (60b) are parsed tautosyllabically as part of a diphthong.

(60)

a.	la?ilo	'affectionate'	b.	kay-kaysa	'to unite'
	baba?i	'woman, girl'		baybay	'ocean beach'
	da?ulo	'leader'		lawlaw	'around'
	ta?o	'person'		?aldaw	'day'

The distribution of glottal stop cannot be accounted for with a single constraint ranking and [-cons] vocoids. To see why first recall that in section 2.6.2 it is shown that a high or mid vowel in a sequence surfaces as a secondary articulation because ONSET crucially dominates SECARTIC. Low vowels do not surface as secondary articulations because the SECARTIC violation compels a violation of the higher ranked {A}=V. The preferred candidate, in this case, violates FILL, e.g.[basa?en] (</basa+ en/) . (60a) is accounted for by the same ranking. These rankings, established in section 2.6.2., are shown below.

(61) a. {ONSET, {A}=V} » FILL » SECARTIC, /lailo/

Candidate	ONSET	{A}=V	FILL	SECARTIC
la.i.lo.	*!			
+ la.Δi.lo.			*	
l^{a}i.lo.		*!		*

b. NODIPH » FILL, /lailo/

Candidate	NODIPH	FILL
lai.lo.	*!	
+ la.Δi.lo.		*

The vocoid sequences in (60b) are problematic because there is no way they can be accounted for by the ranking in (61). The problem centers around the ranking of NODIPH because there is no ranking of NoDiph that can account for (60a) and (60b) without entailing a ranking paradox. NoDiph must dominate Fill to account for (60a) and Fill must dominate NoDiph to account for (60b). According to Hayes and Abad, the distribution of glottal stop in (60) can be accounted for by proposing that the vocoids in (60b) are not [-cons] vocoids, but rather they are [+cons] glides. The effect of this is that the vocoid sequences in (60b) do not violate NoDiph because NoDiph constrains contiguous [-cons] sequences. Since the high vocoids in (60b) are [+cons], these words contain closed syllables, which are common in Ilokano. Furthermore, there is no Onset violation when the glide is [+cons]. With the satisfaction of Onset and NoDiph by faithfully parsing the forms in (60b), Fill violations are never optimal. As is the case with any other postvocalic consonant, (60b) requires Fill to dominate NoCoda.

(62) Fill » NoCoda, /lawlaw/

Candidate	Fill	NoCoda
la.wΔ.la.w.	*!	
+ law.law.		*

Having established that the glides in (60b) are [+cons], the question now turns to some properties of [+cons] glides. The important difference between an underlying high vowel and an underlying glide is that only the former can satisfy V-Mora. The Fill violation in (60a) is compelled by the fact that both vowels must be moraic and syllables have onsets. Although underlying glides do not interact with V-Mora, they can be moraic like other consonants through Weight-by-Position. This means that the prosodic representation of a diphthong with a [-cons] high vocoid and a [+cons] high vocoid are identical.

(63)

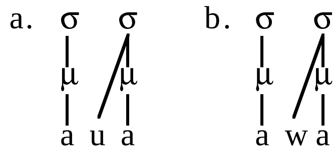
```
      a.   σ                    b.   σ
          / \                       / \
          μ  μ                      μ  μ
          |  |                      |  |
          a  u                      a  w
     [-cons] [-cons]          [-cons] [+cons]
```

(63b) may considered a pseudo-diphthong because it really is a closed syllable. Ilokano has (63b) through NoCoda violations, but it does not have (63a) because it violates the undominated NoDiph.

The identical prosodic and articulatory surface properties of underlying vowels and glides entails that there should be neutralization of the underlying contrast. For example, Hayes and Abad note that the vowel/glide contrast is only discernible postvocalically. This can be shown to follow from constraint interaction which neutralizes the contrast in other environments. Consider the intervocalic position. A sequence /…VGV…/ (where G= [+cons] high vocoid) is faithfully parsed as […V.GV…]. The glide is simply a consonant in the onset. A sequence like /…VHV…/ (where H= [-cons] high vocoid) is parsed as

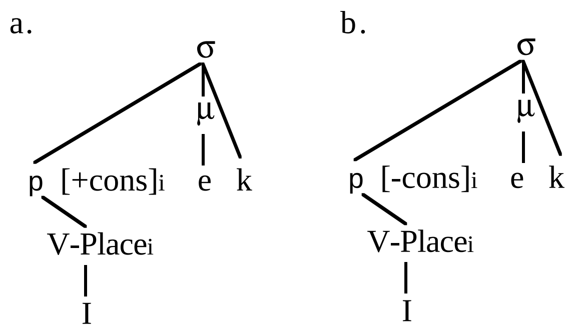
[…V.HV…] with a nonmoraic high vocoid in the onset. Provided that SYLL-SEG dominates V-MORA, the surface representations are identical as shown in (64).

(64)



Neutralization in the prevocalic position is complex but might be accounted for as follows. An underlying form like /piek/ 'chick' surfaces as [p^{y}ek]. If the high vocoid in the underlying form is [-cons], the surface form is the result of a SECARTIC violation. Similarly, a [+cons] glide can also surface as a secondary articulation and, in fact, it must to satisfy No Complex Onset. The only difference is that the unparsed root node is [+cons] rather than [-cons], as shown in (65).

(65) [p^{y}ek] [p^{i}ek]



There is a difference between word-initial and word-medial secondary articulated consonants in Ilokano. The representations in (65) neutralize word-initially because there is no accompanying geminate. The representations in (65), however, should contrast word-internally because a representation like (65a) should be accompanied by a geminate as discussed in chapter 2. This is due to satisfaction of V-MORA, which can only happen with [-cons] vocoids. The [+cons] root node in (65) predicts that there cannot be a geminate. As mentioned in chapter 2, Hayes and Abad note that Ilokano has free variation, e.g. [lutt^{w}en], [lutwen] (</luto+ en/). In chapter 2, the source of the variation was considered to be an indeterminacy in the ranking which leads to the high vocoid being parsed as a secondary articulation or as an onset. If it is parsed as an onset, V-MORA is violated so there is no geminate. Another possibility is that the variation is a result of an indeterminacy in the interpretation of the high vocoids. A [-cons] high vocoid is accompanied by a geminate, but [+cons] high vocoid is not. The variability of geminates in Ilokano, as Hayes and Abad note, is complicated since frequency of geminates increases as sonority decreases. Indeterminacies in the ranking and the specification of the high vocoid might only be part of the story.

Constraint interaction predicts that the underlying vowel/glide contrast does not neutralize given the appropriate constraint ranking. This is the case in Usarufa (spoken in New Guinea) where intervocalic high vocoids contrast (Bee and Glasgow 1977). Consonantal glides surface as onsets and [-cons] high vocoids surface as vowels.

(66)	a.	a.we.	'wait'	
		wi.yi.ye.	'it is boiling'	
	b.	a.u.e.	'it is flesh'	*a.we
		u.i.ye	'he is coming up'	*wi.ye

Since neutralization in Ilokano arises from vowels alternating with their nonmoraic counterparts, the absence of neutralization in Usarufa follows from the fact that high vowels must be moraic. In other words, V-MORA in Usarufa is undominated and it crucially dominates ONSET as shown in (67). The surface forms in (66a) are simply faithful parses of the underlying forms.

(67) a. V-MORA » ONSET, /aue/

Candidate	V-MORA	ONSET
a.we.	*!	
+ a.u.e.		*

Prevocalically, glides cannot appear because there are no consonant clusters in Usarufa. [-cons] high vocoids, on the other hand, surface as vowels, e.g. [ti.o.ta:.ma.] 'shirt'. The fact that a [-cons] high vocoid must surface as a vowel follows from constraint interactions that ensure the moraic parse of the vocoid is most harmonic. A constraint that would compel a nonmoraic parse, such as SECARTIC, dominates ONSET since the surface form has hiatus.

4.3.2 Ponapean Reduplication

Nonmoraic vocoids in Ponapean (a Micronesian language) have basically the same distribution as nonmoraic vocoids found elsewhere, that is, high vowels occur between consonants and their nonmoraic counterparts occur pre- and postvocalically (Rehg and Sohl 1981).

(68)	a.	/uduk/	[uduk]	‘flesh’
		/ilok/	[ilok]	‘wave’
	b.	/aio/	[ayo]	‘yesterday’
		/lauad/	[lawad]	‘to untie’
	c.	/uaar/	[waar]	‘canoe’
		/iaak/	[yaak]	‘crazy’

The intervocalic and prevocalic glides can be analyzed as [-cons] vocoids that surface nonmoraically due to the ranking ONSET » SYLL-SEG » V-MORA.

There are some aspects of vocoid distribution that cannot be accounted for by [-cons] vocoids. Rehg and Sohl note that there are some homophonous words containing postvocalic high vocoids that behave differently with respect to reduplication. Ponapean reduplication is somewhat complex: the basic observation is that there is a complementarity of weight between the reduplicative prefix template and the root-initial syllable (McCarthy and Prince 1986, 1993c). The prefix template is a light syllable when the root-initial syllable is heavy, (69a), and the reduplicative template is heavy when the root-initial syllable is light, (69b).

(69)	a.	pa	paapa	‘to make a sound’
		du	duudu	‘to dive’
	b.	miik	mimiik	‘to suck’
	c.	lal	lallal	‘to make a sound’
		rer	rerrer	‘to tremble’

McCarthy and Prince propose that the complementarity of weight occurs as a result of placing the two syllables in the same foot. A light^heavy sequence and a heavy^light sequence can form a foot but a heavy^heavy sequence cannot.

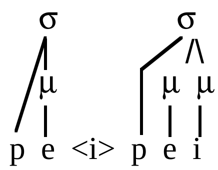
Words with a final high vocoid do not show consistent behaviour with respect to reduplication. Minimal pairs can be found for the two prefix templates. (70a) has the light prefix and (70b) has the heavy one.

(70)	a.	pei	pepei	‘to fight’
		leu	leleu	‘to be cooked’
	b.	pei	peipei	‘to float’
		lou	loulou	‘cooked’

The light prefix in (70a) indicates that the root is bimoraic. Therefore, the roots in (70a) must consists of two [-cons] segments which both satisfy V-MORA. The absence of the high vocoid in the reduplicated form shown in (71) follows from satisfying SONRISE, which prohibits a fall in sonority within a mora. SONRISE must dominate PARSE.[5]

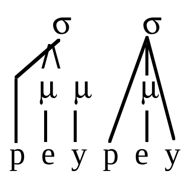
[5]The constraint interactions required for prefix template satisfaction are not discussed here (see McCarthy and Prince 1993a, b, c).

(71)



The fact that the words in (70b) have the heavy prefix implies that these roots must be light. This means that they are like the CVC roots in (69c), which must be light (according to McCarthy and Prince) because they have the heavy prefix. In other words, Weight-by-Position is not assigned word-finally (see Zec 1992, Lamontagne 1993). CVC roots, therefore, take the bimoraic template and the geminate in the surface form follows from template satisfaction. If the roots in (70b) are light, the word-final [-cons] high vocoid cannot satisfy V-MORA. However, this is irreconcilable with (70a) where the vocoids do satisfy V-MORA. Therefore, the word-final vocoids in (70b) must be underlyingly [+cons] glides and so the roots are monomoraic like other consonant-final roots. The heavy template prefix is filled by mapping the melody of the root and the result is a [-cons]^[+cons] bimoraic diphthong.

(72)



The distribution of high vocoids in Ponapean reduplication, therefore, requires an underlying vowel/glide contrast. As in Ilokano, this contrast only occurs postvocalically and it is neutralized in other environments. For example, the contrast between the bivocalic diphthongs in (70a) and the vocalic plus consonant diphthongs in (70b) is neutralized in words where the high vocoid is followed by a consonant.

(73)	laud	lalaud	*laulaud	‘big, old’
	reid	rereid	*reireid	‘to stain’
	pain	papain	*paipain	‘to incite’
	weid	weweid	*weiweid	‘to walk’

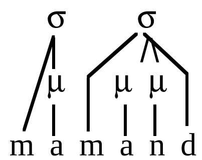
The high vocoids in (73) appear to be [-cons] because the prefix is light indicating that the root is bimoraic. However, CVCC words also have a light prefix.

(74) mand mamand ‘tame’

kens	kekens	‘to ulcerate’
lenk	lelenk	‘acrophobic’

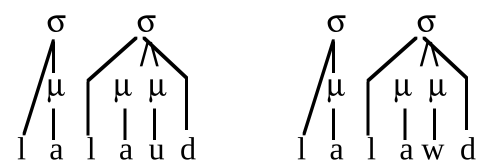
For (74) to have the light prefix, the roots in (74) must be heavy; hence the word-final clusters contribute weight and only word-final consonants are weightless. This distribution of weight postvocalically is part of Weight-by-Position (Hayes 1989, Zec 1992, Lamontagne 1993).

(75)



The assignment of weight in word-final consonant clusters neutralizes the contrast of diphthongs in (73) because a CVGC word is heavy regardless of the high vocoid’s specification for [consonantal]. If the high vocoid is [-cons], it satisfies V-MORA and if it is [+cons] it satisfies Weight-by-Position. As shown in (76), the prefix is light in either case.

(76) a. b.



Potential vowel/glide contrasts are also neutralized intervocalically for the same reasons discussed in the preceding section. The ranking SYLL-SEG above V-MORA produces the same output as a [+cons] glide, as shown in (64). Prevocalically there is a contrast similar to the one in Usarufa where [-cons] vocoids are moraic and [+cons] glides do not surface. Vowel sequences in Ponapean in which the first vowel is high are separated by a homorganic glide, e.g. [diyar] (</diar/) ‘to find’. This is a result of the ranking ONSET » SYLL-SEG » V-MORA plus the high ranking of SECARTIC. A [+cons] glide in this position does not compel a SYLL-SEG violation because there is no ONSET violation. On the other hand, the syllabification [d^yar] from a nonce root like /dyar/ is completely faithful. However, Ponapean does not have secondary articulations except for /m^w/ and /p^w/. The fact that prevocalic high glides do not surface can be accounted for by properly ranking SECARTIC and NCO above PARSE-PL.

Although phonemic glides in Ponapean pattern with consonants with respect to reduplication, the glides do not pattern as consonants in phonotactic restrictions. This is evident from the alternations listed by Rehg and Sohl that occur when dissimilar consonants are adjacent as a result of reduplication.

(77)	a.	lal	lallal	to make a sound
		rer	rerrer	to tremble
	b.	pap	pampap	to swim
		dod	dondod	frequent
	c.	ped	pediped	to be squeezed
		ker	kereker	to flow

Identical sonorants surface as a geminate and consonants that agree in place of articulation surface as a nasal-stop cluster. The nonhomorganic sequences in (77c) surface with an epenthetic vowel. Underlying glides should be like (77c), e.g., /pey/ should be *[peyepey] rather than [peypey]. The glides are [+cons, +son] like /r/ so the major class features do not seem to make the relevant distinction. One possibility is that the underlying glides are [+cons] but the place features are under the V-Place node. The phonotactics in (77), therefore, refer to only C-Place nodes and exclude the glides.

In summary, there are some cases where the distribution of high vocoids necessitates a contrast between vowels and glides. Following Hyman (1985), this distinction is based on different specifications for [consonantal]. [-cons] vocoids interact with V-MORA, but [+cons] vocoids pattern with consonants. This difference in specification accounts for the behaviour of postvocalic high vocoids in Ilokano and Ponapean. This underlying distinction, however, is neutralized in environments where the [-cons] vocoid can surface as its nonmoraic counterpart due to constraint interaction.

4.4 Glide Vocalization

A moraic [+cons] vocoid, as has been noted, is indistinguishable from a high vowel, that is, a moraic [-cons] vocoid. The only difference between the two types of moraic vocoids is that only a [-cons] vocoid can serve as a syllable peak. However, the similarity between a moraic [-cons] vocoid and a moraic [+cons] vocoid leads to the following question: if [-cons] vocoids can alternate between syllable peaks and nonpeaks, can a [+cons] vocoid have the same alternation? Indeed, a [+cons] glide can serve as a syllable peak by what is traditionally called Glide Vocalization.

The analyses of vowels and glides presented so far, however, cannot account for vocalization because there is no constraint interaction that would compel a moraic [+cons] glide to be syllabified as the syllable peak. In this section, Glide Vocalization is accounted for in the same way as the distribution of high vocoids is accounted for in the previous chapters. That is, potential surface forms with a moraic and a nonmoraic parse of a [+cons] glide are evaluated for constraint satisfaction. Vocalized glides surface when a moraic [+cons] glide best-satisfies the constraint ranking. A consequence of this analysis is that a vocalized glide is no different from any other syllabic [+cons] segment, e.g. a nasal or a liquid, serving as a syllable peak (Hyman 1985). To demonstrate how glides and other segments can be syllabified as syllable peaks, constraint interactions are required which have not yet been discussed. Vocalized glides are introduced with analysis of Berber, a language in which vocalization of all consonants (not only glides) is particularly important.

The analysis of vocalized glides in Berber must begin by establishing that there are underlying glides in the language. This question itself has caused some debate. Basset (1952) and Applegate (1971) claim that the distribution of high vocoids can be accounted for with only two vocoids. This appears to be true given that the surface distribution is the usual complementary distribution of vowels occurring adjacent to consonants and nonmoraic vocoids occurring adjacent to vowels. Bynon (1974) notes that even though Berber exhibits this complementary distribution, there must be an underlying contrast between vowels and glides. Two sources of evidence based on the Ait Hadidu dialect are provided for this conclusion: 1. there are geminate glides, but no geminate vowels and 2. there are no vowel sequences, but there are consonant sequences containing glides.

Guerrsel's (1986) analysis of Ait Segrouchen Berber leads to the same conclusion. Guerssel shows that an underlying vowel/glide contrast is necessary to account for the distribution of high vocoids, which does deviate from complementary distribution. The most interesting aspect of vocoid distribution in Berber noted by Bynon and Guerssel is that underlying glides alternate with vowels, but underlying vowels do not alternate with their nonmoraic counterparts. This alternation between underlying glides and vowels is due vocalized glides which are shown in Optimality Theory to be the result of Prince and Smolensky's theory of syllabification in which different possible sonority peaks are evaluated for each candidate.

The analysis of vocoid distribution and vocalized glides in Berber encompasses the different dialects listed below.

Ait Seghrouchen:	Guerssel (1986, 1990)
Ath-Sidhar Rifian	Dell and Tangi (1992)
Imdlawn Tashlhiyt:	Dell and Elmedlaoui (1985,1988)
Kabyle:	Bader (1984), Kenstowicz, Bader and Benkeddache (1985)

The discussion of Berber begins with an analysis of vocalization in Ait Seghrouchen which serves as the basic case. Vocalization in Ait Seghrouchen is then compared to Kabyle and Ath-Sidhar Rifian, which exhibits a slightly different distribution of high vocoids due to the distribution of epenthetic vowels. The distribution of high vocoids in these dialects is shown to stem from a difference in constraint ranking. Lastly, these dialects are compared to Imdlawn Tashlhiyt where there is a greater range of consonants that can be vocalized, which through constraint interaction, effects the distribution of vocoids.

4.4.1 Vocoid Distribution in Ait Seghrouchen Berber

Vowels and their nonmoraic counterparts in Berber, as mentioned, appear to be in complementary distribution. In Ait Segrouchen, Guerrsel (1986) shows that this cannot be correct. One reason for this is that vowels do not alternate with their nonmoraic counterparts. According to Guerssel, postvocalic vocoids always surface as vowels. This is exemplified in (78) with the demonstrative suffix /-u/ and the first person singular object clitic /-i/ which always surface as [-i] and [-u] respectively. The intervocalic glide in (78b) is epenthetic.

(78)	a.	aryaz-u	'this man'	
		tessim-i	'she raised me'	
	b.	arba-y-u	'this boy'	*arbaw
		afa-y-u	'this fire'	*afaw
		tenna-y-i	'she told me'	*tennay
		tebgha-y-i	'she wants me'	*tebghay

The surface forms in (78a) are faithful parses of the underlying forms and epenthesis in (78b) is the result of constraint ranking that leads to a FILL violation in the preferred candidate. The crucial dominating constraints are NODIPH and ONSET, which are both undominated.

(79) a. NODIPH » FILL, /arba+u/

Candidate	NODIPH	FILL
ar.bau.	*!	
+ ar.ba.Δu.		*

b. ONSET» FILL, /arba+u/

Candidate	ONSET	FILL
+ ar.ba.Δu.		*
ar.ba.u.	*!	

Unlike the suffixes in (78), the third person subject marker and the construct state prefixes, which consist of a high vocoid, show an alternation between high vowels and glides.

(80)	i-ru	'he cried'
	y-ari	'he writes'
	u-mazan	'messenger'
	w-ansa	'place'

The alternation in (80) can be accounted for by constraint rankings discussed elsewhere for word-initial and intervocalic glides. Presumably, the high vocoids are [-cons] and ONSET and SYLL-SEG dominate V-MORA. Combining this ranking with (79) should account for the vocoid distribution in (78) and (80). However, this is complicated by the forms of the third person singular and construct state prefixes in (81).

(81) aha y-ru then he cried *[aha-y-i-ru]
arra w-mazan messenger's kids *[arra-y-u-mazan]

If the prefixes are [-cons], the predicted surface forms should have the epenthetic glide since NODIPH is undominated. The diphthongal sequences in (81), therefore, cannot contain two [-cons] segments. NODIPH, however, is satisfied if the high vocoids in (81) are [+cons] glides and so the syllabifications [a.hay.ru] and [ar.raw.ma.zan] from (81) contain closed syllables, not diphthongs. If the high vocoids in (81) are consonantal glides, the vocoids in (80) must be too since they are the same morphemes. Therefore, the high vowels in (80) must be allomorphs of an underlying glide. The constraint interaction must now be developed to account for the vocalization of an underlying glide.

The analysis begins by introducing a constraint against consonants serving as syllable peaks. This constraint, called CONSPEAK, is an encapsulation of Prince and Smolensky's Nuclear Harmony Constraint, which evaluates different segments as syllable peaks.

(82) Consonantal-Peak (CONSPEAK):
Consonants cannot serve as syllable peaks.

Satisfying CONSPEAK ensures consonants must be syllabified in syllable margins. Since the prefixes in (80) are [+cons] glides, satisfying CONSPEAK means that these vocoids are more harmonically syllabified as onsets. Alternatively, a violation of CONSPEAK means the vocoids are parsed as vowels. In (83), two candidates for /w+ mazan/ are given and notice that the satisfaction of CONSPEAK in (83b) compels a FILL violation.[6]

(83) a. [W.ma.zan] b. [wΔ.ma.zan]

The candidates in (83) show a conflict between FILL and CONSPEAK since FILL is satisfied in the preferred candidate and CONSPEAK is violated. Therefore, FILL dominates CONSPEAK.

(84) FILL » CONSPEAK, /w+ mazan/

Candidate	FILL	CONSPEAK
+ W.ma.zan.		*
wΔ.ma.zan	*!	

[6]Following Dell and Elmedlaoui (1985) consonantal syllable peaks are written as a capital letter.

The distribution of high vocoids in Berber requires two distinctly specified morphemes and two constraint rankings. The suffixes in (78) are [-cons] and their distribution is accounted for by {NODIPH, ONSET} » FILL, which ensures that these suffixes always appear as vowels. The prefixes in (80), on the other hand, show a vowel/glide alternation that is accounted for by a [+cons] specification and the ranking in (84). The different specifications of [cons], however, cannot be limited to affixes. This is evident from the examples in (85).

(85)	a.	turiyax	'she wrote us'	*turyax
		tiniyax	'she tells us'	*tinyax
		tebduyax	'she divided us'	*tebdwax
		tessuyax	'she made us a bed'	*tesswax
	b.	tusyax	'she carried us'	*tusiyax
		tulyax	'she ascended for us'	*tuliyax
		tendwax	'she crossed over us'	*tenduyax
		tesswax	'she made us drink'	*tessuyax

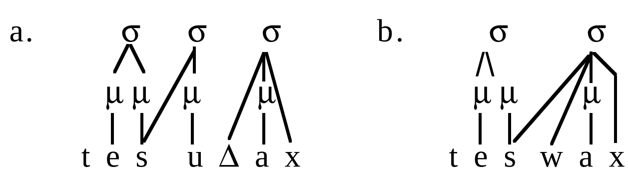
(85) presents the most striking evidence for an underlying vowel/glide distinction because the words in (85a) have a high vowel before the suffix and the words in (85b) have a glide in the same position. The minimal pair [tesswax] and [tessuyax] provides undeniable support for Guerrsel's claim that there is an underlying contrast between glides and high vowels. Without this distinction, the combined constraint ranking {NODIPH, ONSET} » FILL » CONSPEAK, from (79) and (84), incorrectly predicts that underlying [-cons] vocoids always surface as glides because the ranking cannot exclude [tesswax] as the surface form of /tessu+ ax/.

(86) ONSET » FILL » CONSPEAK, /tessu+ ax/

Candidate	ONSET	FILL	CONSPEAK
+ *tes.swax.			
tes.su.Δax.		*!	
tes.su.ax.	*!		

The difference between (85a) and (85b) can be attributed to constraint interaction provided that the vocoids in (85a) are [-cons] and the ones in (85b) are [+cons]. The [-cons] vocoids in (85a) must compel a FILL violation like they do in (79). The required constraint interaction can be determined by looking at the possible syllabifications of /tessu+ ax/ in (87).

(87) [tessu.Δax] [tesswax]



In (87), there is conflict between the FILL violation in (87a) and the V-MORA violation in (87b). The epenthetic consonant indicates that V-MORA must dominate FILL. The combined ranking in (88b) shows that the candidate with the FILL violation is preferred since it is the only candidate that satisfies the undominated constraints.

(88) a. V-MORA » FILL, /tessu+ax/

Candidate	V-MORA	FILL
tes.swax.	*!	
+ tes.su.Δax.		*

b. {NODIPH, ONSET, V-MORA} » FILL, /tessu+ ax/

Candidate	NODIPH	ONSET	V-MORA	FILL
tes.swax.			*!	
tes.suax	*!			
+ tes.su.Δax.				*
tes.su.ax.		*!		

The root-final vocoids of the roots in (85b) are [+cons], e.g. /tusy/, /tendw/. This accounts for the fact that these vocoids surface as glides. The surface forms of (85b) are actually faithful parses of the underlying forms since the preferred candidate does not violate any of the constraints discussed so far.

(89) {NODIPH, ONSET} » FILL » CONSPEAK, /tessw+ ax/

Candidate	NODIPH	ONSET	FILL	CONSPEAK
+ tes.swax.				
tes.sWax	*!			*
tes.sW.Δax.			*!	*
tes.sW.ax.		*!		*

The underlying contrast for vowels and glides is visible only when vocoids are adjacent otherwise high vocoids appear to be in complementary distribution. This is seen in (90), where the root-final vocoids surface as a vowel regardless of the underlying specification. This occurs before consonant-initial suffixes.

(90)

a.	turi-ten	/turi/	‘she wrote them’
	teni-ten	/teni/	‘she tells them’
	tebdu-ten	/tebdu/	‘she divided them’
	tessu-ten	/tessu/	‘she made us a bed’
b.	tusi-ten	/tusy/	‘she carried them’
	tuli-ten	/tuly/	‘she ascended them’
	tendu-ten	/tendw/	‘she crossed them’
	tessu-ten	/tessw/	‘she made them a drink’

The occurrence of high vowels in (90a) is expected because these underlying forms contain [-cons] high vocoids. The surface forms are just faithful parses. Surprisingly, the high vowels in (90b) are also predicted given the established ranking of FILL above CONSPEAK. This ranking ensures that a vocalized glide is preferred to epenthesis.

(91) FILL » CONSPEAK, /tendw+ten/

Candidate	FILL	CONSPEAK
+ ten.dW.ten.		*
ten.dΔw.ten.	*!	

The appearance of complementary distribution occurs because the vowel/glide contrast is neutralized by the constraint ranking which ensures all high vocoids are parsed moraically between two consonants. The illusion of complementary distribution is enhanced by the fact that an epenthetic glide appears between vowel sequences. This gives the impression that vowels occur next to consonants and their nonmoraic counterparts occur next to vowels. Abstracting away from the epenthetic glide, it is possible to see that vowels and glides are not always in complementary distribution since they actually contrast when adjacent to another vowel.

The analysis of vocoid distribution in Ait Seghrouchen proposed here relies on Guerssel’s claim that Berber has an underlying vowel/glide distinction. This is undeniable for there are minimal pairs like [tesswax] and [tessuyax]. The alternation between vowels and glides, following Guerssel, is attributed to vocalized glides. However, the analysis of vocoid distribution proposed here differs significantly from Guerssel’s proposal. In the Optimality Theoretic approach, underlying [-cons] high vocoids always surface as vowels as a result of V-MORA dominating FILL. The vowel/glide alternation in Berber is due to vocalized glides which arise because [+cons] glides can be moraic (hence indistinguishable from high vowels) and serve as syllable peaks.

Guerssel makes the distinction between vowels and glides by proposing that vowels are lexically associated to a rime (a mora in moraic phonology). Glides, on the other hand, have the same feature specification, but they are not linked to a rime.

(92)

```
vowel        glide
  R
  |
  i            i
```

The representations in (92) show the surface contrast between vowels and glides, but Guerssel posits (92) as the underlying representations to eliminate the feature [syllabic]. Both vowels and glides are [-cons] and the alternation between vowels and glides is the result of a rule that assigns rimes to glides in a particular context. Underlying vowels, on the other hand, cannot alternate with glides because there is no rime deletion (or demorification) rule.

Specifying the high vowels as with rimes allows Guerssel to capture the fact that vowels must surface as vowels. This distributional generalization can be called the "protected vowel" since the vowel cannot be without a rime. The protected vowel phenomena in the Optimality Theoretic approach is a consequence of the constraint ranking. A vocoid will surface as a vowel when V-MORA is sufficiently high ranking or if a V-MORA violation compels a violation of a higher ranking constraint. There is nothing intrinsic to the vowel that gives it its protected status.

Deriving protected vowels through constraint interaction also provides an explanation for Levin's (1985) observation that high vowels lexically marked as vowels (and so must surface as vowels) in languages with vocalized glides tend to appear in peripheral positions. This observation leads to a condition on the placement of lexically marked vowels called the Metrical Peripherality Condition.

(93) Metrical Peripherality Condition (Levin 1985)
Lexical marking of rule-governed structure is limited to peripheral positions.

The rule-governed structure Levin is referring to is the assignment of N-nodes (which can be interpreted as moras) to vowels. Marked vocoids have an N-node underlying giving them a representation equivalent to the moraic vowel in (92). This vowel is, therefore, "protected" from alternating with its nonmoraic counterpart and will always surface as a vowel.

Levin proposes the Metrical Peripherality Condition to limit lexical N-assignment to peripheral positions. For example, the medial high vocoid in a surface form like [turi] in Berber can surface as a vowel by being a glide that is vocalized or by being lexically assigned an N-node. The Metrical Peripherality Condition dictates that the medial vocoid cannot lexically have an N-node. The underlying form of [turi] must be /twri/ because lexically assigned N-nodes can only occur at the periphery.

Levin's Metrical Peripherality Condition, in effect, limits protected vowels to edges. However, the peripherality of protected vowels follows from the appropriate constraint ranking because the underlying vowel/glide contrast is neutralized in other environments. Consider the rankings for Ait Segrouchen in (89) and the following positions for high vowels and glides.

(94)	a.	H = [-cons] high vowel	
	i.	/CVCVCH/	[CV.CV.CH.]
	ii.	/CVCVCH+VC/	[CV.CV.CH.ΔVC.]
	iii.	/CVCVCH+CVC/	[CV.CV.CH.CVC.]
	iv.	/CVCHCV/	[CV.CH.CV.]
	b.	G = [+cons] glide	
	i.	/CVCVCG/	[CV.CV.CG.]
	ii.	/CVCVCG+VC/	[CV.CVC.GVC.]
	iii.	/CVCVCG+CVC/	[CV.CV.CG.CVC.]
	iv.	/CVCGCV/	[CV.CG.CV.]

The high vocoid in (ai, iii, iv) is parsed as a vowel to satisfy V-MORA. It is also parsed as a vowel in (aii) because V-MORA dominates Fill. In (94b), the glide is parsed as a vowel in (bi, iii, iv) because FILL and ONSET dominate CONSPEAK, but it is parsed as a consonant in (bii) since this is the faithful parse. This leaves only (aii) as an environment where there is surface contrast between high vowels and glides. The visibility of underlying high vowels occurs at edges because only in this environment does the satisfaction of V-MORA have phonologically visible consequences. In Berber, there is epenthesis since V-MORA dominates FILL. The vowel, therefore, is protected by the constraint ranking, namely, by the ranking of V-MORA above FILL. A condition on the placement of [-cons] vocoids is unnecessary since the high ranking V-MORA and the low ranking CONSPEAK neutralize the underlying contrast word-medially.

The notion of protected vowels in procedural approaches to Berber is undermined by the fact that there is no demorification rule so there is no way a high vowel can alternate with its nonmoraic counterpart. Protected vowels would be necessary in a language that has vowels that must be vowels and a vowel/glide alternation. The one potential case of this is Lenakel, but, as discussed in chapter 3, the interaction of metrical constraints accounts for vocoids that must surface as vowels. Therefore, there is no need to attribute some property to vowels so that they must surface as vowels. All cases of protected vowels will follow from constraint interaction.

The alternative to Guerrsel's and Levin's representation is Hyman's proposal that underlying glides are [+cons], which is adopted here. These glides, therefore, are consonants that can appear as syllable peaks due to constraint conflict. If glides are actually consonants, there should be some phenomena in which they pattern with other consonants. This is demonstrated in the following section with the phonology of other Berber dialects.

4.4.2 Vocalized Glides and Epenthesis in Kabyle and Ath-Sidhar Rifian

Vocoid distribution in Kabyle (Bader 1984, Kenstowicz, Bader and Benkeddache 1985, Guerrsel 1990) is slightly different from the pattern found in Ait Seghrouchen. In Kabyle, the bound state prefix and the third person singular prefix surface as high vowels only when the root has an initial CV sequence, as in (95b). Initial CC sequences, as in (95c), have a glide followed by an epenthetic schwa (Kenstowicz, Bader and Benkeddache 1985).

(95)

a.	w-adu	'wind'	y-usad	'he arrives'
b.	u-fus	'hand'	i-dhudhan	'finger'
	u-kursi	'chair'	i-ruh	'he left'
c.	w&rgaz	'man'	y&frax	'birds'
	w&msis	'cat'	y&fka	'he gave'

Guerssel (1990) provides some minimal pairs from Ait Seghrouchen and Kabyle.

(96)

Ait Seghrouchen	Kabyle	
i-fsel	y&fsel	'he untied'
i-bda	y&bda	'he began'
i-rzem	y&rzem	'he opened'

The high vocoid prefixes in Kabyle are [+cons] like they are in Ait Seghrouchen (Bader 1984). This is evident from the fact that epenthesis occurs at all. If the prefixes were underlyingly vocalic, there is no reason why the surface form for /frax/ would not be [ifrax] 'birds' for this syllabification would be a faithful parse. The prefixes in (95), therefore, must be [+cons] vocoids and what needs to be accounted for is the distribution of vocalized glides in (95b) and epenthetic schwa in (95c).

The absence of glide vocalization and the presence of epenthesis in (95c) shows that CONSPEAK dominates FILL.

(97) CONSPEAK » FILL, /w+ rgaz/

Candidate	CONSPEAK	FILL
Wr.gaz.	*!	
+ wΔr.gaz.		*

Further support for the ranking in (97) comes from epenthesis between a stem-final glide and a consonant-initial suffix, e.g., /rumy +n/ → [rumy&n], *[rumin] 'European, masc.'. Here too, a FILL violation is preferred to finding the most harmonic peak in the second syllable, which would be a vocalized glide.

The distribution of schwa in (95c) is identical to schwa distribution in the trisegmental obstruent clusters in (98).

(98)

th&qsisth	'girl'
th&zrivth	'stress'

In both (95c) and (98), the schwa appears after the first consonant. This is predicted since the glides are [+cons] and therefore they should pattern as consonants. This patterning with consonants, however, is limited to trisegmental clusters. In bisegmental clusters, the distribution of schwa is not the same. In this case, the glide is vocalized.

(99)	a.	/th+ mazigth/	[&thmazigth]	'Berber woman'	*th&mazigth
		/th+ sasith/	[&thsasith]	'hat'	*th&sasith
	b.	/w+ kursi/	[ukursi]	'chair'	*w&kursi
		/y+ ruh/	[iruh]	'he left'	*y&ruh

Bader (1984) notes that the appropriate generalization is that vocalized glides are never followed by two consonants and schwa is always followed by two consonants. This is evident from (98) and (99). To account for the distribution of vocalized glides, it is necessary to start by looking at the distribution of schwa. The condition that schwa must follow two consonants is found in other languages, for example, Iraqi Arabic (Itô 1986).

(100)	Iraqi Arabic		
	/gil-t-la/	[gilitla]	'I said to him'
	/katab-t ma-ktuub/	[katabit maktuub]	'I write a letter'

It appears that in Iraqi Arabic and Berber epenthesis is preferred in closed syllables. To account for this, McCarthy (p.c.) suggests a constraint that prohibits epenthesis in open syllables.

(101) CLOSED-FILL: $*\Delta]_\sigma$
Epenthetic vowels do not occur at syllable edges.

CLOSED-FILL, of course, is only relevant in languages with closed syllables and violations of CLOSED-FILL must be harmonic in languages where there is epenthesis between two consonants. In these cases, CLOSED-FILL is crucially dominated by NOCODA.

From the syllabification of the trisegmental clusters in Kabyle, it seems that CLOSED-FILL and FILL are not ranked with respect to each other, but later it will be shown that CLOSED-FILL must dominate FILL. This ranking is assumed in (102) with candidate syllabifications for /θ+qsisθ/.

(102) CLOSED-FILL » FILL /th+qsisth/

Candidate	CL.-FILL	FILL
thΔ.qΔ.sisth	**!	**
+ thΔq.sisth		*
thqΔ.sisth	*	*

Since glides are [+cons], the forms in (95c) are underlyingly triconsonantal, e.g. /y+frax/, 'bird'. Hence, it is no surprise that the trisegmental clusters in (95c) and (98b) have the same parse, that is, both have an epenthetic vowel between the first and the second consonant of the sequence.

(103) CLOSED-FILL » FILL /y+ frax/

Candidate	CL.-FILL	FILL
yΔ.fΔ.rax	**!	**
+ yΔf.rax		*
yfΔ.rax	*	*

Bisegmental clusters of obstruents and clusters containing glides behave differently as is evident from (95b) and (98a). Bisegmental obstruent clusters are parsed forming closed syllables, which is predicted by CLOSED-FILL.

(104) CLOSED-FILL » FILL, /th+ mazigth/

Candidate	CL.-FILL	FILL
+Δth.ma.zigth		*
thΔ.ma.zigth	*!	*

CLOSED-FILL is also relevant to the parse of bisegmental clusters containing glides. Since glides are [+cons], they should not form the onset of a syllable with an epenthetic vowel. This is correct as shown in (104) where a vocalized glide is more harmonic than an epenthetic vowel.

(105) CLOSED-FILL » CONSPEAK, /y+ ruh/

Candidate	CL.-FILL	CONSPEAK
+ i.ruh.		*
yΔ.ruh.	*!	

The ranking in (105) does not completely account for the asymmetry between bisegmental clusters with glides and those containing obstruents because the candidate [Δy.ruh] (which has the syllabification of the preferred candidate in (104) satisfies both CLOSED-FILL and CONSPEAK as well. However, this candidate violates ALIGN-L(Prwd, σ) since the morpheme boundary does not coincide with a syllable boundary, as shown in (106a) . This syllabification must be compared to (106b) which has a vocalized glide and satisfies ALIGN-L.

(106) a. [Δ|y.ruh]

b. [|Y.ruh]

An argument can be made from this for ranking ALIGN-L above CONSPEAK.

(107) ALIGN-L » CONSPEAK , /y+ ruh/

Candidate	ALIGN-L	CONSPEAK
[Δ|y.ruh.	*!	
+ [|Y.ruh.		*

The vocalized glide, therefore, satisfies ALIGN-L and CLOSED-FILL. Parsing the glide as a consonant compels a violation of both of these constraints. The bisegmental obstruent clusters in (98a) have word-initial epenthetic schwas so these forms violate ALIGN-L, but satisfy CLOSED-FILL. Therefore, CLOSED-FILL must dominate ALIGN.

(108) CLOSED-FILL » ALIGN-L , /th+ mazigth/

Candidate	CL.-FILL	ALIGN-L
[|thΔ.ma.zigth.	*!	
+ [|Δth.ma.zigth.		*!

The distribution of epenthesis and vocalized glides in clusters follows from the constraint rankings listed in (109a) and the composite ranking is given in (109b).

(109) a. CONSPEAK » FILL (97)
ALIGN-L » CONSPEAK (107)
CLOSED-FILL » ALIGN (108)

b. CLOSED-FILL » ALIGN-L » CONSPEAK » FILL

Looking again at the relation between CLOSED-FILL and FILL, recall (102) ranks CLOSED-FILL and FILL although no argument for dominance was given. From (109) it is apparent that these constraints must be ranked because CLOSED-FILL dominates CONSPEAK and CONSPEAK dominates FILL. Therefore, CLOSED-FILL must dominate FILL by transitivity.

(110) illustrates how the ranking in (109b) accounts for the distribution of vocalized glides and schwa in Kabyle. The ranking is illustrated below with examples of different clusters. The trisegmental clusters in (110b &d) are parsed similarly because CONSPEAK dominates FILL. In both cases, therefore, the preferred candidate has a single FILL violation. The difference between the bisegmental clusters in (110a &c) follows from preferring a vocalized glide to an ALIGN-L violation in (110c). In other words, a violation of the lower ranked FILL compels a violation of the higher ranking ALIGN and CLOSED-FILL. The violation of CLOSED-FILL, which dominates ALIGN, is fatal.

(110) a. CLOSED-FILL » ALIGN-L » CONSPEAK » FILL, /y+ ruh/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
+ [|i.ruh.			*	
[|yΔ.ruh.	*!			*
[Δ|y.ruh.		*!		*

b. CLOSED-FILL » ALIGN-L » CONSPEAK » FILL, /y+ fsel/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
[|yΔ.fΔ.sel.	**!			**
[|if.sel.			*	
+ [|yΔf.sel.				*
[Δ|yf.sel.		*!		*

c. CLOSED-FILL » ALIGN-L » CONSPEAK » FILL, /th+ mazigth/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
[|thΔ.ma.zigth	*!			*
+[Δ|th.ma.zigth		*		*

d.CLOSED-FILL » ALIGN-L » CONSPEAK » FILL, /th+ qsisth/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
[|thΔ.qΔ.sisth	**!			**
[|thΔq.sisth				*
+ [|thqΔ.sisth	*!			*

At this point, it is worthwhile to compare vocalized glide distribution in Kabyle and Ait Segrouchen. All underlying glides in Ait Segrouchen vocalize, whereas only underlying glides that precede a single consonant vocalize in Kabyle. The difference in the distribution of vocalized glides is the result of different rankings of FILL and CONSPEAK.

(111) Ait Segrouchen: {NODIPH, ONSET} » FILL » CONSPEAK
Kabyle: CLOSED-FILL » ALIGN » CONSPEAK » FILL

The ranking in Ait Segrouchen ensures a vocalized glide is always more harmonic than an epenthetic vowel, but the reverse ranking in Kabyle allows vocalized glides only when a violation of FILL leads to a violation of ALIGN-L or CLOSED-FILL.

Although vocalized glides behave like consonants with respect to epenthesis in Kabyle, there is another environment in which they behave like vowels. Kabyle, like other Berber dialects, does not tolerate vowel sequences and these sequences can be avoided by an epenthetic glide, as in Ait Seghrouchen, or by elision. In Kabyle, however, vocalized glides participate in vowel elision (Bader 1984).[7]

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[7]Bader notes that there are two types of elision in Kabyle: 1. the first vowel elides, as in (112), and 2. a more complicated process whereby low vowels in either position are

(112)	/baba adhiruh/	[babadhiruh]	‘my father will leave’
	/baba y+ruh/	[babiruh]	‘my father left’
	/yebbi aqshish/	[yebbaqshish“]	‘he pinched the boy’
	/azekka w+rumy/	[azekkurumi]	‘Frenchman’s grave’

The prohibition against vowel sequences in Kabyle follows from NODIPH being undominated. However, the vocalized glides are [+cons] so there is no violation of NODIPH. The faithful parse [ba.bay.ruh] for /baba y+ruh/ contains a closed syllable, not a diphthong.[8] The consonantal glide in Kabyle appears to be consonantal in some respects and vocalic in others. This is similar to Ponapean where consonantal glides behave like consonants with respect to prosodic operations, but do not behave like consonants with respect to phonotactics. It is unclear how to account for elision in (112). One possibility might be that a [+cons] glide has a V-Place node. The prohibition against vowel sequences in (112) can be seen as a prohibition against tautosyllabic V-place nodes, which would include vocalized glides.

Another example of vocalized glide and schwa distribution is seen in the syllabification of consonant sequences in the Ath-Sidhar Rifian dialect (henceforth ASR Berber).[9] According to Dell and Tangi (1992), in ASR Berber a cluster of four consonants (a prefix plus a trisegmental root) is syllabified as two closed syllables.

(113)	/ th+ xzn/	[th&xz&n]	‘keep’
	/dhhn+ th/	[dh&hn& th]	‘rub’

The roots containing glides in (114) have the same distribution of schwa as the roots in (113). This indicates that the glides are consonantal and to show that the glides contrast with [-cons] high vocoids, Dell and Tangi provide examples of roots containing high vowels. These roots, as expected, do not have epenthetic schwas.

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elided when adjacent to a high vowel and the front vowel in either position is elided when next to the back round vowel. Vowel elision is also confined to particular morphological contexts that are not discussed here.

[8]Bader notes that [ba.bay.ruh.] (the faithful parse) is an alternative, yet less preferred, pronunciation.

[9]A similar pattern of syllabification is found in Ayt Ndhir Berber (Penchoen 1973, Waksler 1990).

(114)	a.	/th+ wzn/	[th&wz&n]	* thuz&n	'weigh'
		/th+ yma/	[th&yma]	* thima	'grow'
		/th+ zwr/	[th&zw&r]	* th&zur	'redden'
		/thdhw+ th/	[th&dhwi th]	*q&dhu thθ	'snap'
	b.	/th+ udhf/	[thudh&f]		'enter'
		/th+ ira/	[thira]		'play'
		/th+ mun	[thmun]		'accompany'
		/'thu+ th/	['thdhuθ]		'overtake'

The presence of schwa in (114a) shows that the consonantal glides are more harmonically parsed as glides than as vocalized glides. In terms of constraint ranking, CONSPEAK must dominate FILL and since epenthesis in ASR, like Kabyle, only occurs in closed syllables so CLOSED-FILL violations are fatal. No ranking argument can be made for CLOSED-FILL and FILL, but these constraints are assumed to be ranked for now. These rankings are given in (115).

(115) a. CONSPEAK » FILL, /th+ wzn/

Candidate	CONSPEAK	FILL
+ thΔw.zΔn		**
thW.zΔn	*!	*

b. CLOSED-FILL » FILL, /θ+ wzn/

Candidate	CL.-FILL	FILL
+ thΔw.zΔn		**
thΔwΔ.zΔn	*!	***

Trisegmental clusters containing obstruents and glides are also syllabified identically with epenthesis between the second two segments.[10]

(116)	a.	/xzn/	[xz&n]	*&xz&n
	b.	/wzn/	[wz&n]	*&wz&n, *uz&n
		/yma/	[yma]	*&yma, *ima

[10]Other constraint rankings are involved, but they are not included here. Dell and Tangi state that there are no word-final consonant clusters, but word-initial clusters are permitted. This can be accounted for in the constraint hierarchy by properly ranking the constraints that allow for peripheral segments and the beginnings and ends of words (see Sherer 1993). Interestingly, Kabyle must have the reverse ranking since final clusters, but not initial clusters, are allowed (Bader 1984).

Dell and Tangi note that there is no word-initial epenthesis in ASR Berber, which is accounted for here by ALIGN-L(Prwd, σ). Most importantly, ALIGN-L and CLOSED-FILL are not ranked with respect to each other, which differs from Kabyle where CLOSED-FILL dominates ALIGN-L. The parses for the consonant sequences in (116) are shown in (117). CONSPEAK, which dominates FILL, must be dominated by ALIGN-L since ALIGN-L is satisfied by a vocalized glide and CONSPEAK is satisfied when ALIGN-L is violated.

(117) a. ALIGN, CLOSED-FILL » FILL, /xzn/

Candidate	CL.-FILL	ALIGN	FILL
[|xΔ.zΔn.	*!		**
+ [|xzΔn.			*
[Δ|x.zΔn.		*!	**

b. {ALIGN-L, CLOSED-FILL, CONSPEAK} » FILL, /wzn/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
[|W.zΔn.			*!	*
[|wΔ.zΔn.	*!			**
+ [|wzΔn.				*
[Δ|w.zΔn.		*!		**

Based on the syllabification of roots, ASR Berber does not appear to have an alternation between underlying glides and vowels because CONSPEAK is undominated. However, the third person masculine prefix /y-/ does alternate.

(118) a. /y+ xzn/ [y&x.z&n.]
/y+wzn/ [y&w.z&n.]
b. /y+ mun/ [i.mun.]

The environment in (118b) for vocalized glides in ASR is identical to Kabyle, that is, vocalized glides never appear before two consonants. This means that CONSPEAK is dominated and it is crucially dominated by CLOSED-FILL. This is shown with the syllabification of (118b) in (119).

(119) CLOSED-FILL » CONSPEAK, /y+mun/

Candidate	CL.-FILL	CONSPEAK
yΔ.mun	*!	
+ Y.mun.		*

The distribution of vocalized glides in (118) occurs for the reasons given in the analysis of Kabyle. Vocalized glides appear when the candidate that violates CONSPEAK is more harmonic. This occurs when there is a single consonant following the glide because only in this case does a violation of the lower ranked FILL compel a violation of CLOSED-FILL. When the glide is followed by two consonants, the candidate with epenthetic schwas in closed syllables is preferred since CLOSED-FILL is satisfied and the CONSPEAK violation is fatal.

(120) a. CL.-FILL » CONSPEAK » FILL, /y+ xzn/

Candidate	CL.-FILL	CONSPEAK	FILL
+ yΔx.zΔn			**
Y.x.zΔn		*!	*

b. CL.-FILL » CONSPEAK » FILL, /y+ mun/

Candidate	CL.-FILL	CONSPEAK	FILL
yΔ.mun.	*!		**
+ Y.mun.		*	

The ranking in (120) actually fails to account for vocoid distribution because it excludes the candidate [ymun], which is analogous to the preferred candidate in (117b). The difference between (117b) and (118b) is that the latter is morphologically complex. The ranking in (120) must consider possible syllabifications with respect to morphological boundaries; hence ALIGN is relevant, but in this case ALIGN refers to the left edge of the root and the syllable. As shown in (121a), ALIGN-L(rt, σ) is satisfied by both the consonantal and the vocalized parse of the root-initial glide. In the morphologically complex case in (121b), ALIGN-L is violated by the consonantal parse and it is satisfied when there is a vocalized glide.

(121) a. root-initial glide
[|wzΔn
[|W.zΔn.

b. glide+ root
[y|mun.
[Y.[|mun.

The interaction with morphology in (121) is accounted for by ALIGN-L(rt, σ) which conflicts with CONSPEAK. All candidates satisfy ALIGN-L when the glide is root-initial so the CONSPEAK violation is fatal.

(122) a. ALIGN-L(rt, σ) » CONSPEAK, /y+ mun/

Candidate	ALIGN-L(rt, σ)	CONSPEAK
[y|mun.	*!	
+ Y.[|mun.		*

b. ALIGN-L(rt, σ) » CONSPEAK, /wzn/

Candidate	ALIGN-L(rt, σ)	CONSPEAK
+ [|wzΔn.		
[|W.zΔn.		*!

ALIGN-L(rt, σ) is violated in morphologically concatenated forms, e.g. [θ&w.z&n] (</θ+ wzn/), since the root-initial consonant is syllabified with the prefix. The conflict here is between ALIGN-L(rt, σ) and CLOSED-FILL because satisfying the former compels a violation of the latter. Hence, CLOSED-FILL dominates ALIGN-L(rt, σ).

(123) CL.-FILL » ALIGN-L(rt, σ), /th+ wzn/

Candidate	CL-FILL	ALIGN-L(rt, σ)
thΔ.[|wΔ.zΔn	*!*	
+ [thΔ|w.zΔn		*

To summarize, (124) lists the constraint rankings established for vocalized glides and schwa distribution in ASR.

(124) a. CLOSED-FILL » CONSPEAK (119)
CONSPEAK » FILL (115)
ALIGN-L(RT, σ) » CONSPEAK (122)
CLOSED-FILL » ALIGN-L(RT, σ) (123)

b. CL.-FILL» ALIGN-L(RT, σ) » CONSPEAK » FILL

The composite ranking in (124b) is illustrated in (125) with underlying glides in three environments: 1. root-initial, 2. followed by one consonant, and 3. followed by two consonants. These cases are compared to cases involving all consonants.

(125) a. CL.-FILL » ALIGN-L(RT, σ) » CONSPEAK » FILL, /wzn/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
[|W.zΔn.			*!	*
[Δ|w.zΔn.		*!		**
[|wΔ.zΔn.	*!			**
+ [|wzΔn.				*

b. /y+ mun/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
yΔ.[|mun.	*!			*
[Δ|y.[|mun.		*!		*
+ Y.[|mun.			*	
[y|mun.		*!		

c. /y+xzn/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
yΔ.[|xΔ.zΔn.	*!*			***
Y.[|xΔ.zΔn.	*!		*	**
+ [yΔ|x.zΔn.		*		**
Δy[|xΔ.zΔn.	*!			***

d. /th+ wzn/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
thΔ.[|wΔ.zΔn.	*!*			***
+ [thΔ|w.zΔn.		*		**
[th|W.zΔn.		*	*!	*
Δth[|wΔ.zΔn.	*!			***

e. /θ+ xzn/

Candidate	CL.-FILL	ALIGN-L	CONSPEAK	FILL
thΔ.[|xΔ.zΔn.	*!*			***
+ [thΔ|x.zΔn.		*		**
Δth[|xΔ.zΔn.	*!			***

The ranking of CONSPEAK above FILL ensures epenthesis is preferred to vocalized glides. This accounts for the fact that glides generally behave like obstruents with respect to syllabification. This is seen in the comparison of (125d & e) where in both cases the most harmonic syllabification consists of two closed syllables. In (125d), the candidates with schwa epenthesis and a vocalized glide both satisfy CLOSED-FILL and violate ALIGN-L. The CONSPEAK violation, therefore, is fatal. Vocalized glides cannot appear after two consonants because the CONSPEAK violation compels a CLOSED-FILL violation. This is evident by comparing (125b &c). The fact that only prefixes alternate follows from the ALIGN violation in (125b). A root-initial glide, as in (125a), is consonantal because both the moraic and nonmoraic parses satisfy ALIGN-L; hence the CONSPEAK violation is fatal.

The constraint ranking in (124b) correctly predicts vocalized glides in the syllabification of the longer sequences of consonants in (126).

(126) /y+ wzn +n/ [i.w&z.n&n]
/y+ wzn +n/ [i.w&z.n&n]

The forms in (126) also contain two glides both of which can vocalize. The constraint ranking predicts that only the first glide is vocalized. (127) lists the candidate syllabifications of /y+ wzn+ n/ and the constraints they violate.

(127)
a. yΔ.[|wΔ.zΔ.nΔn CLOSED-FILL x3, FILL x4
b. [yΔ|w.zΔ.nΔn CLOSED-FILL, FILL x3, ALIGN
c. [y|w.zΔ.nΔn CLOSED-FILL, FILL x2, ALIGN
d. Y.[|wΔz.nΔn CONSPEAK, FILL x2
e. [y|W.zΔ.nΔn CONSPEAK, CLOSED-FILL, ALIGN
f. [y|Wz.nΔn CONSPEAK, FILL, ALIGN

All but (127d &f) violate CLOSED-FILL and of these candidates (127f) should be preferred because it has a single FILL violation. However, (127f) violates ALIGN-L since the vocalized glide from the root places the root-initial segment and the prefix in the same syllable. (127f) demonstrates that ALIGN-L must dominate FILL, a ranking that is expected since ALIGN dominates CONSPEAK which in turn dominates FILL.

(128) CLOSED-FILL » ALIGN-L » CONSPEAK » FILL, /y+wzn+n/

Candidate	CL.FILL	ALIGN -L	CONSPEAK	FILL
yΔ.[|wΔ.zΔ.nΔn.	*!**			****
yΔ[|w.zΔ.nΔn.	*!			***
[y|wΔ.zΔ.nΔn.	*!*	*		***
+ Y.[|wΔz.nΔn.			*	**
[y|Wz.nΔn.		*!	*	*
[y|W.zΔ.nΔn.	*!	*		**

Only two candidates satisfy CLOSED-FILL: one has a vocalized /y/ and the other has a vocalized /w/. However, the vocalized /w/ violates ALIGN. Therefore, the candidate with the vocalized prefix is preferred.

The constraint ranking in (128) for ASR Berber limits the neutralization of the underlying glide/vowel contrast to before an initial consonant followed by an epenthetic vowel. There is one other environment in which vocalized glides appear. Dell and Tangi note that phrase-final glides surface as vowel rather than as a glide preceded by an epenthetic schwa.

(129) /fsy/ [f&s.y&th.] [th&f.si.] *θ&f.s&y.
/qdhw/ [q&dh.w&th.] [th&.dhu.] *th&q.∂&w.

The vocalized glides in this environment are not expected given that the glides are like other consonants. The constraint ranking in (128) predicts surface forms with epenthetic schwa since these forms contain two closed syllables. These word-final glides can be seen as a consequence of the preference for a prosodic word to end in an open syllable. This can be written as a constraint called FINAL-V, which is the counterpart to FINAL-C which ensures the prosodic word is consonant-final (McCarthy 1993, McCarthy and Prince 1993b).

(130) FINAL-V: $*C]_{PrWd}$
Prosodic words must be vowel final.

FINAL-V clearly conflicts with CONSPEAK since the consonantal parse of the glide means there is a consonant at the edge of the prosodic word.

(131) FINAL-V » CONSPEAK » FILL, /th+ fsy/

Candidate	FINAL-V	CONSPEAK	FILL
+ thΔf.si.		*	*
thΔf.sΔy.	*!		**

Of course, Berber has plenty of consonants at the right edge of the prosodic word, e.g. [yex.zen]. These occur because satisfying FINAL-V requires leaving the final consonant unparsed in violation of the undominated PARSE or it means having a final epenthetic schwa which violates CLOSED-FILL. Therefore, word-final consonants surface in violation of FINAL-V. This is shown in (132a) in contrast to (132b) where the FINAL-V violation is fatal.

(132) a. CLOSED-FILL, PARSE » FINAL-V » FILL, /th+ xzn/

Candidate	CL.-FILL	PARSE	FINAL-V	FILL
thΔx.nΔ.<n>	*!	*		**
+ thΔx.zΔn.			*	**
thΔx.zΔ.nΔ.	*!*			***

b. PARSE » FINAL-V » CONSPEAK » FILL, /θ+ fsi/

Candidate	PARSE	FINAL-V	CONSPEAK	FILL
+ thΔf.si			*	**
thΔf.sΔy		*!		**
thfΔs<y>	*!			*

In summary, the three Berber dialects require an underlying vowel/glide contrast which is based on Hyman's different specifications for [cons]. The alternation between vowels and glides is the result of vocalized glides which arise from best-satisfying the constraint ranking with a moraic [+cons] glide. The distribution of epenthetic schwa in Kabyle and ASR shows that underlying glides pattern like other consonants. Vocalized glides in these dialects only appear when the FILL violation necessary for the epenthetic schwa, involves a violation of a higher ranking constraint.

4.4.3 Vocalized Glides and Vocalized Consonants in Imdlawn Tashlhiyt

As proposed by Hyman, representing vocalized glides as moraic [+cons] segments makes them identical to any other syllabic segment, such as syllabic nasals or syllabic liquids, since these segments are also [+cons] and moraic. This point is particularly relevant in Imdlawn Tashlhiyt Berber where, as shown by Dell and Elmedlaoui (1985), any segment can serve as a syllable peak. Examples of syllabic liquids, nasals, fricatives and stops are given in (133).

(133)	tR.gLt.	'lock'
	tZ.dMt.	'gather wood'
	tF.tKt.	'you suffered a sprain'
	ra.tK.ti.	'she will remember'

According to Dell and Elmedlaoui, the syllable nuclei are chosen based on sonority. The syllabification algorithm chooses the most sonorous segment for the syllable peak and the surrounding segments are syllabified as syllable margins. For example, for an underlying form like /trglt/, the algorithm picks /r/ and /l/ as the syllabic nuclei since these segments are more sonorous than the surrounding stops.

Prince and Smolensky analyze Imdlawn Tashlhiyt as a case of harmonic syllabification. For each input, a number of candidate syllabifications are available containing different syllabic segments as the nuclei and the preferred candidate includes the most harmonically sonorous nuclei. The evaluation of harmony is based on Dell and Elmedlaoui's sonority scale according to which low vowels are the most sonorous and voiceless stops are the least sonorous.

(134) low vowels > high vocoids > liquids > nasals > voiced fricatives > voiceless fricatives > voiced stops > voiceless stops

From the sonority scale, Prince and Smolensky formulate the following constraint.

(135) The Nuclear Harmony Constraint: (HNUC)
A higher sonority nucleus is more harmonic than one of a lower sonority.

CONSPEAK, which has been used as a general constraint against syllabic consonants, can be dispensed with in favour of HNUC. The range of syllabic consonants in Imdlawn Tashlhiyt requires evaluation of different possible syllabic nuclei that can only be done by HNUC. HNUC, of course, must interact with other constraints, particularly ONSET. This is shown in (136) where, as demonstrated by Prince and Smolensky, ONSET dominates HNUC.

(136) Imdlawn Tashlhiyt
ONSET » HNUC, /trglt/

Candidate	ONSET	HNUC
T.R.G.L.T.	*!****	
Tr.gLt.	*!	|t|, |l|
tRg.lT.		|r|, |t|!
+ tR.gLt.		|r|, |l|
tRg.Lt	*!	|r|, |l|

Three of the candidates violate ONSET leaving only two that must be compared for the sonority of their nuclei. Since /l/ is a more harmonic nucleus, the preferred candidate is [tR.gLt.].

Returning to glides in other dialects, vocalized glides occur when a glide is the most harmonic nucleus as determined by HNUC. This is demonstrated with an example from Ait Seghrouchen.

(137) Ait Seghrouchen
FILL » HNUC, /tendw+ten/

Candidate	FILL	HNUC
te.nDw.ten		|d|!
+ ten.dW.ten.		|w|
ten.dΔw.ten.	*!	

The two candidates that satisfy FILL are equal in all respects, that is ONSET is satisfied and each contains a NOCODA violation. Evaluation with respect to HNUC prefers the candidate with the vocalized glide which is a more harmonic nucleus than a syllabic voiced stop.

The previously discussed dialects differ from Imdlawn Tashlhiyt in the range of possible syllabic segments. As shown, Imdlawn Tashlhiyt allows any segment to be syllabic, but the other dialects allow only vocalized glides other consonant clusters are separated by epenthesis. The difference between the dialects centers upon HNUC, which as Prince and Smolensky note, is a scalar constraint relating relative harmony. However, it can be viewed in absolute terms which would require each step on the scale to be a separate constraint as shown below.

(138) *GL-NUC: glides are not syllabic peaks
*NAS-NUC: nasals are not syllabic peaks

*LIQ-NUC:	liquids are not syllabic peaks
*OBS-NUC:	obstruents are not syllabic peaks

The dialects differ in the way HNUC is partitioned. In the previously discussed dialects, FILL dominates *GL-NUC, but all other constraints on nucleus types are undominated. Hence, vocalized glides are possible, but no other syllabic consonants are. In Imdlawn Tashlhiyt, on the other hand, FILL dominates the complete scale.

HNUC produces the standard complementary distribution of high vowels and their nonmoraic counterparts. A high vocoid between two consonants is the most harmonic nucleus and a high vocoid between two nonhigh vocoids is not. The only exception to this occurs under duress to satisfy ONSET as shown by Prince and Smolensky. The low ranking of HNUC in Imdlawn Tashlhiyt raises a question concerning the need for an underlying vowel/glide contrast. Since FILL dominates HNUC, there is no vowel epenthesis and there is no consonant epenthesis because there are no high vocoids that must be vowels as in Ait Segrouchen (Dell p.c.). Therefore, Imdlawn Tashlhiyt seems to have only one set of underlying high vocoids that is syllabified by HNUC. Dell and Elmedlaoui, however, note, that there are some morphemes, shown in (139b), that have high vocoids that must be consonantal.

(139)	a.	suy	‘let pass!’	b.	zwi	‘beat down’
		lur	‘give back!’		lwR	‘run away’
		turtit	‘garden (fem.)’		twRtat	‘kind of feline’

The intriguing behaviour of high vocoids in Imdlawn Tashlhiyt is that there are no protected high vowels, but rather high vocoids can surface nonmoraically. This means that V-MORA is dominated by ONSET and NODIPH. The fact that high vocoids can surface nonmoraically does not alter the outcome of syllabification through HNUC since high vocoids, either [-cons] or [+cons], occupy the same position on the sonority scale.

The greater sonority of high vocoids predicts that a high vowel syllable peak is preferred to vocalized segments. This can be assumed to be the unmarked case, but constraint interaction can lead to preferring a less sonorous syllable peak. This is noted by Dell and Elmedlaoui and it clearly follows from Prince and Smolensky’s constraint ranking. An underlying form like /haul-tn/ ‘make them plentiful’ surfaces as [ha.wL.tN] where the less sonorous liquid is the preferred nucleus. Consider the syllabifications in (140).

(140)
a. ha.ul.tN.
b. hau.lTn.
c. ha.wL.tN.

The real competition is between (140a) and (140c) where there is a conflict between the less sonorous nucleus in (140c) and the more sonorous nucleus in (140a). However, the high vocoid in (140a) requires a violation of ONSET which is higher ranking. Therefore, /l/ is the most harmonic nucleus.

(141) Imdlawn Tashlhiyt
ONSET, NODIPH » V-MORA, HNUC, /haul-tn/

Candidate	ONSET	NODIPH	V-MORA	HNUC
ha.u.lTn.	*!			|t|
haw.lTn.			*	|t|!
hau.lTn.		*		|t|
+ ha.wL.tN			*	|l|
ha.ul. tN	*!			

In summary, there are two ways in which Imdlawn Tashlhiyt is different from the other dialects. One difference is the range of possible syllabic segments and the other difference is that Imdlawn Tashlhiyt does not have protected vowels, i.e., vowels that must surface as vowels. High vocoids appear adjacent to low vowels through violations of V-MORA that are compelled in order to satisfy ONSET and NODIPH. This ranking also eliminates the need for an underlying vowel/glide contrast (apart from a handful of exceptions) in Imdlawn Tashlhiyt since the low ranking of V-MORA and HNUC neutralize the contrast. The underlying vowel/glide contrast surfaces in other dialects because V-MORA is undominated.

4.5 Conclusion

This chapter provides an account of two other sources of glides, homorganic glides and underlying glides. Homorganic glides arise through a constraint ranking that is best-satisfied by a high vowel linked to its own mora as well as linked to the following syllable. It is shown that homorganic glides obey the same universals as other nonmoraic vocoids. In particular, a language with glides following mid vowels must have glides following high vowels.

The distribution of vocoids in some languages cannot be accounted for without positing an underlying distinction between vowels and glides. The [+cons] glides are consonants and the distinction between vowels and glides surfaces in some environments, but not in others, due to the constraint ranking. Berber is a particularly interesting case of an underlying vowel/glide distinction because there is an alternation between vowels and glides that can only be attributed to underlying glides surfacing as high vowels. These vocalized glides are a consequence of best-satisfying the constraint hierarchy with a glide as the syllable peak. The underlying glides, which behave like other consonants with respect to epenthesis, are vocalized when epenthesis involves a violation of a higher ranking constraint.

4.6 Concluding Remarks

The vowel/glide alternation in Optimality Theory follows from constraint interactions that lead to surface violations of some constraints. This account of the alternation does not require the complications to the grammar encountered in procedural based approaches, for example, there is no underspecification for [cons]. All underlying high vocoids in languages with an alternation are [-cons] and a glide is simply a [-cons] vocoid that is parsed nonmoraically as a consequence of constraint satisfaction. The phenomenon called "the protected vowel", that is, a vowel that must surface as a vowel, is shown to follow from constraint interactions that lead high vocoids to be parsed as vowels. This is seen in Lenakel and Spanish, where high vocoids adjacent to nonhigh vowels fail to alternate because they must be stressed, and in Berber, where high vocoids fail to alternate due to satisfaction of high ranking constraints.

The Optimality Theoretic account here also eliminates the need for repair strategies, like Glide Formation, which, in procedural syllabification, are needed to ensure constraints are satisfied at the level at which they apply. In chapter 2, it is shown that a nonmoraic parse of a high vocoid surfaces prevocalically because this parse maximally satisfies the constraint ranking that ensures surface vowels are monophthongs.

Other aspects of Optimality Theory are also discussed here. One is the failure of bottom-up construction which Prince and Smolensky account for by conflict between metrical and syllable structure constraints. The vowel/glide alternation in Lenakel and Spanish are interesting cases of anti-bottom-up construction that are accounted for here by the satisfaction of metrical structure constraints at the expense of surface violations of syllable structure constraints. Two, in Optimality Theory, interlinguistic variation is the result of different rankings of the same constraints. In chapters 2 and 4, it is shown how the phonology associated with the syllabification of vowel sequences differs across languages due to different constraint rankings. It is also shown in chapter 2 that Optimality Theory correctly predicts the range of typological variation associated with high vocoid distribution.

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