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PROSODIC DOMAINS IN OPTIMALITY THEORY

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ABSTRACT

PROSODIC DOMAINS IN OPTIMALITY THEORY

Cross-linguistically, the notion 'minimal word' has proved fruitful grounds for explanatory accounts of requirements imposed on morphological and phonological constituents. Word minimality requires that a lexical word includes the main-stressed foot of the language. As a result, subminimal words are augmented to a bimoraic foot through diverse strategies like vowel lengthening, syllable addition, etc. Even languages with numerous monomoraic lexical words may impose a minimality requirement on derived words that would otherwise be smaller than a well-formed foot. In addition, the minimal word has been argued to play a central role in characterizing a prosodic base within some morpho-prosodic constituent for the application of processes such as reduplication and infixation.

The goal of this thesis is to offer an explanation as to why and in which contexts grammars may prefer a prosodic constituent which may not be reducible to a bimoraic foot. I provide explanatory accounts for a number of cases where the prosodic structure of morphological or phonological constituents cannot be defined as coextensive with the main stressed foot of the language. To this end, I propose to add to the theory of Prosodic Structure (Chen 1987; Selkirk 1984, 1986, 1989, 1995; Selkirk and Shen 1990) within an optimality-theoretic framework by providing evidence for a new level within the Prosodic Hierarchy, that of the Prosodic Stem (PrStem).

An important aspect of the model of prosodic structure proposed here is a notion of headship which follows directly from the Prosodic Hierarchy itself and from the metrical grouping of prosodic constituents. A theory of prosodic heads is developed which assumes that structural constraints can impose well-formedness requirements on the prosodic shape and the distribution of heads within morphological and phonological constituents.

RESUME

LES DOMAINES PROSODIQUES DANS LA THEORIE DE L'OPTIMALITE

A travers les systèmes linguistiques, la notion de 'mot minimal' s'est trouvée être très riche en solutions explicatives en ce qui concerne les demandes prosodiques imposées à certains constituants morphologiques et phonologiques. La notion de minimalité demande que le mot lexical contienne au moins un pied bien formé, celui recevant l'accent fort du mot. Le mot sous-minimal est donc augmenté de diverses façons afin de devenir bimoraïque. Même les langues aux nombreux mots lexicaux ne consistant que d'un pied monomoraique peuvent demander que les mots dérivés morphologiquement soient au moins bimoraïques. De plus, le mot minimal a été proposé comme le facteur principal dans la délimitation d'une base prosodique à l'intérieur d'un constituant prosodique ou morphologique pour certains procédés comme la réduplication et l'infixation.

Le but de cette thèse est d'offrir une explication, à savoir pourquoi et dans quel contexte une grammaire peut choisir un constituant prosodique qui ne soit pas coextensif avec le pied bimoraïque. Dans ce but, la présente thèse propose une extension à la théorie de la Structure Prosodique (Chen 1987; Selkirk 1984, 1986, 1989, 1995; Selkirk and Shen 1990) à l'intérieur de la théorie de l'Optimalité avec introduction d'un nouveau niveau métrique à l'intérieur de la Hiérarchie Prosodique, celui du radical prosodique (PrStem).

Un aspect important du modèle de la structure prosodique proposé dans cette thèse est une notion de la tête prosodique qui découle directement de la Hiérarchie Prosodique et des groupements métriques des constituants prosodiques. La théorie développée dans cette thèse concernant les têtes prosodiques présuppose des contraintes structurales imposant certaines conditions à la forme prosodique et à la distribution des têtes à l'intérieur des constituants morphologiques et phonologiques.

Acknowledgments

It is entirely due to Glyne Piggott that this dissertation was ever completed. I am especially indebted to him, not just for his comments and criticisms, but also for his patience and good humour. He taught me phonology, but more importantly he taught me to be open-minded and even enthusiastic when faced with novel approaches and new ideas.

To the whole department of linguistics at McGill, I also owe a great deal of gratitude for their support all through these years.

Je tiens aussi à remercier mes parents pour leur amour et compréhension. Je tiens à les remercier pour la confiance qu'ils m'ont accordée à travers toutes les étapes qui ont mené à la complétion de cette thèse. Je leur suis redevable d'une aide précieuse.

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Chapter 1

Introduction

Cross-linguistically, the notion 'minimal word' has proven to be fruitful grounds for explanatory accounts of prosodic requirements imposed on morphological constituents (McCarthy and Prince 1986, 1990ab; Spring 1990; Poser 1990; Mester 1990). Word minimality requires that a lexical word include at least the main stressed foot of the language. As a result, subminimal words are augmented to a bimoraic foot through diverse strategies like vowel lengthening, syllable addition, etc. Even languages that have numerous monomoraic lexical words may impose some minimality requirement on morphologically derived words that would otherwise be smaller than a well-formed foot. In addition, the minimal word has been argued to play a central role in delimiting a prosodic base within some morpho-prosodic constituent for the application of processes such as reduplication and infixation. Interestingly, word minimality requirement on 'derived' words often brings with it the additional requirement that these words be no larger than one foot.

The goal of this thesis is to offer an explanation as to why and in which contexts grammars may prefer a prosodic constituent which is not reducible to a bimoraic foot. In this thesis, a number of cases where the prosodic structure of some morphological or phonological constituents cannot be defined as coextensive with the main stressed foot of the language are given a unified account within an optimality-theoretic framework. To this end I propose to add to the theory of Prosodic Structure (Chen 1987; Selkirk 1984, 1986, 1989; Selkirk and Tateishi 1988; Selkirk and Shen 1990) by providing evidence for a new metrical level within the Prosodic Hierarchy, that of the Prosodic Stem (PrStem). I will show that the addition of the PrStem to the Prosodic Hierarchy eliminates the need to resort to explicit statements such as "P-Stems can be no smaller than two syllables" (Downing 1998), or "The Reduplicant is left and right-aligned with the corresponding edge of different syllables" (McCarthy and Prince 1993b) in order to account for disyllabic requirements imposed on prosodic constituents.

My proposal holds that this sort of disyllabic requirements can be given a unified account by means of structural constraints that are active throughout the phonology of the language. It will be shown that the choice between the different prosodic structures follows from the specific rankings of these structural constraints in some language. I will further argue that these constraints play an important part not only in the prosodic structure of lexical and derived words but also in the stress system of languages.

An important aspect of the model of prosodic structure proposed here is a notion of headship which follows directly from the Prosodic Hierarchy itself and from the metrical groupings of prosodic constituents. A theory of prosodic heads is developed which assumes that structural constraints can impose well-formedness requirements on the prosodic shape and the distribution of heads within morphological and phonological constituents.

This chapter is laid out as follows: In §1.1, a brief outline of the basic tenets of the theory of Prosodic Structure is presented. §1.2 describes the central claims of Optimality Theory. In §1.3, a number of cases where some morphological or phonological domain cannot be easily defined as coextensive with the main-stressed foot of the language are examined. In §1.4, the model of prosodic structure developed in this thesis is introduced. Finally, §1.5 presents an overview of the thesis.

1.1 The Theory of Prosodic Structure

The theory of Prosodic Structure holds that the prosodic organization of sentence phonology is defined on morpho-prosodic constituents that correspond to, but are distinct from, the morpho-syntactic constituents of the sentence. According to this theory of the syntax/prosody interface, sentences are organized into prosodic structures defined in terms of the categories specified by the Prosodic Hierarchy.

1. **The Prosodic Hierarchy** (Selkirk 1995)

Utt	Utterance
IP	intonational phrase
PPh	phonological phrase
PWd	prosodic word
Ft	foot
σ	syllable

The Strict Layer Hypothesis (Selkirk 1984; Nespor and Vogel 1986) imposes structural constraints on the prosodic categories specified by the Prosodic Hierarchy. Conceived as a single constraint, the Strict Layer Hypothesis requires that a prosodic category of level *i* immediately dominates only categories of the next level *i*-1. Inkelas (1989) and Itô and Mester (1992) have argued, however, that the Strict Layer Hypothesis should instead be subdivided into a number of independent well-formedness conditions. Selkirk (1995), for example, proposes the following set of constraints on prosodic domination.

2. **Constraints on Prosodic Domination**
(where C^n = some prosodic category)

(i) *Layeredness* — No C^i dominates a C^j, $j > i$
e.g. "No σ dominates a Ft."

(ii) *Headedness* — Any C^i must dominate a C^{i-1} (except if $C^i = \sigma$)
e.g. "A PrWd must dominate a Ft."

(iii) *Exhaustivity* — No C^i immediately dominates a constituent C^j, $j < i-1$
e.g. "No PrWd immediately dominates a σ."

(iv) *Nonrecursivity* — No C^i dominates a constituent C^j, $j = i$
e.g. "No Ft dominates a Ft."

Taken together, Layeredness and Headedness define the hierarchical organization of the Prosodic Hierarchy. Both appear to hold universally. Exhaustivity, on the other hand, is regularly violated in numerous languages where syllables are found immediately dominated by a PrWd (cf. Inkelas 1989; Itô and Mester 1992; Prince and Smolensky 1993; McCarthy and Prince 1993ab; Kager 1996ab). Nonrecursivity has also been argued to be a violable constraint, at least at the level of the PrWd and higher (Inkelas 1989; McCarthy and Prince 1993ab; Selkirk 1995; Kager 1996a).

Another class of constraints crucial to the well-formedness of prosodic structure is defined in terms of the alignment of edges between morpho-syntactic structure and prosodic structure. These constraints require that the right/left edge of some grammatical constituent coincides with the corresponding edge of some phonological constituent.

The theory of Generalized Alignment proposed by McCarthy and Prince (1993ab) within Optimality Theory extends the notion of edge alignment to include a correspondence of edges between word-internal morphological constituents and word-internal metrical constituents. These constraints are defined following the general schema given below:

3. *Generalized Alignment (GA)*

Align(Cat_1, $Edge_1$, Cat_2, $Edge_2$) $=_{def}$
$\forall$ Cat_1 $\ni$ Cat_2 such that *$Edge_1$* of Cat_1 and *$Edge_2$* of Cat_2 coincide,
where
Cat_1, Cat_2 $\in$ PCat $\cup$ GCat (Prosodic and Grammatical categories)
$Edge_1$, $Edge_2$ $\in$ {Right, Left}

GCat consists of morphological categories (Word, Stem, Affix, Root, etc.), while PCat consists of prosodic categories (Mora, Syllable, Foot and Prosodic Word). Informally, Align(Cat_1, ..., Cat_2, ...) is read as follows: "the designated edge of *every* Cat_1 coincides with the designated egde of *some* Cat_2".

1.2 Optimality Theory

Optimality Theory holds that grammars consist of a set of universal constraints. Surfacing outputs result from the language-specific rankings of these constraints. The main insight of this theory is that the selected outputs need not be "perfect" with respect to the various and sometimes conflicting constraints. The chosen or surfacing outputs need only to be optimal, i.e. the best of all possible outputs within a particular grammar, given the underlying segmental structure of the input and the hierarchical dominance of certain constraints over others in a particular grammar.

In the optimality-theoretic framework, constraints can be roughly divided into two classes. Those that demand perfect identity between input and output forms (faithfulness constraints) and those that impose well-formedness requirements on prosodic constituents (structural constraints). One important aspect of Optimality Theory is the claim that the complexity of surfacing outputs results from the domination by faithfulness constraints of most of the high-ranking structural constraints of the language. Language diversity, on the other hand, follows from the way in which each language's grammar chooses to rank those two sets of constraints among themselves and with respect to each other.

1.3 Some Problematic Cases

According to the Strict Layer Hypothesis of Selkirk (1984), the ideal situation is a prosodic word that only consists of one or more feet, either bimoraic or disyllabic, i.e. no syllable is parsed directly by the PrWd (i.e. no Exhaustivity violations). This is not always possible, however, particularly in odd-syllable words or in words in which the position of heavy syllables interferes with the metrical grouping of syllables into binary constituents.

At issue here is how to account for morphological phenomena and stress patterns in which the distribution of prosodic constituents leaves syllables unfooted in contexts where a more satisfactory parse in regard to the Strict Layer Hypothesis could be obtained. Also at issue is the treatment of minimally disyllabic constituents in languages where the bimoraic syllable is the main-stressed foot.

1.3.1 Minimally Disyllabic Domains

One well-known example of a minimally disyllabic requirement on prosodic constituents comes from the formation of loanword abbreviations in Japanese (Itô 1990; Itô and Mester 1992). As extensively demonstrated in Poser (1984, 1990), name shortening in Japanese conforms to a bimoraic template, either $(\sigma_\mu\sigma_\mu)$ or $(\sigma_{\mu\mu})$. Loanword clippings, however, must be minimally disyllabic. The problem is compounded by the fact that trisyllabic constituents are perfectly acceptable word clippings, as shown in (4c-d).

4. *Word Clippings* (Itô 1990; Itô and Mester 1992)

a. $(\sigma\ \sigma)$

su to (raiki)	'strike'
hi su (terii)	'Hysterie' (German)
ra bo (ratori)	'laboratory'

b. $(\mu\ \mu)\ (\mu\ \mu)$

to ri ku ro (roetireN)	'trichlorethylene'
koN bi ni (ensu)	'convenient store'
baa teN (daa)	'bartender'

c. $(\mu\ \mu)\ \mu$		d. $(\sigma\sigma)\ \mu$	
day ya (moNdo)	'diamond'	te re bi (žon)	'television'
koN bi (neešon)	'combination'	ba su ke (tto)	'basket'

Word clippings have a minimal prosodic shape of two syllables and a maximal prosodic shape of four. The word clippings in (4c-d) represent what Itô and Mester (1992) refer to words that consist of a bimoraic foot followed by a syllable as 'loose' minimal words.

An even more striking pattern is found in Guugu Yimidhirr, an Australian language spoken in Queensland (Haviland 1979). Both its morphology and phonology regularly refer to an initial prosodic domain that is precisely two syllables, irrespective of syllable weight. For example, main stress and vowel length contrasts are restricted to the first two syllables of the word. As shown by the data below, main stress is initial (5a-d), unless a long vowel is found in the second syllable of the word, in which case the long vowel receives main stress (5e-g). When both the first and second syllables contain a long vowel, both syllables receive main stress (5h).

5. *The Distribution of vowel length* (Kager 1996a)

a.	míil	'eye'	e.	dawáaɽ	'star'
b.	wáaɖa	'crow'	f.	bulbúuɽ^{m}bul	'pheasant'
c.	wáaɽigàn	'moon'	g.	ɖamáaɽbinà	'magpie goose'
d.	gúuɽumùgu	'meat hawk'	h.	dáaráalŋàn	'kangaroo'

The secondary stress pattern is determined by the position of long vowels within the word. If there is only one heavy syllable in second position, then stress is iambic, otherwise the secondary stress pattern is trochaic. Obviously, the initial disyllabic domain of Guugu Yimidhirr cannot be defined as a foot, since it may consist of two bimoraic syllables (5h).

1.3.2 Bimoraic Syllables as the Main-Stressed Foot

In the right-headed stress system of Chugach, one of two dialects of Pacific Yupik, long vowels and diphthongs are obligatorily parsed as a unique foot (Leer 1985ab). Closed syllables, on the other hand, are usually parsed as part of a disyllabic foot. In fact they are often found in the weak position of a foot.

6. *Chugach Ternary Stress System* (Hayes 1995)

a. a.tú.qu.ni.kí	'if he (refl.) uses them'
b. án.či.qu.kút	'we'll go out'
c. núy.yái	'her hair'
d. náa.qu.ma.lú.ku	'apparently reading it'
e. íq.ɬuk.qíi.ŋa	'she lied to me'
f. át.max.čí.quá	'I will backpack'

Word-initially, however, a closed syllable is always parsed as a monosyllabic foot (6b, e-f). In addition, the onset of a long vowel or diphthong becomes geminated when preceded by a word-initial short open syllable in order for the initial syllable to be parsed as a foot (6c). The challenge presented by Chugach, apart from the problem of weight variability in closed syllables, is how to define the trisyllabic grouping LLL and the disyllabic grouping HL, while accounting for the fact that a bimoraic syllable is never parsed as the head of a disyllabic foot (LH), usually regarded as the most harmonic iambic foot (McCarthy and Prince 1990b; Prince 1990).

The left-headed stress system of Mohawk presents a similar problem. Although the language does not have underlying long vowels, whenever the stressed syllable is open, the vowel is lengthened, resulting in a HL sequence at the right edge. Mohawk has main stress on the rightmost nonfinal syllable. Interestingly, as shown by the data below, the presence of an epenthetic (underlined) vowel in the final or penultimate syllable results in the retraction of main stress to the antepenultimate syllable (7d-f).

7. *Mohaw Stress Pattern* (Piggott 1995)

a.	k-atirut-haˀ	[katirútthaˀ]	'I pull it'
b.	wak-ashet-u	[wakashé:tu]	'I have counted it'
c.	k-hyatu-s	[khyá:tus]	'I write'
d.	te-k-rik-s	[tékeriks]	'I put them together'
e.	t-ʌ-k-ahsutr-ʌ-ˀ	[tʌkahsúterʌˀ]	'I will splice it'
f.	ʌ-k-arat-ˀ	[ʌká:rateˀ]	'I lay myself down'
g.	ro-kut-ot-ˀ	[rokú:toteˀ]	'he has a bump on his nose'

What is most striking about the data above is that a stressed vowel never lengthens when immediately followed by an epenthetic vowel (7d-e). Another aspect of the disruptive effect of epenthetic vowels can be found in their invisibility to the word-minimality condition. Subminimal stems (i.e. stems with only one underlying vowel) are augmented through the insertion of a prothetic [i].

8.

a.	k-yʌ-s	[íkyʌs]	c.	s-riht	[íseriht]
b.	k-ek-s	[í:keks]	d.	t-n-ehr-ˀ	[ítenehreˀ]

As shown in (8c-d), augmentation results in a metrical grouping that is minimally trisyllabic and maximally quadrisyllabic, whenever an epenthetic vowel is present. Thus, although the main stress foot is bimoraic, the minimal word in Mohawk is not reducible to either a bimoraic or disyllabic foot.

An even more interesting pattern is found in the stress system of Estonian (Prince 1980). Although the language seems at first glance to have heavy closed syllables (i.e. final CvCC syllables are stressed), closed syllables are found in both the strong and the weak positions of a disyllabic foot.

9.	*Binary Stress in Estonian*	*Ternary Stress in Estonian*	
a.	té.ra.và.mal.t	té.ra.va.màl.t	'more skillful, gen.sg.'
b.	pá.ri.màt.tel.t	*pá.ri.mat.tèl.t	'the best, abl.pl.'

c.	pí.mes.tà.va.le	pí.mes.ta.và.le	'blinding, ill.sg.'
d.	pí.mes.tà.vas.se	pí.mes.ta.vàs.se	'blinding, ill.sg.'
i.	pí.mes.tàt.tu.te	*pí.mes.tat.tù.te	'the dazelled, gen.pl.'
j.	ú.lis.tà.va.mài.t	ú.lis.ta.và.mai.t	'...'

The Estonian stress system differentiates between closed and open syllables in two ways. First, a final superheavy syllable (CvvC and CvCC) that cannot be parsed by a disyllabic foot always forms a foot on its own. This is shown in the ternary pattern (i.e. second column) of (9a-b) and in the binary pattern (i.e. the first column) of (9j) Second, in the optional ternary stress pattern, only an open syllable can be left unfooted. A closed syllable must be parsed as the head of a following foot (9b, i).

Thus, the system of Estonian must either allow for a ('LH) trochaic foot or one must assume that weight is variable in the language. The problem with the latter assumption, is how to define the context in which a closed syllable is treated as light (or heavy). Any analysis of the stress system of Estonian must also account for the variably disyllabic and trisyllabic groupings.

1.4 A Model of Prosodic Structure

The fact that, in languages as diverse as Japanese, Guugu Yimidhirr and Mohawk where the main stress foot is bimoraic, some prosodic or morphological constituent may require a minimally disyllabic shape shows that the assumption that word minimality is reducible to the notion of foot minimality cannot account for all the minimality requirements that may be imposed on prosodic constituents. Any constituent that is minimally two syllables and maximally two feet cannot be treated as coextensive with the main stressed foot.

1.4.1 The Prosodic Stem

Following Inkelas (1989), Downing (1998) proposes that the Prosodic Hierarchy should be extended to include the sub-lexical morpho-prosodic constituents P-Stem and P-Root.[1]

---

[1] Affixes, like function words, would not be part of the Prosodic Hierarchy.

These morpho-prosodic constituents smaller than the phonological word are distinct from the metrical constituents which are ususally considered to be the sub-lexical members of the Prosodic Hierarchy.

10.

The P-Hierarchy	vs.	**The Metrical Hierarchy**
Utterance		
|		
intonational phrase	Post-lexical	
|		
phonological phrase		
|		
----- phonological word -----		Prosodic Word
|		|
phonological stem	Lexical	Foot
|		|
phonological root		Syllable

Downing's proposal allows for mismatches between some morphological constituent (M-Constituent) and its corresponding morpho-prosodic constituent (P-Constituent). In other words, the two constituents may be misaligned to improve the structural well-formedness of the P-Constituent (always assuming that phonological processes are defined on prosodic domains rather than morpho-syntactic domains).

Extending Downing's P-Hierarchy and Metrical Hierarchy further, I propose that the disyllabic requirement imposed on morpho-prosodic and prosodic metrical constituents reflects the properties of a metrical constituent, the Prosodic Stem (PrStem) which is found between the PrWd and the foot within the Prosodic Hierarchy. [2]

11. **Metrical Hierarchy**

Prosodic Word
|
Prosodic Stem
|
Foot
|
Syllable

---

[2] Such a constituent has also been proposed by Itô (1990) for Japanese word clippings, but her assumptions about the prosodic stem are closer to those of Downing than to mine. She assumes the prosodic Stem to be morphologically defined and that ternary domains result from the addition of a light syllable Affix to an obligatorily bimoraic stem. Her proposal is discussed in more detail in §2.1.

According to this model, the foot is immediately dominated by some PrStem which by transitivity is also defined as the head of the PrWd.

Downing assumes that there is direct correspondence between M-constituents and P-constituents. In my proposal, no such correlation is assumed between a phonological stem (P-Stem) and a PrStem. In fact, given the possibility of recursive PrWd structures, not every PrWd needs be in direct correspondence with some phonological word (P-Word). Similarly, a phonological stem may include more than one PrStem within its morpho-prosodic domain.

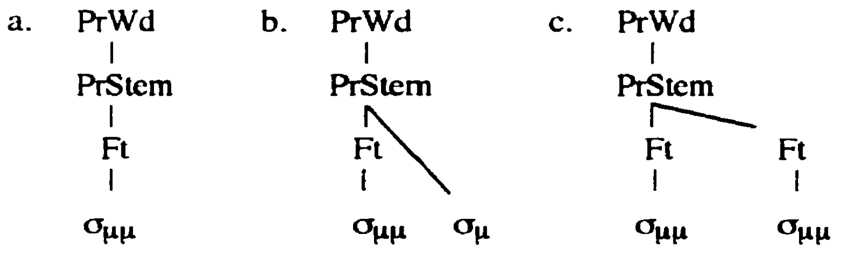
1.4.1 Prosodic Structure

Central to our concerns in this thesis is the prosodic organization of the PrStem and its distribution within a PrWd. I will start by assuming that all sublexical metrical constituents are maximally binary, including the PrStem. [3]

12. **BINARYBRANCHING COND**
Heads of metrical constituents are maximally binary.

This universally undominated constraint demands that the sublexical metrical constituents PrStem, foot and syllable maximally consist of a head and a non-head constituent. The candidates in (13) illustrate the prosodic organization of a PrStem uniquely dominated by a PrWd. Note that the bimoraic foot in the structures below also stands for a disyllabic foot.

13



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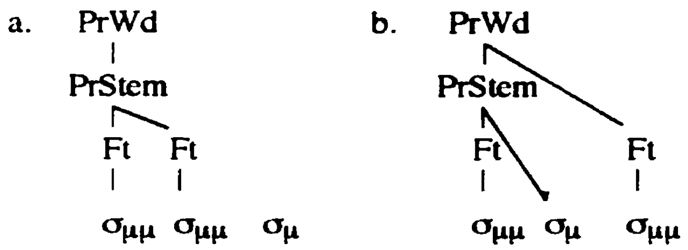
[3] Although there have been a few analyses that assumed otherwise, the standard assumption in prosodic phonology is that feet are maximally disyllabic and syllables maximally bimoraic.

The smallest prosodic structure in (13a) satisfies the Strict Layer Hypothesis, as does the candidate structure in (13c). The candidate in (13b), on the other hand, minimally violates Exhausitivity. Two additional candidates which also violate Exhaustivity are given below.

14



In (14a), the rightmost syllable is directly parsed by the PrWd, violating Exhaustivity, while both feet are immediately dominated by the PrStem, satisfying the constraint. In (14b), the rightmost foot and the medial monomoraic syllable violate Exhaustivity.

I propose that of the three PrStem structures which violate Exhausitivity, those in (13b) and (14b) should be evaluated as more optimal than the candidate in (14a) with respect to the parsing of prosodic constituents.

15. **PARSE-PRCAT**
Every prosodic category is parsed in the head or non-head position of some metrical constituent.

Here I assume that a relation between a head and a non-head is restricted to the same level or one level down within the Prosodic Hierarchy. That is, a syllable directly parsed by the PrWd cannot be defined as being in a non-head relation with either the head PrStem or the head foot of a PrStem. This notion of locality can be expressed in terms of Itô and Mester's (1992) Hierarchical Locality condition which limits the access to structural information to only one level down.

16. *Hierarchical Locality*
A condition operating at prosodic level C_i has access only to structural information at C_i and at the subjacent level C_{i-1}.

According to the locality condition, the head foot of a PrStem can only be in a relation with another foot (level C_i) or a syllable (level C_{i-1}) immediately dominated by the PrStem. The head PrStem of a PrWd, on the other hand, cannot be in a head-non-head relation with a syllable (level C_{i-2}) immediatly dominated by the PrWd.

1.4.2 Headedness and Metrical Constituents

In the model of prosodic structure developed here, the Prosodic Hierarchy is assumed to encode both constituent domination and headship. A problem inherent to the standard view of most proponents of the intrinsic nature of heads lies in the assumption that absence of prominence on the grid follows from the absence of foot structure in the output. For those that view headedness as imposed on metrical constituents, lack of prominence is assumed to result from the parsing of a headless constituent (Hung 1994; Crowhurst 1996; Hewitt and Crowhurst 1996).

Satisfaction of Headedness, however, is usually assumed to be universal at least with respect to the prosodic word and higher prosodic constituents (cf. Selkirk 1995). If Headedness is a requirement imposed on all (non-terminal) sublexical metrical constituents of the Prososic Hierarchy, then headless feet (and headless PrStems) could never be well-formed prosodic constituents.[4]

Here I propose that the notion of headship resulting from the Prosodic Hierarchy is independent of the notion of prominence of the grid. My proposal is laid out as follows: the metrical grid only reflects relative prominence between grid marks projected by the heads of constituents. Well-formedness constraints dealing with syllable structure and how syllables are to be parsed into metrical constituents determine the position of heads within the PrWd. The location of grid marks to the metrical grid, on the other hand, is determined by constraints defining what type of head may project onto the grid. Thus, lack of prominence on the grid only reflects the non-projection of a grid mark by a certain type of head rather than the absence of constituency or the existence of headless constituents.

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[4] The prosodic structure of syllables, on the other hand, is dependent on the segmental and moraic content of the lexical input. Although moras are regarded as the head of a syllable, the moraic content of a syllable is often unpredictable, allowing for headless syllables. Also, in contrast with the metrical constituents in the Prosodic Hierarchy, moras are confined to the syllable itself.

1.5 Thesis Overview

In the rest of the thesis, theoretical and empirical evidence for the PrStem will be presented. The analysis of strictly or minimally disyllabic constituents in languages where the bimoraic syllable ($\sigma_{\mu\mu}$) is a possible foot will be shown to offer strong evidence for the PrStem as a new metrical constituent within the Prosodic Hierarchy. This conception of an enriched Prosodic Hierarchy will be shown to offer a restrictive and unified account of the possible prosodic shapes that define the minimal PrWd accross languages. Analyses of binary and ternary stress systems will also provide support for the introduction of the PrStem by demonstrating the role played by this new metrical constituent in longer words, where the PrStem is not coextensive with the whole word.

In chapters 2 and 3, the diverse prosodic shapes of truncated words in Japanese and the nominal and verbal systems of Arabic are analyzed and the role played by the PrStem is shown to be crucial in the minimal shape of truncated nouns in Japanese and of nominal and verbal stems in Arabic. In chapter 4, the stress systems of a number of Arabic dialects also offer evidence for the position taken in this dissertation that headedness and grid prominence are related but independent notions.

The first section of chapter 5 presents an analysis of the strictly disyllabic system of Guugu Yimidhirr. A number of properties of the main stress domain are accounted for by assuming that the PrStem immediately dominates the main-stressed foot of the language. The second section deals with the ternary stress system of Cayuvava. It is argued that with the addition of only one constraint and by postulating some rerankings for the constraints already introduced in the preceding chapters, most of the differences between the ternary pattern of Cayuvava and the binary pattern of Guugu Yimidhirr can be accounted for in a straightforward manner. In the last section, the optionally binary and ternary stress patterns of Estonian are shown to follow from the rerankings of the structural constraints introduced earlier in the dissertation.

Finally, chapter 6 presents an analysis of the iambic and trochaic stress systems of Chugach and Mohawk respectively. It is argued that the variable weight of closed syllables in some contexts and the requirement that a heavy syllable be uniquely parsed as a foot follow from requirements on the parsing of metrical constituents and of their heads.

Chapter 2

Japanese Truncation

In Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1993ab, 1994), language variation follows from the way in which grammars choose to order the set of universally available constraints with respect to one another. One important aspect of this framework is that the complexity of surfacing outputs results from the domination of some faithfulness constraints over most of the high-ranking structural constraints of the language.

In phonologically-conditioned morphological processes such as reduplication and truncation, sets of correspondence constraints distinct from those regulating input-output faithfulness are assumed. One of the most interesting predictions of this framework is that reduplicated or truncated forms should allow for the surfacing of 'unmarked' structures --- 'unmarked' in terms of the high-ranking structural constraints of a particular language (McCarthy and Prince's (1994) "the emergence of the unmarked" or TETU).

McCarthy and Prince (1993b, 1994) argue for example that, when not constrained by higher-ranked faithfulness constraints, the optimal PrWd consists of at least one foot to satisfy the Prosodic Hierarchy (HEADEDNESS), every syllable is immediately dominated by a foot (PARSE-σ), which is minimally bimoraic (FTBIN) and perfectly aligned with the edge of a PrWd (ALL-FT-LEFT/RIGHT).

As pointed out by Itô and Mester (1992), the existence of a large class of syllable groupings larger than a single bimoraic foot has always been problematic for any theory that predicts word minimality to be reducible to foot minimality. Also problematic is the existence of different phonologically-empty morphological constituents within a single language that productively differentiate between a bimoraic foot and a disyllabic foot. In this chapter, a unified account of truncation phenomena in Japanese is provided in terms of 'the emergence of the unmarked'. I will argue that the various prosodic shapes of the truncation morphemes in Japanese result from the satisfaction of a number of high-ranking structural constraints which are minimally violated in the general phonology of Japanese.

2.1 The Bimoraic Foot as Minimal PrWd

Itô (1990) makes the observation that Tokyo Japanese has numerous monomoraic words (e.g. *su* 'vinegar', *ta* 'rice field', *ko* 'child'). These words are lexical roots that are not augmented to bimoraicity. In other words, Japanese allows for a subminimal foot as the minimal PrWd. Bimoraicity imposed on 'derived' words, on the other hand, is a pervasive process in the language. Poser's (1984, 1990) extensive study of personal name shortening in Japanese has demonstrated that morphological truncation conforms to a bimoraic constituent, i.e. a bimoraic trochaic foot. Three different types of truncation are discussed in this section.

Hypocoristic formation in Japanese shortens personal names to a single bimoraic foot (Poser 1990; Mester 1990; Itô 1990).[1] (Only a placeless nasal (N), the first part of a geminate or a nasal homorganic to a following stop may be found at the right edge of a syllable in Japanese.)

1. *Hypocoristic Formation* (Poser 1984, 1990)

Midori	Mido-čaN, Mii-čaN
Yooko	Yoko-čaN, Yoo-čaN
Akira	Aki-čaN
Hiromi	Hiro-čaN, Romi-čaN
Mariko	Mari-čaN, Mako-čaN, Riko-čaN, Maa-čaN
JuNko	JuN-čaN
Hanako	Hana-čaN, Haa-čaN, Hač-čaN
Kazuhiko	Kazu-čaN

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[1] For a discussion of Japanese hypocoristics in Optimality Theory, see Benua (1995), Suzuki (1995).

The truncated forms are always followed by the Hypocoristic suffix -čaN. A bimoraic shape, however, is imposed on all the truncated forms.

In the second pattern, the Rustic Girls' name formation, female names are also shortened to a bimoraic foot. Rustic Girls' names take the honorific prefix *o-*.

2. *Rustic Girls' Names* (Poser 1990; Mester 1990)

Yukiko	o-Yuki	*o-Yuu, *o-Yuko
Fumie	o-Fumi	*o-Fuu, *o-Fue
Yooko	o-Yoo	
RaNko	o-RaN	
Ietaka	o-Ie	(input is a last name)[2]
Kirišima	o-Kiri	(input is a last name)

These shortened names differ from Hypocoristics in that the truncated forms in the Rustic Girls' formation are an identical copy of the initial bimoraic foot of the base. No variation is allowed in the mapping of the base to the bimoraic foot.

The third type of truncation discussed in Poser (1990) involves the names of regular clients of Geisha Houses and Japanese-style bars and restaurants. These clients are referred to by a shortened form of their family names. Formation of the Geisha House Client names differs from the two previous patterns in that these truncated forms consist of only one bimoraic syllable.

3. *Geisha House Client Names* (Poser 1990; Mester 1990)

Tanaka	o-Taa-saN	*o-TaN-saN	*o-Tana-saN
HoNda	o-Hoo-saN	o-HoN-saN	
Saito	o-Saa-saN	o-Sai-saN	*o-Sato-saN
Hattori	o-Haa-saN	*o-Has-saN	*o-Hato-saN
Yasuda	o-Yaa-saN	*o-Yas-saN	*o-Yasu-saN

The truncated forms are obligatorily followed by the suffix *-saN* and are preceded by the honorific prefix *o-*.

All three truncative morphemes surface with a prosodic shape that can be defined as a minimal PrWd: i.e. an output form whose prosodic shape is no smaller but also no larger than one bimoraic foot. In the next section, two additional morphological processes in

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[2] The last two examples are from Suzuki (1995).

Japanese are discussed. Both processes are characterized by a canonical[3] prosodic shape that is larger that a foot.

2.2 The 'Loose' Minimal Word

The first pattern involving truncated forms with a canonical prosodic shape larger than a foot is that of word clippings discussed in Itô (1990) and Itô and Mester (1992). This system of loanword abbreviations is quite productive in Modern Japanese. One of the most interesting characteristics of these truncated forms is the ban on bimoraic monosyllabic words. Truncated forms such as **dai* (cf. daiyamondo 'diamond'), **koN* (cf. koNbineešon 'combination') or **paa* (cf. paamaneNto 'permanent') are impossible word clippings in Japanese. Another interesting characteristic of these loanword abbreviations is that they can only begin with a foot, and not a syllable, i.e. ('$\sigma_{\mu\mu}$) or ('$\sigma_{\mu}\sigma_{\mu}$) (cf. *demo* vs. **demoN* from demoNsutoreešoN 'demonstration'). The full range of word clippings is illustrated below.

4. *Word Clippings* (Itô 1990; Itô and Mester 1992)

a.	$(\sigma\ \sigma)$	
	su to (raiki)	'strike'
	hi su (terii)	'Hysterie' (German)
	ra bo (ratori)	'laboratory'
	o pe (reešion)	'operation'
b.	$(\mu\ \mu)\ (\mu\ \mu)$	
	to ri ku ro (roetireN)	'trichlorethylene'
	a su pa ra (gasu)	'asparagus'
	koN bi ni (eNsu)	'convenient store'
	baa teN (daa)	'bartender'
c.	$(\mu\ \mu)\ \mu$	
	paa ma (neNto)	'permanent (perm hair style)'
	day ya (moNdo)	'diamond'
	koN bi (neešon)	'combination'
	ap pe (Ndisitisus)	'Appendizitis' (German)

---

[3] I use the term **canonical** prosodic shape to refer to the maximal expansion of a particular prosodic category.

d. (σ σ) μ

te re	bi	(žon)	'television'
ba su	ke	(tto)	'basket'
a ru	mi	(ɲuumu)	'aluminium'
a ni	me	(ešon)	'animation'

Word clippings have a minimal prosodic shape of two syllables and a maximal prosodic shape of four. The word clippings in (4c-d) represent what Itô and Mester (1992) refer to as 'loose' minimal words: i.e. words that consist of a bimoraic foot followed by a monomoraic syllable. Those in (4b) are described as supraminimal words.

Another set of data involving a prosodic shape larger than a single foot is provided by *zuuja-go*, a secret language among Japanese jazz musicians. In their analysis of the reversing argot *zuuja-go*, Itô and Mester (1992) show that the output patterns of this word game can be roughly divided into two categories depending on the size of the input. If the input has three moras or less, the output is usually trimoraic. If, on the other hand, the input is four moras or more, the output must consist of a sequence of syllables that can be parsed into two feet.

5.

Input		*ZG-Output*		
≤ 3μ		**Ft +**	**σ**	
1μ	me	ee	me	'eyes'
1μ	hi	ii	hi	'fire'
2μ	jazu	zuu	ja	'jazz'
2μ	mesi	sii	me	'food'
3μ	beesu	suu	be	'base'
3μ	piyano	yano	pi	'piano'
≥ 4μ		**Ft +**	**Ft**	
4μ	koohii	hii	koo	'coffee'
4μ	ikebana	bana	ike	'flower arrangement'
5μ	maneešaa	žaa	mane	'manager'
6μ	toroNbooN	boN	toro	'recorder'

Crucially, the *zuuja-go* pattern is characterized by an initial bimoraic foot followed by another prosodic category, either a syllable or a foot. In the next section, an overview of previous analyses of Japanese truncation within a serial framework is presented.

2.3 Previous Analyses

The problem presented by truncated forms in Japanese is twofold. First, we need to explain the prosodic requirements that impose restrictions on the parsing of a bimoraic foot: i.e. the ban on disyllabic feet ($\sigma_\mu \sigma_\mu$) in the formation of Geisha House Client names and the ban on monosyllabic feet ($\sigma_{\mu\mu}$) in the formation of word clippings. Second, we need to account for prosodic shapes that are larger than the main-stressed foot: the trimoraic ($(\mu\mu)\sigma_\mu$) and quadrimoraic ($(\mu\mu)(\mu\mu)$) forms in word clippings. An additional challenge is how to restrict the maximal prosodic shape of the truncated forms to two feet.

Most of the previous analyses of Japanese truncation have dealt with only a subset of the data introduced in the preceding section. Mester (1990), for example, focuses on the three productive processes of personal name shortening presented above. In keeping with the theory of Prosodic Morphology (McCarthy and Prince 1990ab; Lombardi and McCarthy 1991), Mester proposes to differentiate between the different shortening processes by appealing to the theory of prosodic circumscription (McCarthy and Prince 1990a).

In the model of Prosodic Morphology (McCarthy and Prince 1986, 1988, 1990ab), truncation is described as involving the mapping of the base melody onto a prosodically defined template. Mester (1990) argues that truncation templates can operate in two independently established ways: (a) as a prosodic target to which the base melody is mapped; (b) as a prosodic delimiter that effectively reduces base forms to a certain prosodic size. Mester proposes that the choice between these two strategies is what underlies the different prosodic shapes of the Hypocoristics and of the Rustic Girls' names. Mester analyzes the Hypocoristic morpheme as a bimoraic target template onto which the base form is mapped. As illustrated in (6), the mapping to the bimoraic foot template by the base melody is not constrained by the prosodic structure of the base.

```
6.    a.    [ μ   μ ] + čaN            b.    [ μ   μ ] + čaN
             /\   /\                          /\ /
            t a k a  ko   TakačaN            t a   ka ko   TaačaN

      c.    [ μ   μ ] + čaN
             /\   /
            t a N  a ko   TaNčaN
```

The Rustic Girls' morpheme, on the other hand, requires a bimoraic foot template which is defined as a prosodic delimiter that isolates the first foot of the base. The honorific prefix *o-* is then affixed to the positively circumscribed base, with the residue left unparsed.

```
7a.   [ μ   μ ]   -->     [ μ   μ ]     b.    [ μ   μ ]   -->      [ μ   μ ]
       /\   /\             /\   /\             /\  /                 /\  /
      y u k i  ko     o +  y u k i            y  o   ko        o +  y  o
```

Finally, Mester argues that the derivation of Geisha House Client names involves two different templates. First, a delimiting template circumscribes the initial syllable of the base. This truncated base is then mapped onto a bimoraic target template.

```
8a.                   σ
                      |
      Uno   --->    u no   --->     u             o-Uu-saN
                                    | \
                                  [ μ  μ ]

 b.                     σ                 [ μ  μ ]       o-HoN-saN
                       /|\                 /\ |
      HoNda  --->    h o N  da    --->    h o N
                                           |/\
                                          [ μ  μ ]       o-Hoo-saN
```

The problem with delimiting templates is that, as pointed out by McCarthy (1995), prosodic circumscription views as purely accidental the fact that the Rustic Girls' name formation both circumscribes a foot and maps to a foot template. That is, the prosodic shape of some Rustic Girls' names is that of a specific bimoraic foot (either monosyllabic or disyllabic), because prosodic circumscription restricts the base melody to the initial bimoraic foot in the input. However, the fact that both the delimiting template and the mapping template involve a foot (or in the case of Geisha House Client formation, a syllable) is regarded as purely coincidental.

Furthermore, as Mester himself notes, the possibility of targeting a monomoraic syllable in the Geisha House Client name formation seems problematic with regard to the proposal advanced in McCarthy and Prince (1990ab) that the delimiting use of prosodic templates should be restricted to the minimal word. As supporting evidence for the proposal that delimiting templates may target a single syllable, Mester briefly discusses a different truncation morpheme, one which obligatorily attaches to the Hypocoristic suffix *-ko*. The main characteristic of this truncation morpheme is that it is restricted to a monosyllabic shape. In contrast with the Geisha House Client names, this syllable can be either bimoraic or monomoraic. Mester gives as an example ***Hiromi*** which can surface as ***Hi.ko, Ro.ko, Mi.ko, Hik.ko, Hii.ko, RoN.ko.*** etc. but not as ****Hiro.ko, *Romi.ko*** or ****Hi.ro.mi.ko.***[4]

9. *Hypocoristic Formation* (based on Mester 1990)

Hiromi	Hi-ko, Ro-ko, Hii-ko, Hik-ko	*Hiro-ko, *Romi-ko
Tanaka	Ta-ko, Na-ko, Taa-ko, TaN-ko	*Tana-ko, *Naka-ko
HoNda	Ho-ko, Hoo-ko, HoN-ko	
Saito	Sa-ko, Saa-ko, Sai-ko	
Hattori	Ha-ko, Haa-ko, Hak-ko	*Hato-ko
Yasuda	Ya-ko, Su-ko, Yaa-ko, Yak-ko	*Yasu-ko, *Suda-ko

The new set of data, however, only adds to the problem of how to uniformally account for the truncation phenomena in Japanese in that the truncated forms in (9) are shown to optionally surface as a monomoraic syllable (the truncation morpheme cannot be viewed as minimally consisting of a well-formed foot).

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[4] The suffix is distinct from the usual ending *-ko* for women's names found in many of the examples in (2) and (3) above. These Hypocoristic forms are introduced in Tateishi (to appear).

Itô (1990) deals with a different type of problem posed by the Japanese data. She discusses almost exclusively the differences and similarities between Hypocoristics (1) and word clippings (4). Her analysis of the two processes relies on the observation that truncated names are never found in isolation (i.e. they are always followed by the affix -čaN), while word clippings involve free-standing words. Itô proposes a morphologically based prosodic distinction between (bound) *stem* and (free) *word* in Japanese. She argues that the two morpho-prosodic categories STEM and WORD must satisfy separate minimality requirements.

10. Minimal Stem Requirement: Min(STEM) $= F = (\mu\ \mu)$
Minimal Word Requirement: Min(WORD) $> \sigma$

In other words, the minimal prosodic stem is a bimoraic foot, while the minimal prosodic word is at least disyllabic. Both the prosodic stem and the prosodic word are defined as morphological constituents with a specific prosodic shape.

Itô assumes that, in contrast with underived words which come with their own underlying templates, Hypocoristics and word clippings are derived from their base forms, and therefore must satisfy the minimality requirements of the language. The idea is that since stems are part of words and every word must contain a stem, then, the disyllabic prosodic words must also properly contain the bimoraic prosodic stem. And since Japanese is a suffixing language, Itô argues that the unmarked position of the bimoraic stem is at the left edge of the prosodic word. Under this view, the contrast between the hypocoristic *sai (-càN)* 'little Saiko' and the word clipping *saike* from *saikederikku* 'psychedelic' follows directly from the minimal size requirements in (10).

11 a. Word
/ \
Stem Suffix
/ \
(sai) -čaN

b. **Word**
/ \
Stem Suffix
/ \
(sai) ke

c. **Word**
|
Stem
/ \
su to

In both (11a) and (11b), the disyllabic word contains a bimoraic stem followed by a syllable, which is defined by Itô as a quasi-suffix in the word clipping form. This suffixed syllable can be either monomoraic (11b) or bimoraic (as in (baa).(teN) from *baateNdaa* 'bartender'). In the word clipping *suto* from *sutoraiki* 'strike' (11c), on the other hand, the stem and the word completely overlap.

As shown by the latter form, the quasi-suffix is not an obligatory part of the prosodic word. Itô notes that the minimality requirements cannot prevent the inclusion of additional material to the truncated forms. This is exemplified by the free variation found in forms like *herikoputaa* 'helicopter' (disyllabic $[[\text{he.ri}]_{St}]_{Wd}$ vs. trisyllabic $[[\text{he.ri}]_{St}.\text{ko}]_{Wd}$). As a result, there is no explanation as to why word clippings should be restricted to two metrical constituents, i.e. two syllables, two feet, or a foot followed by a syllable. Itô's proposal is also problematic from an empirical point of view, since it cannot explain either the disyllabic ban of the Geisha House names or the optional monomoraic shape of the Hypocoristic forms attached to the suffix *-ko*.

A different proposal which anticipates many aspects of Optimality Theory is offered by Itô and Mester (1992). In their analysis of Japanese word clippings, Itô and Mester account for the 'loose' minimal word template in loanword abbreviations by proposing that the requirements governing prosodic constituents should be viewed as resulting from the interaction between distinct but related conditions on prosodic licensing.

As a minimal well-formedness condition governing the Prosodic Hierarchy, Itô and Mester propose Proper Headedness.

12. *Proper Headedness*
    Every (non-terminal) prosodic category of level i must have a head,
    that is, it must immediately dominate a category of level i - 1.

To account for unfooted syllables within a PrWd, they propose that the strong version of maximal parsing be replaced by a weaker version (the Weak Layering Hypothesis).

13. *Maximal Parsing*
    Prosodic structure is maximally parsed, within the limits imposed by other
    (universal and language-particular) constraints on prosodic form.

Itô and Mester then propose that the canonical prosodic shape of word clippings is achieved through the imposition of a well-formedness constraint restricted to words that are related to more basic forms by means of prosodic-morphological processes.

14. *Word Binarity*
    P-derived words must be prosodically binary.

To account for the minimal prosodic shape of word clippings, Itô and Mester argue that the moraic content of syllables is outside the domain of word-level conditions. They speculate that the opacity of syllable internal structure with respect to the word constraint may follow from a general locality condition limiting the accessibility of internal prosodic structure. That is, any constraint that specifically defines the prosodic shape of the PrWd domain should only see syllables and feet.[5]

15. *Hierarchical Locality*
    A condition operating at prosodic level C_i has access only to structural information at C_i and at the subjacent level C_{i-1}.

Under this view, the moraic content of syllables is invisible to well-formedness constraints imposed on PrWds, since only the foot-internal structure would be accessible at the word-level. Requirements regarding foot well-formedness, on the other hand, would have access to syllable-internal structure.

Crucially, Itô and Mester's analysis provides an approach in which the minimal prosodic shape of word clippings can be defined solely in terms of constraints on the shape of specific prosodic categories. That is, the prosodic shape of word clipping is defined by Foot Binarity and Word Binarity, while the left edge requirement is defined as a constraint that favors the coincidence of the left edge of a PrWd with that of a foot.

16. *Left Edge Matching*
    Left word edges preferentially coincide with foot edges.

---

[5] Itô and Mester (1992) assume that a mora is the terminal element in the Prosodic Hierarchy. Following McCarthy and Prince (1986, 1990ab, 1993ab), I assume that syllables, not moras, are the terminal elements in the Prosodic Hierarchy, with moras being defined as attributes of syllables and segments. See also Hung (1994), for arguments that moras are outside of the domain of the Prosodic Hierarchy within the framework of Optimality Theory.

Still problematic for their analysis, however, is the fact that Word Binarity, a minimality requirement, must also be viewed as a maximality requirement. Moreover, Word Binarity cannot be viewed as a condition imposed on all derived words in Japanese, since it is clearly not satisfied in the Rustic Girls' name formation (cf. o-Yoo and o-RaN in (2)).[6]

2.4 Japanese Truncation and Correspondence Theory

Optimality Theory seems particularly well-suited to deal with the non-uniformity of the truncation phenomena in Japanese. Central to the framework is the notion that high-ranking structural constraints may be minimally violated in some contexts in order to satisfy higher-ranked faithfulness constraints. The prediction then is that satisfaction of the high-ranking structural constraints should occur in contexts where faithfulness between the lexical input and the surfacing output does not play a role.

Correspondence theory (McCarthy and Prince 1995) postulates that phonologically-empty morphological constituents come with their own set of faithfulness constraints which regulate identity relations between a morphologically or prosodically-specified base and an output. Given the range of possible rankings that can be posited between the faithfulness constraints themselves and between these constraints and the structural constraints of the language, non-uniformity is predicted to be the norm rather than the exception.

2.4.1 The Emergence of the Unmarked

To my knowledge, there has been no previous attempt to provide a unified account of the two types of Japanese truncation morphemes, bound and free-standing, within Optimality Theory. I begin by briefly discussing two analyses that offer an optimality-theoretic account for some of the truncation morphemes presented in §2.1 and §2.2.

In their study of over- and underapplication in reduplication, McCarthy and Prince (1995) develop a theory of correspondence where reduplication involves a relation between

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[6] Note that to assume the honorific prefix o- to be part of the truncated form would be problematic, since the prefix does not obey the Left Edge Requirement. Here I assume that the prefix o- is an affixal clitic parsed by a recursive PrWd (cf. Selkirk 1995)

the base and the reduplicant (BR Identity), a relation between the lexical input and the base (IO Faith), and in some cases a relation between the input and the reduplicant (IR Faith).

17.
$$\begin{tikzcd}
\text{Input:} & \text{/Affix}_{\text{Red}} \arrow[d, shift left] & \text{-Stem/} \arrow[d, shift left] \\
\text{Output:} & \text{Red} \arrow[u, shift left, "\text{IR-Faith}"] \arrow[r, shift left] & \text{Base} \arrow[u, shift left, "\text{IO-Faith}"'] \arrow[l, shift left, "\text{BT-Identity}"]
\end{tikzcd}$$

Extending McCarthy and Prince's model to truncation morphology, Benua (1995) proposes that truncation involves two correspondence relations, an input-to-base relation (IO-Faith) and an output-to-output relation between two distinct (P-)Stems (BT-Identity). In contrast with reduplication morphology where base and reduplicant affix are part of the same input and simultaneously generated, in truncation morphology, the base and the truncated form surface as two separate words. The correspondence relations between the lexical input and the base, and between the base and the truncated form are encoded in the schematic model below (Benua 1995; McCarthy and Prince 1995).

18.
$$\begin{tikzcd}
\text{Input:} & \text{Root} \arrow[d, shift left] \\
\text{Output:} & \text{Base} \arrow[u, shift left, "\text{IO-Faith}"] \arrow[r, shift left] & \text{Stem}_{\text{Trunc}} \arrow[l, shift left, "\text{BT-Identity}"]
\end{tikzcd}$$

The input is mapped to the base by IO correspondence, and BT correspondence relates the base to the truncated form. Benua also assumes that in languages with multiple truncation morphemes, each truncation morpheme comes with its own set of BT-Identity constraints (cf. McCarthy and Prince 1995; Urbanczyk 1995).

Following McCarthy and Prince (1994), Benua argues that truncation to a bimoraic foot in Japanese is a case of the emergence of the unmarked PrWd. A PrWd is unmarked when it uniquely dominates a bimoraic foot that is perfectly aligned at the edge of the PrWd. Such an unmarked prosodic structure results from the domination of Max^{BT} by what Benua calls the 'PrWd restrictor' constraints, Ft-Bin, All-Ft-Left and Parse-σ.

19. **Ft-Bin** (McCarthy and Prince 1993a)
Feet are binary at some level of analysis (μ, σ)

All-Ft-Left
Align (Ft, Left, PrWd, Left)
"The left edge of every foot coincides with the left edge of some PrWd."

Parse-σ
Every syllable is parsed by a foot.

This is illustrated in the tableau below with the Hypocoristic form Mido-čaN from *Midori*. Note that the input structure of the Hypocoristic form is incomplete in that it abstracts the truncation morpheme away from its obligatory suffix -čaN.

20. Ft-Bin >> Parse-σ >> All-Ft-Left >> Max^{BT}

Candidates μ μ μ Base: mi.do.ri	Ft-Bin	Parse-σ	All-Ft-Left	Max^{BT}
μ μ a. √ (mi.do)				**
μ μ μ b. (mi.do.ri)	*!			
μ μ μ c. (mi.do).(ri)	*!		**	
μ μ μ d. (mi.do).ri		*!		

Ft-Bin is assumed here to require strict binarity so that the candidates in (20b-c) violate the constraint in being either too large (20b) or too small (20c). The candidate in (20c) also violates lower-ranked All-Ft-Left. As for the last candidate, it fatally violates Parse-σ. Interestingly, Benua does not discuss the optional bimoraic form Mii-čaN, so there is no account as to why the latter form is regarded as optimal as Mido-čaN, even though Mii-čaN creates two additional violations of Max^{BT}. (It does result, however, in one less violation of All-Ft-Left.)

Benua (1995) also provides an analysis of the Rustic Girls' name formation which reformulates Mester's (1990) prosodic circumscriptional analysis in optimality-theoretical terms. Adopting a proposal by McCarthy (1995), she proposes that the perfect faithfulness of the truncated form to the initial bimoraic foot of the base follows from two constraints that require the correspondence of peripheral segments with some prosodic constituent.

21. ANCHOR-R(FT)
"Every correspondent of a foot-final segment is foot-final."

22. ANCHOR-L(FT)
"Every correspondent of a foot-initial segment is foot-initial."

Such 'circumscription-type' constraints, however, fall short of providing an explanation for the strictly monosyllabic shape of Geisha House names, e.g. *o-Hoo-saN* from *(HoN)da* and *o-Taa-saN* from *(Tana)ka*. This type of prosodic identity constraint becomes even more problematic for the optionally bimoraic and monomoraic forms found with the Hypocoristic suffix -ko, e.g. *Mi-ko, RoN-ko* and *Hik-ko* from *(Hiro)mi*.

A different challenge presented by the Japanese data with respect to 'the emergence of the unmarked' notion of word minimality is how to define the various prosodic shapes of the word clippings. In the case of 'loose' minimal words, McCarthy and Prince (1994) assume that for some morpheme, ALL-FT-LEFT is satisfied, while PARSE-σ is minimally violated. This account does not so readily extend to loanword abbreviations in Japanese, however, since a perfectly well-formed word clipping consisting of two feet satisfies PARSE-σ fully while minimally violating ALL-FT-LEFT.[7]

Another solution, adopted by Suzuki (1995), is to assume that a PrWd larger than a foot follows from satisfying NONFINALITY.[8]

23. **NONFINALHFT**
No PrWd is right-aligned with its head foot.

The idea behind this proposal is that any word that begins with a heavy syllable will have to include a following syllable to satisfy the nonfinality constraint (cf. disyllabic *mai.ku* from

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[7] These word clippings that consist of two feet are usually dismissed as supraminimal, thus outside of the domain of any analysis of word minimality in Japanese.

[8] Suzuki's (1995) optimality-theoretical analysis of the Japanese data, however, is based on the assumption that MinWd is a prosodic requirement imposed on PrWds, contra McCarthy and Prince (1994).

maikurohoN 'microphone'). Under this view, trisyllabic forms like *te.re.bi* from *terebizōn* 'television' reflect the need to fully satisfy NONFINALHFT.

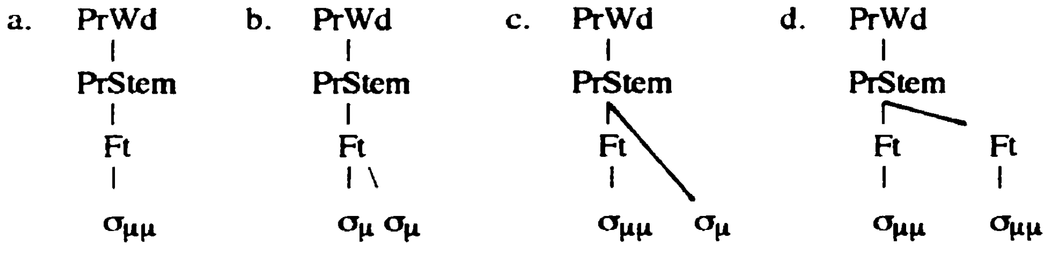
Although Suzuki's proposal provides a straightforward explanation for the lack of monosyllabic word clippings, it fails to account for the very productive word clipping pattern that consists of a single disyllabic foot. The expectation is that in a form with three initial light syllables, the third syllable of the base should be part of the output in order to satisfy NONFINALHFT. Furthermore, the free variation noted by Itô (1990) for forms like *herikoputaa* 'helicopter' (disyllabic *he.ri* vs. trisyllabic *he.ri.ko*), strongly argues against such an analysis. Suzuki's analysis does not offer any explanation for quadrisyllabic forms like *(a.su).(pa.ra)* from *asuparagasu* 'asparagus' which are dismissed as supraminimal and outside of any analysis of word minimality in Japanese.

2.4.2 The Emergence of the PrStem

I propose that the various prosodic shapes of the truncation morphemes in Japanese can be given a unified account by assuming a Prosodic Hierarchy of metrical constituents in which the PrWd immediately dominates a PrStem. I will demonstrate how this model of prosodic structure accounts for the truncation morphemes in Japanese in terms of 'the emergence of the unmarked' by showing that the truncated forms fully satisfy high-ranking structural constraints that are minimally violated in the general phonology of the language as a result of higher-ranked FAITH^{IO} constraints.

As illustrated by the different candidate structures in (24), all of the prosodic shapes of the truncated forms can be organized as a PrWd that uniquely dominates a PrStem.

24



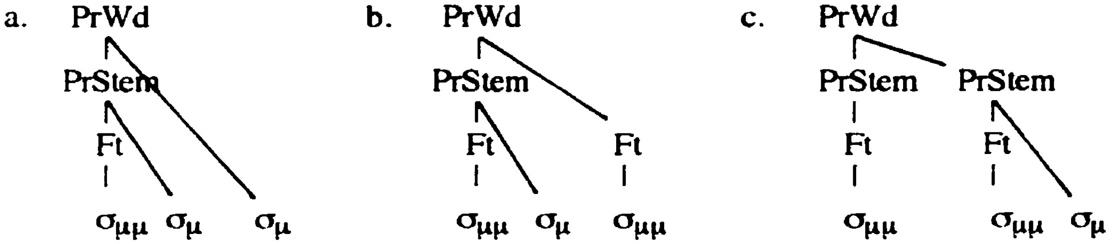
The first question to be addressed here is what makes the bimoraic PrWd in (24a) perfectly well-formed as a suffixed shortened name, yet unacceptable as a free-standing abbreviated loanword. The prosodic shapes which characterize word clipping formation (24b-d) have in common a minimally disyllabic constituent at some level of prosodic organization. To account for this minimality requirement, I propose a binarity constraint imposed on the PrStem, that is defined in terms of headship.

25. **BRANCHHEAD**
The head of a PrStem is in a rhythmic relation with a non-head constituent at some level of analysis. (σ, Ft).

In a PrStem that uniquely dominates its head foot as in (24b), the head syllable must be in a rhythmic relation with a non-head syllable within the foot. In a PrStem where the head foot dominates a bimoraic syllable, BRANCHHEAD can be satisfied in one of two ways: by adding a syllable (24c) or a foot (24d) in the non-head position of the PrStem.

By contrast, none of the PrWd structures in (26) are well-formed truncated stems. The next question then is in what makes these candidates unacceptable word clippings.

26



The candidate in (26b) is easily dismissed since it clearly adds an unnecessary violation of ALL-FT-LEFT. The candidate in (26c), on the other hand, does not add to the number of ALL-FT-LEFT violations that can be found in the well-formed word clipping in (24d). I propose that this candidate is eliminated as a result of creating a fatal violation of the high-ranking structural constraint ALIGN-PRSTEM-LEFT. In contrast with ALL-FT-LEFT, this latter constraint is assumed to be categorically rather than gradiently violated.

27. **ALIGN-PRSTEM-LEFT**
Align (PrStem, Left, PrWd, Left)
"The left edge of every PrStem coincides with the left edge of some PrWd."

Consider now the candidate in (26a). This prosodic structure is characterized by a final syllable directly parsed by the PrWd, with the leftmost unfooted syllable being parsed by the PrStem. Each parsing results in a violation of EXHAUSTIVITY (see §1.1). To account for the unacceptability of (26a) as a well-formed word clipping, I propose that PARSE-σ should be defined in terms of head/non-head relation. Based on this definition of syllable parsing, only the rightmost syllable would violate the constraint.

28. **PARSE-σ**
    A syllable is parsed in the head or non-head position of some metrical constituent.

Here I assume that some locality condition, similar to Itô and Mester's (1992) Hierarchical Locality, limits the access to structural information, so that a syllable directly parsed by the PrWd cannot be defined as being in a non-head relation with the head PrStem.

29. *Hierarchical Locality*
    A condition operating at prosodic level C_i has access only to structural information at C_i and at the subjacent level C_{i-1}.

To sum up, a well-formed word-clipping fully satisfies BRANCHHEAD, ALIGN-PRSTEM-LEFT and PARSE-σ, while minimizing violations of ALL-FT-LEFT. Two-footed structures will be discussed in §2.5.3. This proposal is illustrated in the tableau below. (The parentheses represent foot boundaries, while the square brackets indicate PrStem boundaries.)

30. BRANCHHEAD >> ALIGN-PRST-LEFT >> PARSE-σ >> ALL-FT-LEFT >> MAX^{BT}

Candidates μμ μ μμ μμ Base: kon.bi.nee.šoN	BRANCH-HEAD	ALIGN-PRST-LEFT	PARSE-σ	ALL-FT-LEFT
μμ μ a. ✓ [(koN).bi]				
μμ μ μμ b. [(koN).bi].(nee)				*!*
μμ μ μ c. [(koN).(bi.ne)]				*!
μμ d. [(koN)]	*!			

In (30a), the optimal output satisfies the four high-ranking structural constraints at the cost of multiple Max^{BT} violations. Smaller and larger word clippings, on the other hand, violate high-ranking BranchHead in (30d) and All-Ft-Left in (30b-c), respectively.

The choice of the prosodic shape of a particular word clipping is usually restricted by the segmental structure of the base (BT-Identity). Here I assume that of the four high-ranking stuctural constraints in (30), All-Ft-Left is the only on that is crucially dominated by BT-Identity constraints, with the exception of Max^{BT}. Some forms, however, have a base that allows for more possibilities, as illustrated in the tableau below.

31. BranchHead >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left >> Max^{BT}

Candidates μ μ μ μ μμ Base: he.ri.ko.pu.taa	Branch-Head	Align-PrSt-Left	Parse-σ	All-Ft-Left
μ μ a. √ [(he.ri)]				
μ μ b. √ [(he.ri).ko]				
μ μ μ μ c. [(he.ri).(ko.pu)]				*!*
μμ d. [(hee)]	*!			

In (31a-b), the two outputs satisfy the four high-ranking structural constraints at the cost of multiple Max^{BT} violations. A PrStem that consists of two feet, however, violates lower-ranked All-Ft-Left, as shown in (31c). In (31d), the bimoraic foot violates high-ranking BranchHead.

The question to be addressed at this point is how to provide for the optional choices available to some of the word clipping forms, as shown in (31a-b). An important aspect of Optimality Theory is that whenever high-ranking constraints are satisfied, the choice of the optimal output is left to lower-ranked constraints. The prediction then is that there should be only one optimal output for every word clipping.

Building on an idea of Kager (1996b), I propose that variability in the choice of an output comes from the variable rankings of two conflicting constraints within the constraint hierarchy. The choice between disyllabic [(he.ri)] and trisyllabic [(he.ri).ko] I propose, follows directly from the variable rankings between the two constraints NonfinalHFt and AlignHFt.

32. **NonfinalHFt**
No PrWd is right-aligned with its head foot.

33. **AlignHFt**
A PrWd is right-aligned with its head foot.

The constraint AlignHFt requires that the head foot of a PrWd be final, while Nonfinal-HFt requires the opposite, that the head foot never be final in a PrWd. No output will ever satisfy both constraints simultaneously. Which constraint will be satisfied in the output then follows from the choice of a specific ranking between the constraints. This is illlustrated by the double tableau below.

34. BranchHead >> ---AlignHFt >> NonfinalHFt --, >> All-Ft-Left >> Max^{BT}
`NonfinalHFt >> AlignHFt'

Candidates I μ μ μ μ μμ Base: he.ri.ko.pu.taa	Branch-Head	AlignHFt	Nonfinal-HFt	All-Ft-Left
μ μ a. ✓ [(he.ri)]			*	
μ μ μ b. [(he.ri).ko]		*!		
μ μ μ μ c. [(he.ri).(ko.pu)]		*!*		**
Candidates II μ μ μ μ μμ Base: he.ri.ko.pu.taa	Branch-Head	Nonfinal-HFt	AlignHFt	All-Ft-Left
μ μ a. [(he.ri)]		*!		
μ μ μ b. ✓ [(he.ri).ko]			*	
μ μ μ μ c. [(he.ri).(ko.pu)]			**!	**

As shown in the tableau above, ALIGNHFT is assumed to be gradiently violable. Note that even if we were to assume that ALIGNHFT is categorically violated, lower-ranked ALL-FT-LEFT would still choose [(he.ri).ko] as the output of the second tableau.

Itô (1990) notes that once an abbreviated form is established, other possible forms are highly disfavored. The assumption then is that each newly created word clipping is stored with some specific ranking between NONFINALHFT and ALIGNHFT as part of its lexical entry. According to Itô, however, there are some loanwords that have more than one abbreviated forms. The different prosodic shapes of the word clippings then follow directly from their underlying prosodic shape and from the choice of a specific ranking between two lower-ranked conflicting constraints.

2.4.3 Compounding

Word clippings that consist of two feet are usually abbreviated compounds. Each member of a compound is an independent word which can form a word clipping on its own. As noted by Itô (1990), a loanword such as *koNpanii* 'party, company' can be shortened to disyllabic *koNpa*. As part of the compound *kurasu-koNpa* 'class party', the same form can further shorten to monosyllabic *koN* as in *kura-koN*. However, no member of a shortened compound may be parsed as a monomoraic syllable: *ku-koN, *kura-ko, even though the latter truncated form is an acceptable word clipping.

Here I propose that both the requirement demanding that a word clipping be foot initial and the requirement that each member of a compound be minimally parsed as a foot are the surface effects of a single constraint on the alignment of edges between a sub-lexical morpho-prosodic constituent and a sub-lexical metrical constituent (Downing 1998).

35. **ALIGN-P-STEM-LEFT**
Align (P-Stem, Left, Ft, Left)
"The left edge of every P-Stem coincides with the left edge of some foot."

This is illustrated in the tableau below. (The straight lines indicate P-Stem boundaries.)

36. Align-P-Stem-Left ; BranchHead >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left >> Max^{BT}

Candidates μ μ μ μμ μ Base: ku.ra.su - koN.pa	Align-P-Stem-Left	Branch-Head	Align-PrSt-Left	All-Ft-Left
μ μ μμ a. √ [|(ku.ra).|(koN)]				**
μ μ μ μμ b. [|(ku.ra).su].|(koN)				***!
μ μμ c. [|ku.|(koN)]	*!			*
μ μ d. [|(ku.|ko)]	*!			

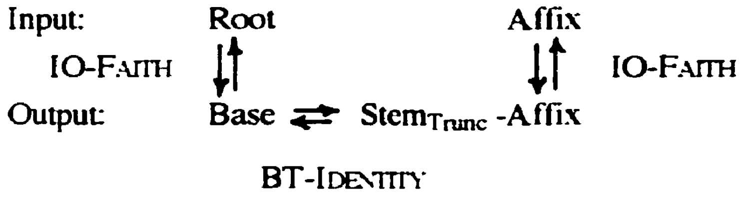
Both forms in (36c) and (36d) are eliminated through a fatal violation of Align-P-Stem-Left. The choice of the optimal output is thus left to lower-ranked All-Ft-Left. Double-footed word clippings that cannot be defined as compounds will be discussed in §2.5.3.

2.5 Bound Truncated Stems

The question to be addressed now is why the prosodic shapes of shortened names should be restricted to a foot, either bimoraic or disyllabic. I propose, following Itô (1990), that the difference between shortened names and word clippings lies in large part in a distinction between bound stems and free words. The crucial assumption here is that with respect to bound morphemes, i.e. truncated stems that are obligatorily followed by an affix, structural constraints are imposed on both the truncated stem and the affix simultaneously. In other words, the solution as to why shortened names are restricted to a bimoraic foot shape lies in part in the optimality-theoretic notion that the prosodic shapes of phonologically-empty morphemes result from the satisfaction of high-ranking structural constraints, rather than from lexically-specified prosodic requirements imposed on those morphemes.

The correspondence relations involved in generating the suffixed name shortenings are encoded in the schematic model below.

37.



The input root is mapped to the base through ROOT-IO-FAITH constraints, while the affix is mapped to the output through AFFIX-IO-FAITH. In turn, the BT-IDENTITY constraints relate the base to the truncated forms. As shown in (37), the truncated morpheme is lexically marked as a morphological stem (M-Stem). In the next sections, it will be shown that variability in the choice of an output in some of the truncated name formations follows in part from the satisfaction of a constraint on the alignment of P-Stem edges.

2.5.1 Hypocoristic Formation

Consider first the Hypocoristic forms. The challenge here is how to restrict the prosodic shape of these truncated forms to a bimoraic foot, while allowing for both a disyllabic and a monosyllabic output, irrespective of the prosodic structure of the base. As shown in (38) below, both *Midori* and *Yooko* have a disyllabic and monosyllabic form.

38. *Hypochoristic Formation* (Poser 1984, 1990)

Midori	Mido-čaN, Mii-čaN
Yooko	Yoko-čaN, Yoo-čaN
Hiromi	Hiro-čaN, Romi-čaN, Hii-čaN
Mariko	Mari-čaN, Mako-čaN, Riko-čaN, Maa-čaN
JuNko	JuN-čaN
Hanako	Hana-čaN, Haa-čaN, Hač-čaN

The analysis proposed here assumes that the prosodic shapes of truncated names are in part the result of the domination of Affix-IO-FAITH over the high-ranking structural constraints of the language. Following Itô (1990), I assume that the Hypocoristic suffix and the truncated stem are evaluated simultaneously by the constraint hierarchy. This is shown in the tableau below.

39. Affix-Faith^{IO} >> Align-P-Stem-Left >> BranchHead >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left >> Max^{BT}

Candidates μ μ μ μμ Base: mi.do.ri -čaN	Affix-Faith^{IO}	Align-P-Stem-Left	Branch-Head	All-Ft-Left
μ μ μμ a. [(mi.do)].(čaN)				**!
μμ μμ b. ✓ [(mii).(čaN)]				*
μ μ μ c. [(mi.do).ri]	*!**			
μ μμ d. [mi.(čaN)]		*!		*
μ μ μ μμ e. [(mi.do).ri].(čaN)				**!*

In tableau (39) above, the choice of a monosyllabic foot for the truncated stem (39b) results from satisfying IO-Faith and the high-ranking structural constraints, while at the same time minimizing violations of All-Ft-Left. In (39d), the truncated stem is left-aligned with an unfooted syllable violating Align-P-Stem-Left. In (39a) and (39e), the PrStem dominates a disyllabic foot, creating a fatal violation of All-Ft-Left. To assume that the bimoraic suffix is directly parsed by the PrStem [(mi.do).čaN] to satisfy All-Ft-Left fully, on the other hand, would result in a fatal violation of Weight-to-Stress.

Variability in the prosodic shape of the Hypocoristic forms, however, suggests that something more is at work. As shown in the tableau above, with regard to All-Ft-Left, (39a) is less optimal than (39b). The prediction then is that [(mi.do)].(čaN) should not be a possible output. Part of the answer as to why both foot shapes are possible Hypocoristic forms lies in the lexical marking of the Hypocoristic morpheme as a morphological stem. Following McCarthy and Prince (1993ab), I assume that the minimally bimoraic shape of a phonologically-empty morpheme marked as a morphological stem follows from satisfying a constraint requiring the edges of a corresponding morpho-prosodic constituent to be aligned with those of a PrWd.

40. **P-Stem=PrWd**
The left and right edge of a P-Stem coincide with the left and right edge of a PrWd.

Satisfaction of this alignment constraint when imposed on a bound stem, however, results in a recursive PrWd structure violating NonRecur (Selkirk 1995).

41. **NonRec**
No PrWd dominates a PrWd.

I assume here that BranchHead dominates P-Stem=PrWd and NonRec, with All-Ft-Left being lower-ranked. The variable ranking of the two potentially conflicting constraints P-Stem=PrWd and NonRec in turn results in an optional choice between a bimoraic and a disyllabic foot. (The square brackets in bold indicate PrWd boundaries.)

,NonRec >> P-Stem=PrWd,

42. Affix-Faith^{IO} >> BranchHead >> --P-Stem=PrWd >> NonRec -- >> All-Ft-Left >> Max^{BT}

Candidates I μ μ μ μμ Base: mi.do.ri -čaN	Branch-Head	P-Stem=PrWd	NonRec	All-Ft-Left
μ μ μμ a. ✓ [[[(mi.do)]].(čaN)]			*	**
μμ μμ b. [[[(mii)]].(čaN)]]	*!		*	*
μμ μμ c. [[(mii).(čaN)]]		*!		*
Candidates II μ μ μ μμ Base: mi.do.ri -čaN	Branch-Head	NonRec	P-Stem=PrWd	All-Ft-Left
μ μ μμ a. [[[(mi.do)]].(čaN)]		*!		**
μμ μμ b. ✓ [[(mii).(čaN)]]			*	*
μ μ μμ c. [[(mi.do).(čaN)]			*	*!*

Since Affix-Faith^{IO} is always satisfied in the output, it is left out of this and subsequent tableaux. Note that the variable rankings of Stem=PrWd and NonRec do not play a role in the formation of word clippings, due to the latter's status as free-standing word. Similarly, the variable rankings of NonfinalHFt and AlignHFt do not affect the choice of the output in the obligatorily affixed truncated names: i.e. NonfinalHFt is always satisfied, while AlignHFt is minimally violated.

2.5.2 Prosodic Subcategorization

Consider now the Geisha House Client names. In contrast with Hypocoristic forms, this truncation morpheme presents very little variation with respect to a choice of outputs. What is striking about this particular shortening formation is that the truncated stem only surfaces as a monosyllabic foot.

43. *Geisha House Client Names*

Tanaka	o-Taa-saN		*o-Tana-saN
HoNda	o-Hoo-saN	o-HoN-san	*o-Hos-saN
Saito	o-Saa-saN	o-Sai-san	*o-Sato-saN
Hattori	o-Haa-saN		*o-Has-saN

The solution I propose in order to account for the distinct prosodic shape that differentiates the Geisha House Client names from the Hypocoristics lies in the assumption that an affix can be subcategorized for a specific prosodic base (McCarthy and Prince 1993ab). In other words, the answer as to why the truncated stems of the Geisha-House Client names are restricted to a monosyllabic shape lies in their status as a 'base' for the obligatory affixation of *-saN*. I propose a lexically-specific alignment constraint that expresses the prosodic subcategorization requirement of the suffix-*saN*.

44. **Affix-to-Hσ**
The left edge of the truncation affix -saN is right-aligned with the head syllable of some PrWd.

This is illustrated in the tableau below.

45. Affix-to-Hσ ; BranchHead >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left >> Max^{BT}

Candidates μ μ μ μμ Base: tanaka -saN	Affix-to-Hσ	Branch-Head	Align-PrSt-Left	All-Ft-Left
μμ μμ a. ✓ [[(taa).(saN)]]				*
μμ μμ b. [[[(taa)]].(saN)]		*!		*
μ μ μμ c. [[[(ta.na)]].(saN)]	*!			**

Note that the domination of Affix-to-Hσ and BranchHead over NonRec and P-Stem=PrWd (cf. tableau (42)) ensures that the only possible output is the one in (45a). The little variability available to this truncation morpheme is further restricted by the domination of the BT-Identity constraint Str-Role^{BT} (taa.saN) over Max^{BT} *(taN.saN).

Supporting evidence for the proposal that the Geisha House stem is prosodically determined by the subcategorization constraint Affix-to-Hσ, rather than from the truncation morpheme being lexically-specified for some prosodic requirement can be found in the prosodic shapes of the Hypocoristic morpheme when associated with the suffix *-ko*. As noted by Mester (1990), this particular Hypocoristic suffix also takes a syllable as its base. In contrast with the Geisha House names, however, this syllable can be either bimoraic or monomoraic.

46. *Hypocoristic Formation* (based on Mester 1990)

Hiromi	Hi-ko, Ro-ko, Hii-ko, Hik-ko	*Hiro-ko, *Romi-ko
Tanaka	Ta-ko, Na-ko, Taa-ko, TaN-ko	*Tana-ko, *Naka-ko
HoNda	Ho-ko, Hoo-ko, HoN-ko	
Saito	Sa-ko, Saa-ko, Sai-ko	
Hattori	Ha-ko, Haa-ko, Hak-ko	*Hato-ko
Yasuda	Ya-ko, Su-ko, Yaa-ko, Yak-ko	*Yasu-ko, *Suda-ko

By assuming that Hypocoristic-*ko* subcategorizes for the same Affix-to-Hσ constraint as the suffix -*saN*, the monosyllabic shape of the Hypocoristic stem can be accounted for in a straightforward manner, using the same structural constraint rankings that were proposed for Hypocoristic -čaN, as shown by the tableau below.

47. Affix-to-Hσ >> BranchHead >> --AlignHFt >> NonfinalHFt -- >> All-Ft-Left
NonfinalHFt >> AlignHFt

Candidates I μ μ μ μ Base: hi.ro.mi -ko	Affix-to-Hσ	Branch Head	Nonfinal-HFt	AlignHFt
μμ μ a. √ [[(hii).ko]]				*
μ μ b. [[(hi.ko)]]			*!	
μ μ μ c. [[(hi.ro).ko]]	*!			*

Candidates I μ μ μ μ Base: hi.ro.mi -ko	Affix-to-Hσ	Branch Head	AlignHFt	Nonfinal-HFt
μμ μ a. [[(hii).ko]]			*!	
μ μ b. √ [[(hi.ko)]]				*
μ μ μ μ c. [[(hi.ro).(mi.ko)]]	*!		*	

What is striking about the possible prosodic shapes of these Hypocoristic forms is that they follow directly from the variable rankings of AlignHFt and NonfinalHFt, irrespective of the following suffix. That is, the variable weight of the monosyllabic Hypocoristic stem when attached to the suffix -*ko*, and the variable choice in the type of foot that characterizes the Hypocoristic stem when attached to the suffix -*čaN* are given the same explanatory account. Differences between the two Hypocoristic forms come from the lexically-specific subcategorization constraint of the suffix -*ko* (Affix-to-Hσ) and from the segmental content of the two hypocoristic suffixes (Affix-Faith^{IO}). Similarly, the bimoraic shape of the suffix *-saN* in addition to the subcategorization constraint AFFIX-TO-Hσ ensures a monosyllabic foot shape for the Geisha House truncated stem.

To summarize, the different prosodic shapes of both word clippings and suffixed truncated names have been shown to satisfy a number of high-ranking structural constraints that are minimally violated in the general phonology of the language: ALIGN-P-STEM-LEFT, ALIGN-PRST-LEFT, PARSE-σ and BRANCHHEAD. In addition, the more restricted prosodic shapes of the suffixed truncated names have been argued to follow in part from their status as bound stems, while the variability found within truncated morphemes has been argued to result from the variable rankings of potentially conflicting lower-ranked constraints.

2.5.3 Lexically-Specific Ranking

In this study of truncation phenomena in Japanese, the constraint BRANCHHEAD has been posited as the force behind a number of restrictions imposed on the prosodic shape of both word clippings and bound truncated stems, with in some cases lower-ranked ALL-FT-LEFT restricting even further the prosodic shapes of the truncated stems. There are, however, a number of truncated forms that appear to be exceptional in that they are marked structures with regard to either BRANCHHEAD or ALL-FT-LEFT. The one particularly glaring example of a marked structure with regard to BRANCHHEAD is that of the Rustic Girls' name formation.

48. *Rustic Girls' Names*

Yukiko	o-Yuki	*o-Yuu, *o-Yuko
Fumie	o-Fumi	*o-Fuu, *o-Fue
Yooko	o-Yoo	
RaNko	o-RaN	

A different problem comes from non-compound forms like those in (49) that surface with a double-footed structure, resulting in seemingly unnecessary violations of ALL-FT-LEFT.

49.	a.su.pa.ra	asuparagasu	'asparagus'
	koN.bi.ni	koNbinieNsu	'convenient store'
	fu.ra.su.to	furasutorees̀oN	'frustration'
	iN.to.ro	iNtorodakus̀oN	'introduction'
	koN.sa.ba	koNsaabatibu	'conservative (in attire)'

Pater (1996) proposes that exceptionality with respect to the general phonology of the language should be treated as the result of a lexically-specific constraint ranking that only applies to a subset of the lexicon.

Consider first the Rustic Girls' formation. In marked contrast with the Hypocoristic forms and Geisha House Client names, this truncation morpheme presents a perfect copy of the initial foot of the base.

51. *Rustic Girls' Names*

Yukiko	o-Yuki	*o-Yuu, *o-Yuko
Fumie	o-Fumi	*o-Fuu, *o-Fue
Yooko	o-Yoo	
RaNko	o-RaN	
Ietaka	o-Ie	(input is a last name)[9]
Kirišima	o-Kiri	(input is a last name)

Benua (1995) provides an analysis of Rustic Girls' names that reformulates the prosodic circumscriptional analysis of Mester (1990) in terms of prosodic identity between corresponding outputs: ANCHOR-R(FT) and ANCHOR-L(FT) (see §2.4.1).

The problem posed by an analysis of perfect copy effects in terms of prosodic identity is that it only works for words that contain one foot. As shown by the tableau below, a two-footed base allows for more variability in the choice of an output. Note that the structural constraints in (52) are expressed according to the model of prosodic structure I assume, i.e. a syllable that is directly parsed by the PrStem does not result in a violation of PARSE-σ.

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[9] The last two examples are from Suzuki (1995).

52. Anchor-L(Ft) ; Anchor-R(Ft) >> Parse-σ >> All-Ft-Left >> Max^{BT}

Candidates μμ μ μ Base: (ie).(ta.ka)	Anchor-L(Ft)	Anchor-R(Ft)	Parse-σ	All-Ft-Left	Max^{BO}
μμ a. [(ie)]					****!
μ μ b. [(ie).ta]		*!			**
μμ μ μ c. [(ie).(ta.ka)]				*!	
μ μ d. ✓ [(i.ka)]					***

In order to get perfect correspondence between a longer base and a truncated form, Cont^{BT} must be added to the set of high-ranking BT-constraints of the Rustic Girls' formation.

53. Contiguity^{BT}
The portion of S_1 standing in correspondence forms a contiguous string.
(no skipping)
The portion of S_2 standing in correspondence forms a contiguous string.
(no intrusion)

Consider now the candidate output in (52b). This form violates Anchor-R(Ft) since the initial segment of the unfooted syllable corresponds to a segment which is foot-initial. In a trisyllabic base, however, an output stem like for example [(Yo.ki).ko] would correspond perfectly to the prosodic shape of the base without violating either of the prosodic identity constraints. Recall that such trisyllabic forms are perfectly acceptable word clippings, so they cannot be dismissed out of hand as impossible truncated forms.

The question then is how can the maximally bimoraic prosodic shape of the Rustic Girls' names be differentiated from the minimally disyllabic shape of the word clippings. I begin by proposing a reformulation of Benua's analysis in terms of the standard constraints Wt-Ident^{BT}, Cont^{BT} and Anchor-Left, thus eliminating the prosodic identity constraints from the sets of BT-Identity constraints.

54. Anchor-Left
Any element at the left edge of S_1 has a correspondent at the left edge of S_2.

55. **Wt-Ident** (McCarthy 1995)

If α and β are in a correspondence relation,

and α is monomoraic, then β is monomoraic (no lengthening).

and α is bimoraic, then β is bimoraic (no shortening).

Full satisfaction of these constraints ensures that the initial foot of the base is mapped in the output, in contrast with the Hypocoristic forms *Rico-cäN* and *Mako-cäN* from *Mariko* and *Yoko-càN* from *Yooko.*

56. Wt-Ident^{BO} ; Cont^{BO} ; Anchor-Left >> Branch-Head >> Parse-σ >> Max^{BT}

Candidates μ μ μ Base: yo.ki.ko	Wt-Ident^{BT}	Cont^{BT}	Anchor-Left	Branch-Head	Max^{BO}
μμ a. ✓ [(yo.ki)]					**
μ μ b. [(ki.ko)]			*!		**
μ μ c. [(yo.ko)]		*!*			**
μμ μ d. [(yoo).ki]	*!				**

In (56b), the initial segment of the truncated form does not correspond to the initial segment of the base, resulting in a violation of Anchor-Left. In (56c), the initial segments are the same, but the output string that corresponds to the base string skips the second syllable of the base, resulting in a fatal violation of Cont^{BT}. Finally, the lengthening of the initial vowel in (56d) creates a violation of undominated Wt-Ident^{BT}.

The problem to be addressed at this point is how to account for the exceptionality of monosyllabic outputs with respect to BranchHead and how to prevent trisyllabic outputs. I propose that what looks like 'circumscriptional' effects follows from a lexically specific version of AlignHFt for the Rustic Girls' truncation morpheme.[10]

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[10] A similar proposal is first introduced in Prince and Smolensky (1993:101) who assume that the constraint Free-V: 'A word final vowel must not be parsed' is limited to the nominative in Lardil.

57. **ALIGNHFT-γ**
A PrWd is right-aligned with its head foot.

This is illustrated in the tableau below.

58. ALIGNHFT-γ ; WT-IDENT^{BO} ; CONT^{BO} ; ANCHOR-LEFT >> PARSE-σ >> BRANCHHEAD
>> ---ALIGNHFT >> NONFINALHFT --- >> ALL-FT-LEFT >> MAX^{BT}
\ NONFINALHFT >> ALIGNHFT /

Candidates μμ μ μ Base: (ie).(ta.ka)	ALIGNHFT-γ	CONT^{BO}	ANCHOR-LEFT	BRANCH-HEAD	ALIGN-HFT
μμ a. ✓ [(ic)]				*	
μ μ b. [(ie).ta]	*!				*
μμ μ μ c. [(ie).(ta.ka)]	*!				*
μ μ d. [(ta.ka)]			*!		

The truncated stem being lexically-specified for the higher-ranked version of ALIGNHFT-γ, the monosyllabic foot in (58a) is the optimal output, even though it violates BRANCHHEAD. When ALIGNHFT-γ does not apply, as with the word clippings, the disyllabic form in (58b) is preferred.

The question left to be answered with respect to truncation phenomena is how to account for the non-compound forms in (60) which surface with a double-footed structure (Itô 1990). What is striking about these forms is that each can generate a different output that would not violate ALL-FT-LEFT.

60.

a.su.pa.ra	*a.su, *a.su.pa	asuparagasu	'asparagus'
koN.bi.ni	*koN.bi	koNbinieNsu	'convenient store'
fu.ra.su.to	*fu.ra, *fu.ra.su	furasutorces̀oN	'frustration'
iN.to.ro	*iN.to	iNtorodakus̀oN	'introduction'
koN.sa.ba	*koN.sa	koNsaabatibu	'conservative (in attire)'

Here I propose that there is a subset of the truncated stems which are lexically-specified for a version of Align-P-Stem-Right which is ranked between NonfinalHFt and AlignHFt.

61. **Align-P-Stem-Right-γ**
Align (P-Stem, Right, Ft, Right)
"The right edge of every P-Stem coincides with the right edge of some foot."

Note that this constraint is always satisfied in the abbreviated compounds as a result of fully satisfying Align-P-Stem-Left, Align-PrStem-Left and Parse-σ, while minimizing All-Ft-Left violations.

62. BranchHead >> NonfinalHFt >> Align-P-Stem-Right-γ >> AlignHFt >> All-Ft-Left >> Align-P-Stem-Right ; Max^{BT}

Candidates I μ μ μ μ μ μ Base: a.su.pa.ra.ga.su	Nonfinal-HFt	Align-P-Stem-R-γ	AlignHFt	All-Ft-Left
μ μ μ μ a. ✓ [(a.su).(pa.ra)]			**	**
μ μ μ b. [(a.su).pa]		*!	*	*
μ μ c. [(a.su)]	*!			

To summarize, the open system of truncation in Japanese offers the same possibilities as does the general phonology of the language: i.e. prosodic subcategorization of affixes, lexical specification of a subset of the lexicon for the high-ranking of some constraint, and the satisfaction of high-ranking structural constraints when not dominated by faithfulness constraints.

Chapter 3

Arabic Stem Patterns

Another challenge to standard assumptions about word minimality is found in the root-and-pattern system of Arabic. In the Arabic nominal system, the minimal prosodic shape is that of a monosyllabic foot ($\sigma_{\mu\mu}$), followed by an 'extrametrical' consonant, while the maximal prosodic shape of nominal stems is disyllabic, irrespective of syllable weight. In fact, every possible sequence involving heavy and light syllables is actually used in the nominal system. The prosodic shapes of nominal stems are presented in the table below, abstracting away from prefixes and suffixes (McCarthy and Prince 1990a).

1. *Basic Nominal Patterns*

	2 Moras		*3 Moras*		*4 Moras*
Biliterals	barr	sabab	ǰadiid	baarir	ǰaaruur
Triliterals	baȟr	badal	ˀataan	kaatib	ǰabbaar
Quadriliterals				xanǰar	rasmaal

Also problematic is the fact that the minimal prosodic shape of verbal stems is a disyllabic foot ($\sigma_{\mu}\sigma_{\mu}$). Although Arabic is viewed as a quantity-sensitive language, the monosyllabic bimoraic foot is not a possible verbal stem. The maximal prosodic shape of verbal stems is also disyllabic, abstracting away from the obligatory final non-moraic consonant.

2. *Basic Verbal System (finite form)*

Form 1	*Form 2*	*Form 3*	*Form 4*	*Form 7*	*Form 8*	*Form 9*	*Form 10*	*Form 11*
ħalal	ħallal	ħaalal	ʔaħlal	nħalal	ħtalal	ħlalal	staħlal	ħlaalal
faʕal	faʕʕal	faaʕal	ʔafʕal	nfaʕal	ftaʕal	fʕalal	stafʕal	fʕaalal
		Q1				*Q4*		
		daħraj				dħarjaj		

In chapter 2, I proposed that disyllabic domains in languages where a heavy syllable is usually parsed as a foot (i.e. Weight-to-Stress) can be accounted for by assuming that the PrStem is the head of the PrWd. I argued that the ban on bimoraic syllables as the minimal prosodic shape of PrWds in the Japanese truncation system followed from the high-ranking of BRANCHHEAD within the constraint hierarchy of the language.

In this study of the prosodic morphology of Arabic, I propose that a unified account of the nominal and verbal stem systems can be provided by assuming that the minimal word is a PrWd that contains only one PrStem. I intend to show that in this particular model of prosodic structure, the different shapes of nominal stems and of related verbal stems within a paradigm can be accounted for by the different sets of correspondence relations involved.

3.1 Previous Analyses

In their analysis of verbal and nominal systems of Arabic, McCarthy and Prince's (1990a) strict adherence to the foot inventory (i.e. moraic trochee, syllabic trochee and iamb) leads to the proposal that the canonical prosodic shape of verbal stems cannot be analyzed as an underived template, i.e. as a template uniquely specified as a syllable, a foot or a PrWd. Consequently, they argue that the disyllabic prosodic shape of the verbal stems should be deconstructed into two independent templates: a base and a suffix (cf. also Itô 1990).

McCarthy and Prince propose that in a disyllabic verbal stem, an initial monomoraic syllable represents the prosodic template of Form 1 (i.e. [fɑʕɑl]) and of its closely related forms (Forms 7, 8, and 9), while an initial bimoraic syllable is the default template, since it appears with all the other, unrelated forms. The monosyllabic suffix is argued to have two different prosodic shapes, a light syllable which defines the finite form and a heavy syllable that characterizes all the other, nonfinite forms. Finite forms would thus have either of the two prosodic shapes below.

3.

According to McCarthy and Prince's proposal, then, the minimal disyllabic shape of verbal stems follows from their morphological structure. They further propose that the maximal disyllabic shape results from a condition stipulating that a template contains at most two syllables.[1]

4. *Maximal Stem Constraint*
Templates are maximally disyllabic.

The final 'extrametrical' consonant is derived from a rule requiring that all nominal and verbal stems end with an incomplete syllable (i.e. the final consonant is parsed as the onset of a non-moraic syllable).

5. *Final Incompleteness*
$\emptyset \dashrightarrow (\sigma) / \_\_\_]_{\text{Stem}}$

In addition, they suggest that in forms such as [f.ta.ʕal], the initial consonant should be analyzed as being parsed by an extrasyllabic mora, which they argue is syllabified as the coda of an incomplete syllable. Following Moore (1990), McCarthy and Prince view this extrasyllabic mora as a separate morpheme, i.e. a detransitivising verbal prefix. Thus, the

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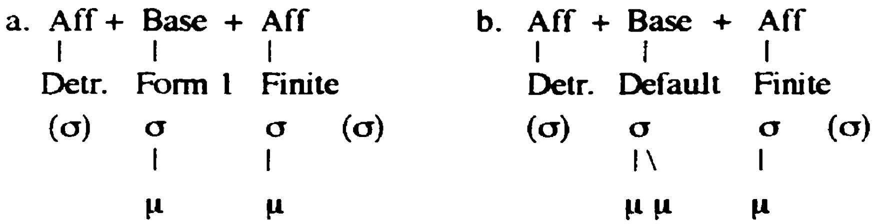
[1] McCarthy and Prince argue that such a descriptive constraint is not as arbitrary as it seems. They assume that there are general considerations of locality that require that no rule counts to greater than two. Since the rules specifying the Arabic templates are subject to locality, the Maximal Stem Constraint can be obtained from a general principle of UG.

morphological structure of a verbal stem in the finite form has the maximal prosodic shape shown below:

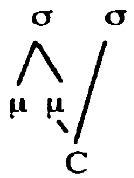
6.



Finally, the general conditions of prosodic well-formedness in Arabic, such as Melody Conservation (McCarthy and Prince 1986:66,105), requiring that all root consonants be linked to the verbal stem template, and the Maximal Stem Constraint, requiring that the prosodic shape of a stem be maximally disyllabic, ensure that the surface realization of Q1 for quadriliteral roots is prosodically parsed as an initial bimoraic syllable followed by a monomoraic syllable: [daħ.ra.ǰ].

The difference between Forms 2 and 3 for biliteral and triliteral roots, however, must be accounted for by a morphologically-triggered gemination rule, since it should not be possible to distinguish between the two types of heavy syllables.

7. *Medial Gemination in Form 2*



Thus, McCarthy and Prince are able to give an account of the verbal stem system in Arabic which respects the principles of Prosodic Morphology by subdividing the verbal stems into different morphological constituents that have each their own template.

More problematic is the analysis provided by McCarthy and Prince to account for the canonical prosodic shapes of nouns. Their analysis assumes that the nominal stems can draw on a small set of basic noun templates. Mapping to these templates must obey the well-formedness conditions of Arabic: the Maximal Stem Constraint, Final Incompleteness, Melody Conservation, etc. Each nominal template therefore needs to be specified for very little information to derive the correct surface form. So for example in (3a-b), the two types of bimoraic foot need only be specifed for either a monosyllabic trochee $F_{QT}(\sigma)$ or a disyllabic trochee $F_{QT}(\sigma\sigma)$. The different nominal templates are illustrated in (8).

8

a. CvCC (barr)
F_{QT}
|
σ

b. CvCvC (badal)
F_{QT}
/\
σ σ

c. CvCvvC (ǰadiid)
F_I

d. CvvCvvC (ǰaamuus)
CvC_iC_ivvC (ǰabbaar)
$F_{QT}F_{QT}$

e. CvC_iC_jvC (xanjar)
σ
|
μ

f. CvC_iC_jvvC (rasmaal)
σ
/\
μ μ

Since the iambic foot is assumed to alway surface as its maximal expansion ($\sigma_\mu\sigma_{\mu\mu}$), there is no need to specify anything more than the type of foot (F_I). A nominal template can also be specified as containing more than one foot (8d). The quadriliteral roots in (8e-f), on the other hand, need only be specified as to whether the final syllable is monomoraic or disyllabic.[2]

Basically, templates that are larger than a foot are handled by two distinct strategies. Within the nominal system, templates are defined either as a trochaic foot ($\sigma_{\mu\mu}$) or ($\sigma_\mu\sigma_\mu$), an iambic foot ($\sigma_\mu\sigma_{\mu\mu}$) or as a sequence of two trochaic feet ($\sigma_{\mu\mu}$)($\sigma_{\mu\mu}$). The prosodic shape of verbal stems, on the other hand, are defined through the morphological concatenation of two different templates. In addition, the maximal prosodic shape of stems is simply stipulated as being disyllabic. Consequently although the individual templates satisfy the Prosodic Morphology Hypothesis (i.e. uniquely specified as a syllable, a foot or a PrWd), the canonical prosodic shapes of both the nominal and verbal stems do not

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[2] The deverbal stems ($\sigma_{\mu\mu}$)σ_μ are argued by McCarthy and Prince (1990a) to be outside of the domain of the nominal templatic system.

Furthermore, the surface realization of templates may be affected by lengthening rules (i.e. mora affixation) and gemination rules that can be triggered either by morphological or lexical specification.

In the following sections, I present an analysis of the nominal and verbal stem systems in Arabic within the framework of Optimality Theory. I will show that, within the model of prosodic structure proposed here, the theory of Correspondence (McCarthy 1995; McCarthy and Prince 1995; Benua 1995) provides for a unified account of the root-and-pattern morphology of Arabic.

3.2 Root-and-Pattern Morphology in OT

Following McCarthy and Prince (1995) and Benua (1995), I assume that root-and-pattern morphology, like truncation, is governed by two distinct sets of correspondence relations: a relation between an input (a consonantal root and a vocalic melody) and an output (IO-FAITH), and a relation between a base and all its related output forms within a paradigm (BO-IDENTITY). I propose that IO-FAITH constraints play a crucial role in differentiating between the various prosodic shapes of the nominal stems, while distinct sets of BO-IDENTITY constraints are involved in characterizing a large part of the prosodic shapes of verbal stems within a paradigm.

3.2.1 The Prosodic Structure of Arabic

Consider first the problem of how to characterize all of the possible prosodic shapes of nominals in Arabic. As noted before, there is only one type of nominal stem that does not begin with the head syllable of a trochaic foot: $(\sigma_{\mu}\sigma_{\mu\mu})$. In this model, the right-headed prosodic constituent is assumed to be organized as a right-headed PrStem, i.e. a light syllable followed by a bimoraic foot: $[\sigma_{\mu}(\sigma_{\mu\mu})]$,. This proposal is consistent with the standard assumption that Arabic is a trochaic language. The canonical prosodic shapes of the nominal stems are given again below.[3]

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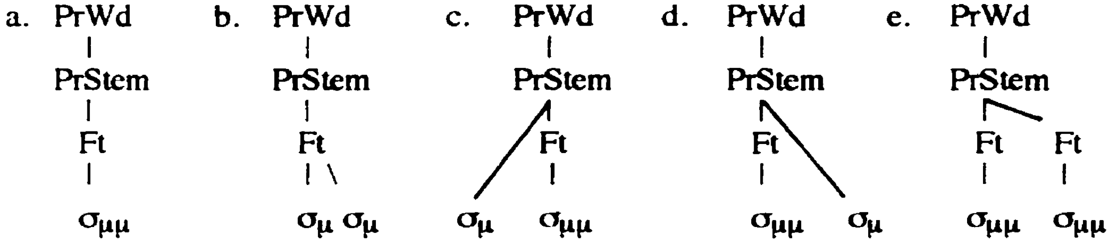
[3] There are a few monomoraic and non-moraic nouns (i.e. consisting of only one consonantal root) but they are quite rare. McCarthy and Prince regard them as exceptional in nearly every respect.

9. *Basic Nominal Patterns*

	2 Moras		*3 Moras*		*4 Moras*
Biliterals	barr	sabab	ǰadiid	baarir	ǰaaruur
Triliterals	baȟr	badal	ˀataan	kaatib	ǰabbaar
Quadriliterals				xanǰar	rasmaal

Each of the prosodic shapes of nominal stems can be organized as a uniquely dominated PrStem. This is illustrated with the five candidates below. Note that the verbal stems are restricted to the prosodic structures in (10b) and (10d-e).

10



Every candidate satisfies ALIGN-PRSTEM-LEFT and PARSE-σ fully. The constraint ALL-FT-LEFT, on the other hand, is minimally violated by the candidates in (10c) and (10e).

11. **ALIGN-PRSTEM-LEFT**
Align (PrStem, Left, PrWd, Left)
"The left edge of every PrStem coincides with the left edge of some PrWd."

12. **ALL-FT-LEFT**
Align (Ft, Left, PrWd, Left)
"The left edge of every foot coincides with the left edge of some PrWd."

What is interesting about the prosodic organization of the candidates in (10) is that they all end in a foot with the exception of (10d) where the PrStem ends in a light syllable. This last candidate has a very restricted distribution in the nominal system, yet is widespread in the verbal system. As noted by McCarthy and Prince (1990a), if we exclude quadriliterals, nearly all the $(\sigma_{\mu\mu})\sigma_{\mu}$ nominals result from a single morphological process which derives the Form 1 active participle *kaatib* from the corresponding finite verb *katab*. Here I assume that the deverbal stems result from an output-to-output relation between a verbal base and an output nominal stem (BO-IDENTITY), rather than being derived from a nominal lexical root (IO-FAITH). I therefore regard them as being outside of the domain of study of the nominal system.

3.2.2 Consonant 'Extrametricality'

An important characteristic of nominal and verbal stems in Arabic is the presence of a final 'extrametrical' consonant. McCarthy and Prince treat this final consonant as the onset of an empty syllable. Within the optimality-theoretic framework, 'extrametrical' constituents are often seen as the result of satisfying some nonfinality constraint. For example, the parsing of a final 'extrametrical' syllable by the PrWd rather than by a foot results from satisfying NONFINALHFT, while the lack of weight found in a final consonant follows from satisfying NONFINALHσ.

13. **NONFINALHσ**
No PrWd is right-aligned with its head syllable.

To see why the behavior of final consonants in the Arabic stem system seems to challenge this view of extrametricality, consider again the prosodic structures in (10). Each candidate ends in a root consonant which does not contribute to either the disyllabic requirement of the PrWd or the weight of the preceding syllable. If we assume, following McCarthy and Prince (1990a), that the final consonant is parsed as the onset of a headless syllable, the prosodic shapes of the nominal stems would be as shown below.

14a. $('\sigma_{\mu\mu})C_{\sigma}$ b. $('\sigma_{\mu}\sigma_{\mu})C_{\sigma}$ c. $\sigma_{\mu}('\sigma_{\mu\mu})C_{\sigma}$ d. $('\sigma_{\mu\mu})\sigma_{\mu}C_{\sigma}$ e. $('\sigma_{\mu\mu})(\sigma_{\mu\mu})C_{\sigma}$

In (14a-c), the final consonant ensures that the head foot is not final in a PrWd. In (14d-e), however, satisfaction of NONFINALHFT does not hinge on the parsing of a consonant as the onset of a final headless syllable, i.e. the head foot is already nonfinal. The question then is what forces the final consonant in (14d-e) to be parsed as the onset of a headless syllable, short of stipulating that Arabic stems must end in an incomplete syllable, as McCarthy and Prince (1990a) in fact do.[4]

I propose that the solution as to why a verbal or nominal stem must end in a consonant lies in Broselow, Chen and Huffman's (1997) theory of coda weight. Their model assumes that the weight of consonants in closed syllables is an effect of a universally high-ranking constraint which requires every coda consonant to be dependent on a mora.

15. **MORAICCODA** (Broselow et al. 1997:64)
    All coda consonants must be dominated by a mora.

Broselow et al. propose that the way in which languages differ as to whether a consonant dependent on a mora adds weight to a syllable or not follows from the language-specific ranking of two violable constraints: NOCMORA which demands that the head of a mora be a vowel (resulting in weightless coda consonants sharing a mora with a preceding vowel) and NOSHAREDMORA which requires that every mora be linked to a single segment (resulting in bimoraic closed syllables).

16. **NOCMORA**
    The head of a mora must be a vowel.

17. **NOSHAREDMORA**
    Moras should be linked to single segments.

In their study of syllable weight, Broselow et al. propose the ranking MORAICCODA >> NOSHAREDMORA >> NOCMORA for both Levantine Arabic and Egyptian Arabic. They also note that the lack of weight in final CvC syllables in the Arabic stress system may possibly result from a constraint forbidding a final consonant to head a mora. Adopting Broselow et al's analysis of Arabic coda weight, I propose that the answer as to why final consonants are weightless in Arabic lies in a ranking between a constraint forbidding a final consonant

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[4] Or more directly that a PrWd must end in a consonant as in McCarthy and Prince (1993b:23) FINAL-C: "Every PrWd is consonant-final". In my analysis, the parsing of the stem final consonant as the onset of an empty-headed syllable follows from the interaction of a number of constraints, rather than from a specific constraint requiring stems to be consonant final.

to be the head of a mora (NoFinalCMora) and a constraint requiring a syllable to dominate a moraic head (NoHeadlessSyll).

18. **NoFinalCMora**
No PrWd final consonant is the head of a mora.

19. **NoHeadlessSyll**
A syllable must dominate a mora.

The parsing of a final consonant as the onset of a headless syllable in a nominal or verbal stem would thus be enforced by the following ranking:

20. MoraicCoda >> NoSharedMora >> NoFinalCMora >> NoHeadlessSyll ; NoCMora

These proposed rankings are illustrated below with a quadriliteral root as the lexical input. Note that in tableau (21), Align-PrStem-Left is satisfied fully in all the candidates, while Parse-σ is violated in (21a) to satisfy NoFinalCMora without violating any of the higher-ranked constraints.

21. MoraicCoda ; Max^{IO} >> NoSharedMora >> NoFinalCMora >> NoHeadless Syll ; NoCMora >> Parse-σ

Noun Candidates μ x n ǰ r a	MoraicCoda	Max^{IO}	NoSharedMora	NoFinalCMora	*HeadlessSyll
μμ μ a. ✓ [(xan).ǰa].r					*
μμ μμ b. [(xan).(ǰar)]				*!	
μμ μ c. [(xan).ǰar]			*!		

In (21b), the final consonant is the head of a mora, violating NoFinalCMora. In (21c), on the other hand, the final mora is shared by the consonant and a preceding vowel, resulting in a fatal violation of NoSharedMora. The optimal candidate in (21a) violates only lower-ranked NoHeadlessSyll and Parse-σ.

Now consider another possible candidate for the quadriliteral form: *[(xan).(ǰa.ra)]. As shown by the lexical input of tableau (21), the vocalic melody is assumed to consist of one monomoraic vowel which is copied whenever necessary. Following McCarthy (1995), I assume that the central difference between concatenative and nonconcatenative languages lies in the low-ranking of O-Cont in nonconcatenative languages.

22. O-Contiguity
    The portion of S_2 standing in correspondence forms a contiguous string.
    (no intrusion)

Another important aspect of the root-and-pattern system of Arabic is the domination of Integr^{IO} by Dep^{IO} which forces copying of input segments over epenthesis whenever there is not enough lexical material to satisfy higher-ranked structural constraints.

23. Integrity^{IO}
    No element of S_1 has multiple correspondents in S_2.

This is illustrated in the tableau below.

24. MoraicCoda ; Max^{IO} ; Dep^{IO} >> NoSharedMora >> NoFinalCMora >> Integr^{IO} >> NoHeadlessSyll ; NoCMora >> Parse-σ

Noun Candidates μ x n ǰ r a	Dep^{IO}	NoShared Mora	NoFinalC Mora	Integr^{IO}	*Headless Syll
μμ μ a. ✓ [(xan).ǰa].r				*	*
μμ μ μ b. [(xan).(ǰa.ra)]				**!	
μμ μ c. [(xan).ǰI].r .	*!				*
μμ μμ d. [(xan).(ǰar)]			*!	*	

As shown in (24), the domination of Integr^{IO} and lower-ranked NoHeadlessSyll by high-ranking Dep^{IO} and by the structural constraints which determine the weight of coda consonants enforces a disyllabic shape on the PrStem and the parsing of a final headless syllable by the PrWd. A triliteral form is illustrated below.

25. MoraicCoda ; Max^{IO} ; Dep^{IO} >> NoSharedMora >> NoFinalCMora >> Integr^{IO} >> NoHeadlessSyll ; NoCMora >> Parse-σ

Noun Candidates μ b ħ r a	NoShared Mora	NoFinalC Mora	Integr^{IO}	*Headless Syll	Parse-σ
μμ a. ✓ [(baħ).r .]				*	
μ μ b. [(ba.ħa).r .]			*!	*	

Note that to have the final consonant parsed directly by the PrWd in either candidate would simply add an unnecessary violation of Parse-σ.

Consider now the minimal prosodic shape of a biliteral root. In contrast with the triliteral and quadriliteral roots, the ranking NoFinalCMora >> Integr^{IO} is insufficient to ensure the parsing of a final root consonant as the onset of a headless syllable. Both the bimoraic form [(bar).r .] and disyllabic [(ba.ra)] result in exactly one violation of Integr^{IO}. In other words, NonfinalHFt, which is high-ranking in the stress system of Arabic (see chapter 4), also plays a role in the nominal stem system as shown below in (27).

26. **NonfinalHFt**
    No PrWd is right-aligned with its head foot.

27. MoraicCoda ; Max^{IO} ; Dep^{IO} >> NoSharedMora >> NoFinalCMora ; NonfinalHFt >> Integr^{IO} >> NoHeadlessSyll ; NoCMora >> Parse-σ

Noun Candidates μ b r a	Nonfinal HFt	NoFinalC Mora	Integr^{IO}	*Headless Syll	Parse-σ
μμ a. ✓ [(bar).r .]			*	*	
μ μ b. [(ba.ra).r .]			**!	*	
μ μ c. [(ba.ra)]	*!		*		
μμ d. [(bar)]	*!	*!			

In (27b), the disyllabic foot requires a copy of the input vowel to fill the head of the second syllable, resulting in a second and fatal violation of INTEGR^{IO}. The candidate in (27d), on the other hand, fully satisfies INTEGR^{IO} but violates both NOFINALCMORA and NONFINALHFT.

The tableaux in (24) and (25) above demonstrate that the minimal prosodic shape of triliteral and quadriliteral nominal stems can be accounted for by language-specific rankings of IO-FAITH constraints and their interaction with the structural constraints determining the weight of coda consonants. As for biliteral nominal stems, NONFINALHFT has been shown to play a central role in determining their minimal prosodic shape. Crucially, nominal stems in Arabic have a minimal prosodic shape that is largely predictable from their consonantal root (IO-FAITH). What those minimal prosodic shapes have in common is that they satisfy NONFINALHFT, ALIGN-PRSTEM-LEFT and ALL-FT-LEFT fully, with PARSE-σ violations found only in quadriliteral stems. Another interesting aspect of the minimal prosodic shapes of the nominal stems is that they all satisfy BRANCHHEAD. In the next sections, this structural constraint will be shown to play an important role in the prosodic shape of nominal stems.

3.2.3 The Disyllabic Foot

The problem to be addressed at this point is how to account for biliteral and triliteral stems that surface as a disyllabic foot. Consider the prosodic shapes of the nominal stems, shown again in (28).

28. *Basic Nominal Patterns*

	2 Moras		*3 Moras*		*4 Moras*
Biliterals	barr	sabab	ǰadiid	baarir	ǰaaruur
Triliterals	bahr	badal	ʔataan	kaatib	ǰabbaar
Quadriliterals				xanǰar	rasmaal

Having dismissed the deverbal stems from the domain of analysis and having accounted for the minimal prosodic shapes of the biliteral, triliteral and quadriliteral stems, this leaves us with the nominal stems in the second, third and fifth columns. The main difference between these forms and the ones in the first and fourth columns is that the former are characterized by a PrStem which is right-aligned with a foot. Following Pater (1996), I propose that this large subset of the nominal system is lexically-specified for a high-ranking version of the constraint Align-PrSt-Right.

29. **Align-PrSt-Right-γ**
Align (PrStem, Right, Foot, Right)
"The right edge of every PrStem coincides with the right edge of some foot."

Align-PrSt-Right, however, cannot by itself ensure a disyllabic structure in triliterals or biliterals (i.e. **[(bar)].r* vs. *[(ba.ra)].r*). Some other force must be at work to force the parsing of a disyllabic foot in the nominal stems. I propose that this disyllabic requirement can be straightforwardly accounted for by the constraint BranchHead, which requires the head of a PrStem to be in a relation with a prosodic consituent in a non-head position.

31. **BranchHead**
The head of a PrStem is in a rhythmic relation with a non-head constituent at some level of analysis. (σ, Ft).

The tableau in (32) shows the interaction between BranchHead, which is assumed to be undominated in the general phonology of Arabic, and Align-PrSt-Right, which is lexically specified as high-ranking for a subset of the nominal lexicon.

32. BranchHead >> Align-PrStem-Left >> Align-PrSt-Right-γ >> Integr^{IO}
>> NoHeadlessSyll >> Parse-σ >> All-Ft-Left >> Align-PrSt-Right

Noun Candidates μ s b a	Branch- Head	Align- PrSt-R-γ	Integr^{IO}	Parse-σ	All-Ft- Left
μ μ a. ✓ [(sa.ba)].b .			**	*	
μμ b. [(sab).b .]		*!	*		
μμ c. [(sab)].b .	*!		*	*	

Observe that the smallest nominal stem [(sab).b .] in (32b) satisfies BranchHead, allowing for the optimality of the disyllabic candidate whenever a biliteral or triliteral stem is not lexically specified for Align-PrSt-Right-γ (i.e. in the general phonology of the language). The candidate in (32c), on the other hand, violates BranchHead. The central role played by Align-PrSt-Right in the parsing of a quadriliteral root is illustrated in the tableau below.

33. BranchHead >> Align-PrStem-Left >> Align-PrSt-Right-γ >> Integr^{IO}
>> NoHeadlessSyll >> Parse-σ >> All-Ft-Left >> Align-PrSt-Right

Noun Candidates μ r s m l a	Branch-Head	Align-PrSt-R-γ	Integr^{IO}	Parse-σ	All-Ft-Left
μμ μμ a. ✓ [(ras).(maa)].l .			*	*	*
μμ μ b. [(ras).ma].l .		*!	*	*	

Although violaton of Align-PrSt-Right-γ eliminates the left-headed candidate in (33b), satisfaction of the constraint does not force a two-footed structure. In a quadrililteral, the parsing of the PrStem-final syllable as a foot through lengthening of the vowel is not the only way that Align-PrSt-Right-γ could be satisfied without violating undominated Max^{IO}. Another possible candidate is *[ra.(sam)].l .*, which ties with *[(ras).(maa)].l .* for the lower-ranked constraints Integr^{IO}, Parse-σ and All-Ft-Left.

What is striking about *[ra.(sam)].l .* is that it is not a well-formed stem in Arabic. Nominal and verbal stems with the structure $[('\sigma_{\mu\mu})(\sigma_{\mu\mu})]C_{\sigma}$ or $[\sigma_{\mu}('\sigma_{\mu\mu})]C_{\sigma}$ always end in a foot with a long vowel, never a closed syllable (McCarthy and Prince 1990a:43).[5] Only the bimoraic stem allows (in fact requires) a moraic coda in this position, i.e. adjacent to a final headless syllable.

So far I have argued that the requirement of a final headless syllable for Arabic stems should be analyzed as resulting from the language-specific ranking of the weight

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[5] There is always a few lexical exceptions, like [disamšq] 'Damascus'.

constraints of Broselow et al. with NoFinalCMora and NoHeadlessSyll. The rankings alone, however, cannot explain the absence of coda consonants in a foot followed by a headless syllable which is directly parsed by the PrWd. Note that to assume a constraint forbidding a moraic consonant to be adjacent to a final headless syllable would incorrectly evaluate [(sab).b .] as non-optimal. Such a constraint could not distinguish between a headless syllable parsed by a PrStem, which allows a preceding moraic coda, and one parsed by a PrWd, which does not. Crucially, the moraic coda of the rightmost foot is optimal only when the following syllable satisfies Parse-σ.

Downing (1998) proposes that this sort of dependency between two constraints is best expressed by conjoining the two constraints to define a new constraint. Following work by Hewitt and Crowhurst (1996), she assumes that this type of conjunction is satisfied if and only if there is some domain in which both constraints are satisfied. To account for why moraic codas are not acceptable when followed by a syllable directly parsed by a PrWd, I propose a distinct constraint conjoining NoFinalCMora and Parse-σ. One advantage of choosing NoFinalCMora as one of the conjoined constraints is that the domain of the new constraint is limited to codas that are at most one syllable away from the right edge of the PrWd. As shown by the rankings at the top of tableau (34) below, the conjoined constraint is regarded as distinct from the constraint Parse-σ.

34. Max^{IO} >> BranchHead >> NoFinalCMora∩ Parse-σ >> Align-PrSt-Right-γ >> Integr^{IO} >> Parse-σ >> All-Ft-Left

Noun Candidates μ r s m l a	Max^{IO}	NoFinalCMora ∩ Parse-σ	Align-PrSt-R-γ	All-Ft-Left
μμ μμ a. √ [(ras).(maa)].l .				*
μ μμ b. [ra.(sam)].l .		(√) *! (*)		*
μμ μ c. [(ras).ma].l .			*!	

As shown in (34b), the conjoined constraint is violated if either of the two constraints is violated and satisfied only if both are satisfied. Coda consonants that are more than one syllable away from the right edge of a PrWd are not subject to NoFinalCMora and are therefore outside of the domain of the conjoined constraint.

3.2.4 Mora Faithfulness

Up to this point, the minimal prosodic shapes of biliteral, triliteral, and quadriliteral nominal stems have been shown to result from satisfying high-ranking faithfulness and structural constraints, while the maximal prosodic shapes of these stems have been argued to follow from a lexically-specific version of Align-PrSt-Right assigned to a subset of the nominal lexicon.

Consider now biliteral and triliteral stems which are in fact characterized by an initial unfooted syllabe (e.g. triliteral [ʔa.(taa)].n .). What is striking about this unexpected shape ---'unexpected' with respect to the structural constraints already discussed--- is that the most straightforward solution which is to assume faithfulness to an input bimoraic vowel will not work. Faithfulness to underlying quantitative distinctions is usually expressed by the constraint Wt-Ident^{IO}.

35. **Wt-Ident** (McCarthy 1995)
    If α and β are in a correspondence relation,
        and α is monomoraic, then β is monomoraic (no lengthening).
        and α is bimoraic, then β is bimoraic (no shortening).

Recall that in the case of the quadriliteral *[(ras).(maa].l* ., weight correspondence between the monomoraic input vowel and the bimoraic vowel in the second foot of the output violates Wt-Ident^{IO}. In *[ʔa.(taa)].n* ., on the other hand, it would be the first vowel of the output that violates Wt-Ident^{IO}, assuming that the input vowel is bimoraic.

To account for the violation of the faithfulness constraint in both the quadriliteral and the triliteral, I propose that two-footed structures in Arabic violate a constraint requiring that every foot dominated by a PrStem be parsed as its head.

36. **Ft-to-PrStem**
Every foot dominated by a PrStem is parsed as its head.

Satisfaction of Monoheadedness which requires every prosodic constituent to be uniquely headed results in a violation of Ft-to-PrStem for each two-footed but one-headed PrStem, as shown in (37d).[6]

37. Align-PrStem-Left ; BranchHead >> Align-PrSt-Right-γ >> Ft-to-PrStem >> Wt-Ident^{IO} >> Integr^{IO} >> NoHeadlessSyll >> Parse-σ >> All-Ft-Left

Noun Candidates μμ ʔ t n a	Align-PrSt-R-γ	Ft-to-PrStem	Wt-Ident^{IO}	Integr^{IO}	All-Ft-Left
μ μμ a. √ [ʔa.(taa)].n .			*	*	*
μ μ b. [(ʔa.ta)].n .			**!	*	
μμ μ c. [(ʔaa).ta].n .	*!		*	*	
μμ μμ d. [(ʔaa).(taa)].n .		*!		*	*

Only (37c) violates high-ranking Align-PrSt-Right-γ, while a violation of Ft-to-PrStem eliminates (37d). The choice of the optimal candidate is thus left to Wt-Ident^{IO}.

The two-footed quadriliterals, on the other hand, result from the domination of Ft-to-PrStem by Max^{IO} and Align-PrSt-Right-γ, as shown by the tableau below.

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[6] Note that in Japanese, Ft-to-PrStem would have to be very low-ranking.

38. Max^{IO} ; NoFinalCMora ∩ Parse-σ ; BranchHead >> Align-PrStem-Left >> Align-PrSt-Right-γ >> Wt-Ident^{IO} >> Ft-to-PrStem >> Integr^{IO} >> NoHeadlessSyll >> Parse-σ >> All-Ft-Left

Noun Candidates μ r s m l a	Max^{IO}	NoFinalCμ ∩ Parse-σ	Align-PrSt-R-γ	Ft-to-PrStem	Wt-Ident^{IO}
μμ μμ a. ✓ [(ras).(maa)].l .				*	*
μμ μ b. [(ras).ma].l .			*!		
μ μμ c. [ra.(sam)].l .		(√) *! (*)			

Observe that the main difference between the quadriliteral form in (38) and the triliteral form in (37) follows directly from their number of root consonants and the ranking Max^{IO} >> Ft-to-PrStem >> Wt-Ident^{IO}.

Consider now the two-footed structure in triliterals like [ǰabbaar]. These nominal stems have a consonantal root that could be defined with two identical medial consonants, making them somewhat exceptional. McCarthy and Prince (1990a), however, note that medial gemination applies productively in the noun of profession or habitual action and semi-productively in one type of broken plural.

The analysis proposed here takes the position that forms like [ǰabbaar] result from a floating mora which is a lexical feature of some consonantal roots.[7] The obligatory parsing of the mora by the consonantal root is assumed to follow from a faithfulness constraint which requires for every mora in the input to be associated with an output segment: μ-Max^{IO}. In contrast with Wt-Ident^{IO}, which forbids both lengthening and shortening, μ-Max^{IO} only blocks the loss of an input mora and can be satisfied through compensatory lengthening.

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[7] In the morphological derivation of nouns of profession or habitual action, however, the gemination of the medial consonant would be analyzed as the infixation of a floating mora to the head syllable of the nominal stem. (See the analysis of the verbal system in the next section.)

39. **μ-Max^{IO}**

Every mora of S_1 has a correspondent linked to a segment in S_2.

This is illustrated in the tableau below.

40. μ-Max^{IO} >> BranchHead ; NoFinalC$\mu \cap$ Parse-σ >> Align-PrSt-Right-γ >> Ft-to-PrStem >> Wt-Ident^{IO} >> Integr^{IO} >> NoHeadlessSyll >> Parse-σ >> All-Ft-Left

Noun Candidates μ μ ǰ b r a	μ-Max^{IO}	NoFinalCμ $\cap$ Parse-σ	Align-PrSt-R-γ	Ft-to-PrStem	Wt-Ident^{IO}
μμ μμ a. ✓ [(ǰab).(baa)].r .				*	*
μμ μ b. [(ǰab).ba].r .			*!		
μ μ c. [(ǰa.ba)].r .	*!				
μ μμ d. [ǰa.(bab)].r .		(✓) *! (*)			

Another possible candidate [. ǰ.(ǰa.ba)].r . creates a fatal violation of Onset.[8]

Finally, we are left with the nominal forms in the last column, which contain two long vowels. McCarthy and Prince (1990:44) point out that triliteral stems like [ǰaamuus] are rather rare and not used in any systematic way by the morphology. As noted by McCarthy and Prince, Levy (1971) even refers to these forms as only 'semi-canonical'. I will therefore assume that the 'semi-canonical' status of this latter type of nominal stems results from a vowel melody containing one or two long vowels and a lexically specific version of Wt-Ident which dominates Ft-to-PrStem in the constraint hierarchy, ensuring that each of the two long vowels will be parsed as the head of a foot.

41. Wt-Ident-γ >> Ft-to-PrStem >> Wt-Ident

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[8] Note that in the case of *[ʔa.(taa)].n* . with an input long vowel, μ-Max^{IO} is satisfied in the output form since both input moras are parsed by an output segment.

To sum up, within the model of prosodic structure developed here, I have shown that the minimal prosodic shapes of nominal stems can be accounted for in a straightforward way by the interaction between the high-ranking faithfulness and structural constraints of the language. Less predictable prosodic shapes, on the other hand, have been shown to follow from the lexically specific version of Align-PrSt-Right assigned to a subset of the nominal lexicon. I will turn now to the verbal system of Arabic.

3.3 The Verbal Stem System

The phonology of the verbal system shows many similarities with that of the nominal system. The minimal prosodic shape of verbal stems is disyllabic $[(\sigma_{\mu}\sigma_{\mu})]\sigma$, while its maximal prosodic shape in the non-finite forms contains two monosyllabic feet $[(\sigma_{\mu\mu})(\sigma_{\mu\mu})]\sigma$. In the finite form, however, the verbal stem may contain only one foot which is alway left-aligned with the PrStem.[9]

42. *Basic Verbal System (finite form)*

Form 1	*Form 2*	*Form 3*	*Form 4*	*Form 7*	*Form 8*	*Form 9*	*Form 10*	*Form 11*
ħalal	ħallal	ħaalal	ʔaħlal	nħalal	ħtalal	ħlalal	staħlal	ħlaalal
faʕal	faʕʕal	faaʕal	ʔafʕal	nfaʕal	ftaʕal	fʕalal	stafʕal	fʕaalal
		Q1				*Q4*		
		daħraǰ				dħarǰaǰ		

I propose that most of the root-and-pattern morphology of the verbal system (i.e. the conjugation of the Arabic verb) is best represented as a relation between the basic verb form (Form 1) and all the other related forms within a paradigm.[10]

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[9] Note that forms 5 and 6, tv-CvC$_i$C$_i$vC and tv-CvvCvC respectively, along with form Q2 tv-CvCCvC are not included in the tableau. These forms can be handled by assuming that the affix must be prefixed to a morphological stem: Align (Affix, Right, Stem, Left). The affix must be further specified so as to attach only to forms 2, 3 and Q1. Crucially, prefixes and suffixes that are required to be aligned with a morphological stem are outside of the domain of the verbal stem system.

[10] The numerals in Form 1, Form 2, etc. are the designations for the Western system of classification.

43. Input: Cons.Root / Voc.Melody
IO-Faith ⇅
Output: Base$_{\text{Form 1}}$ ⇄ Stem$_{\text{Form 2, Form 3, etc.}}$
BO-Identity

Unlike the nominal system, the minimal prosodic shape of the verbal base is a disyllabic foot. Another difference between the two systems is the absence of two-footed structures in the finite form of verbal stems. These two observations can be given a unified account by assuming that in the finite form, there is a lexically specific version of Align-PrSt-Right assigned to verbal stems, one which is dominated by Ft-to-PrStem.

44. Align-PrSt-Right-γ >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left >> Align-PrSt-Right

The role played by Align-PrSt-Right-β in the verbal system is illustrated in the tableau below.

45. NoFinalCMora∩ Parse-σ ; BranchHead >> Align-PrStem-Left >> Ft-to-PrStem >> Align-PrSt-Right-β >> Wt-Ident^{IO} >> Integr^{IO} >> Parse-σ >> All-Ft-Left

Verb Candidates μ ħ l a	Branch-Head	NoFinalCμ ∩ Parse-σ	Ft-to-PrStem	Align-PrSt-R-β	Integr^{IO}
μ μ a. √ [(ħa.la)].l .					**
μ μ b. [(ħa.la).l .]				*!	**
μμ c. [(ħal).l .]		(√) √ (√)		*!	*

In a triliteral or biliteral root, the lexically specific alignment constraint forces a disyllabic foot shape on the verbal stem, as shown in (45c). In a quadriliteral root, however, the domination of Align-PrSt-Right-β by Ft-to-PrStem results in a violation of the former in the optimal verbal stem in (46a) below.

46. NoFinalCMora∩ Parse-σ ; BranchHead >> Align-PrStem-Left >> Ft-to-PrStem >> Align-PrSt-Right-β >> Wt-Ident^{IO} >> Integr^{IO} >> Parse-σ >> All-Ft-Left

Verb Candidates μ d ħ r ǰ a	Branch-Head	NoFinalCμ ∩ Parse-σ	Ft-to-PrStem	Align-PrSt-R-β	Integr^{IO}
μμ μ a. ✓ [(daħ).ra].ǰ .				*	*
μμ μμ b. [(daħ).(raa)].ǰ .			*!		*
μμ μμ c. [(daħ).(raǰ)].ǰ .		(✓) *! (*)	*		**

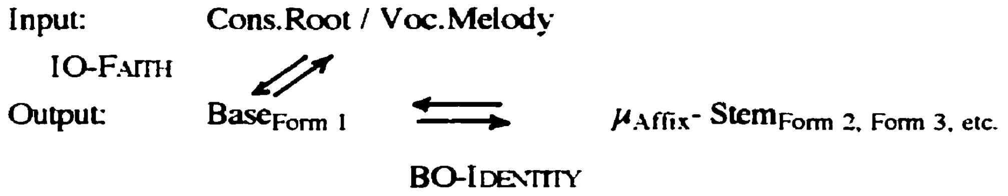
As shown by the two tableaux above, the minimal prosodic shapes of verbal stems can be straightforwardly accounted for by some reranking between Ft-to-PrStem and a lexically specific version of Align-PrSt-Right.

3.3.1 Output-to-Output Correspondence

The problem that has to be addressed now is how to account for the prosodic shapes of the output stems related to the base forms. Abstracting away from initial and final consonants parsed by headless syllables, all of the output stems can be characterized as a bimoraic foot followed by a light syllable. Differences between these output stems within the finite form paradigm come from some weight specification usually associated with a segment in the head syllable of the base. Form 3, for example, lengthens the vowel in the head syllable of the base. Following different patterns, forms 4, 8, 9 and Q4 assign a mora to the initial consonant of the base. In Form 2, on the other hand, the second consonant of the base is geminated resulting in a bimoraic head syllable, while in Form 7, an initial mora is linked to a consonantal prefix.

What these morphological forms have in common is (i) the addition of a mora to an input element, either a consonantal prefix or a segment from the base, and (ii) that this additional weight targets in some way the initial syllable of the base. To account for these observations, I propose that the output stems are 'derived' from the base by the affixation of a floating mora to the phonologically-empty stems. The differences between the output stems themselves are assumed to follow from the distinct sets of BO-Identity constraints specific to each of the forms within the finite paradigm.

47.



In addition I propose that the moraic affix is lexically subcategorized for a specific prosodic base. The subcategorization constraint associated with the moraic affix is shown below.

48. **AFFIX-TO-Hσ**
The right edge of the μ_{Affix} is left-aligned with the head syllable of some PrWd.

Identity between the base and the output stems is determined by the interaction of the BO constraints with μ-MAX$^{\text{IO}}$, which requires an affixed mora to surface in the output, and with the subcategorization constraint AFFIX-TO-Hσ.

Consider first the relation between the base and the Form 2 stem. The formulation of AFFIX-TO-Hσ in (48) demands perfect alignment between the right edge of the prefixed mora and the left edge of some head syllable. In Form 2, however, the right edge of the affixed mora is associated with the right edge of the head syllable instead of the left edge. This type of infixation can be accounted for if we assume that ANCHOR-LEFT$^{\text{BO}}$ dominates AFFIX-TO-Hσ in Form 2 of the verbal stem.

49. **ANCHOR-LEFT**
Any element at the left edge of S_1 has a correspondent at the left edge of S_2.

The gemination of the second consonant of the base, on the other hand, follows from the domination of INTEGR$^{\text{BO}}$ by WT-IDENT$^{\text{BO}}$. The proposals are illustrated in the tableau below. (Note that $^{\mu}{}_{[\text{Form2}]}$ should be read as μ_{Affix}- Stem$_{[\text{Form2}]}$.)

50. μ-Max^{IO} ; Max^{BO} >> BranchHead >> Anchor-Left^{BO} >> Affix-to-Hσ >> Wt-Ident^{BO} >> Integr^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left

Verb Candidates μ μ Base: ħa.la.l $^{\mu}{}_{[Form2]}$	μ-Max^{IO}	Anchor-Left^{BO}	Affix-to-Hσ	Wt-Ident^{BO}	Integr^{BO}
μμ μ a. ✓ [(ħal).la].l .			*		*
μμ μ b. [(ħaa).la].l .			*	*!	
μ μ μ c. [a.(ħa.la)].l .		*!			*
μ μ d. [(ħa.la)].l .	*!				

In (50c) the affixed mora is perfectly aligned with the left edge of the head syllable, but its association with an initial vowel results in a fatal violation of Anchor-Left^{BO}. In (50d), the non-parsing of the mora, while vacuously satisfying Affix-to-Hσ, violates undominated μ-Max^{IO}. The choice of the optimal output is thus left to lower-ranked Wt-Ident^{BO}. Note that every candidate in (50) satisfies Ft-to-PrStem, while only those in (50c-d) satisfy lower-ranked Align-PrSt-Right-β.

In contrast with Form 2, the output of Form 3 is characterized by the lengthening of the vowel in the head syllable. To account for this difference in output forms, we need to assume that some of the BO-Identity constraints specific to Form 3 are ranked differently from the constraints involved in the relation between Form 2 and the base. Crucially, the relation between Form 3 and the base is characterized by the dominance of Wt-Ident^{BO} by Integr^{BO}. This is illustrated in the tableau below.

51. μ-Max^{IO} ; Max^{BO}>> BranchHead >> Anchor-Left^{BO} >> Affix-to-Hσ >> Integr^{BO} >> Wt-Ident^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left

Verb Candidates μ μ Base: ħa.la.l $\mu_{[Form3]}$	μ-Max^{IO}	Anchor-Left^{BO}	Affix-to-Hσ	Integr^{BO}	Wt-Ident^{BO}
μμ μ a. ✓ [(ħaa).la].l .			*		*
μμ μ b. [(ħal).la].l .			*	*!	

Note again that the domination of Affix-to-Hσ by Anchor-Left^{BO} forces the infixation of the mora to the right edge of the head syllable rather than its prefixation at the left edge of the head syllable.

There is, however, a third possible output not shown in the tableau above which associates a prefixed mora to the initial consonant of the base: [ħ.(la.la)].l . Interestingly, this prosodic shape is in fact used to define Form 9 in the verbal paradigm. I propose that the main difference between Form 9 and the two previous Forms is the ranking of the faithfulness constraint Linear^{BO}.

52. **Linearity^{BO}**
S_1 is consistent with the preceding structure of S_2, and vice versa.

Linear^{BO} requires that the linear order of the base segments be preserved in the linear order of the output stem. Here I propose that what is specific to the relation between the Form 9 output stem and the base is the low-ranking of Linear^{BO}. This would contrast with the high-ranking of Linear^{BO} in Forms 2 and 3. The tableau illustrating Form 3 is given again in (53) below to shown the role played by Linear^{BO} in selecting the optimal candidate. The ranking of Linear^{BO} in Form 9 is illustrated in the next tableau (54).

53. μ-Max^{IO} ; Max^{BO}>> BranchHead >> Anchor-Left^{BO} ; Linear^{BO} >> Affix-to-Hσ >> Integr^{BO} >> Wt-Ident^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left

Verb Candidates μ μ Base: ħa.la.l $^{\mu}{}_{[Form3]}$	Anchor-Left^{BO}	Linear^{BO}	Affix-to-Hσ	Integr^{BO}	Wt-Ident^{BO}
μμ μ a. ✓ [(ħaa).la].l .			*		*
μμ μ b. [(ħal).la].l .			*	*!	
μ μ μ c. [ħ.(la.la)].l .		*!		*	*
μμ μ d. [(aħ).la].l .	*!				*

Recall that the same ranking for Linear^{BO} is assumed in the relation between Form 2 and the base. Form 9 is shown below.

54. μ-Max^{IO} ; Max^{BO} >> BranchHead >> Anchor-Left^{BO} >> Affix-to-Hσ >> Wt-Ident^{BO} >> Integr^{BO} >> Linear^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left

Verb Candidates μ μ Base: ħa.la.l $^{\mu}{}_{[Form9]}$	μ-Max^{IO}	Anchor-Left^{BO}	Affix-to-Hσ	Integr^{BO}	Linear^{BO}
μ μ μ a. ✓ [ħ.(la.la)].l .				*	*
μμ μ b. [(ħal).la].l .			*!	*	
μμ μ c. [(aħ).la].l .		*!	*		*

As shown in (54a), full satisfaction of Anchor-Left^{BO} and Affix-to-Hσ results in the first consonant of the base being parsed as the coda of an empty-headed syllable. Observe also that satisfaction of the two high-ranking constraints results in the satisfaction of lower-ranked Align-PrSt-Right-β.

Consider now the Form 4 verbal stem. This output form differs from the previous stems, in that the affixation of a mora does not result in either lengthening or gemination. In fact, Form 4 can be characterized by the absence of violation for the two identity constraints Integr^{BO} and Wt-Ident^{BO}. Instead, metathesis between the initial root consonant and the following vowel takes place, violating both Anchor-Left^{BO} and Linear^{BO}.

The distinct rankings of the BO-Identity constraints specific to the relation between Form 4 and the base are illustrated in the following tableau.

55. μ-Max^{IO} ; Max^{BO} >> BranchHead >> Wt-Ident^{BO} ; Integr^{BO} >> Affix-to-Hσ >> Anchor-Left^{BO} ; Linear^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left >> Linear^{BO}

Verb Candidates μ μ Base: ħa.la.l $^{\mu}$$_{[Form-4]}$	Wt-Ident^{BO}	Integr^{BO}	Affix-to-Hσ	Anchor-Left^{BO}	Linear^{BO}
μμ μ a. ✓ [(aħ).la].l .			*	*	*
μμ μ b. [(ħaa.la)].l .	*!		*		
μ μ μ c. [ħ.(la.la)].l		*!			*
μμ μ d. [(ħal.la)].l .		*!	*		

Note that in (55a), in spite of the metathesized first two segments of the base, the affixal mora is still assumed to be aligned with the right edge of the head syllable, resulting in the violation of Affix-to-Hσ.

Consider finally the prosodic shape of Q4 verbal stems. I propose that the parsing of the initial root consonant as the moraic coda of a headless syllable can be accounted for in a straightforward manner by assuming that Affix-to-Hσ dominates Align-PrSt-Left in the verbal system. This is illustrated in the tableau below.

56. μ-Max^{IO} ; Max^{BO} >> BranchHead >> Anchor-Left^{BO} >> Affix-to-Hσ >> Align-PrSt-Left >> Wt-Ident^{BO} >> Integr^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left

Verb Candidates μμ μ Base: daħ.ra.ǰ μ$_{[Q4]}$	μ-Max^{IO}	Anchor-Left^{BO}	Affix-to-Hσ	Align-PrSt-Left	Integr^{BO}
μ μμ μ a. ✓ d.[(ħar).ǰa].ǰ .				*	*
μμ μ b. [(daħ).ra].ǰ .	*!		*		
μμ μμ c. [(daħ).(raa)].ǰ .			*!		

3.3.2 Double Prefixation

Additional evidence for the analysis proposed above comes from the behavior of the consonantal prefixes in Forms 7 and 8. The initial position in the output of the prefix *n-* in Form 7, compared with the second position of the prefix *t-* in Form 8, strongly suggests that both prefixes are subcategorized for Affix-to-Hσ and are subject to the sets of BO-Identity constraints specified for the output stems. Form 7 can be defined as resulting from the prefixation of consonantal n- and of a moraic affix to the Form 4 stem, while Form 8 results from the prefixation of consonantal t- and of a moraic affix to the Form 9 stem. This is shown in the two tableaux below.

57. μ-Max^{IO} ; Affix-Max^{IO} >> BranchHead >> Wt-Ident^{BO} ; Integr^{BO} >> Affix-to-Hσ >> Anchor-Left^{BO} ; Linear^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left >> Linear^{BO}

Verb Candidates μ μ Base: ħa.la.l n-$^{\mu}$$_{[Form4]}$	Affix-Max^{IO}	Wt-Ident^{BO}	Integr^{BO}	Affix-to-Hσ
μ μ μ b. √ [n.(ħa.la)].l .				√(μ-) √(n-)
μμ μ b. [(naħ).la].l .				*!(μ-) *(n-)
μ μ μ c. [ħ.(na.la].l .				√(μ-) *!(n-)
μμ μ d. [(aħ).la].l .	*!			*(μ-)

In (57), the constraint is specified for both affixes simultaneously. Each affix which is not left-aligned with the head syllable adds a violation mark to the column. Note that (57b) is less optimal than (57c), since it has one additional violation. The optimal candidate in (57a) however, does not violate either of the two instances of the subcategorization constraint.

58. μ-Max^{IO} ; Max^{BO} >> BranchHead >> Anchor-Left^{BO} >> Affix-to-Hσ >> Wt-Ident^{BO} >> Integr^{BO} >> Linear^{BO} >> Ft-to-PrStem >> Align-PrSt-Right-β >> Parse-σ >> All-Ft-Left

Verb Candidates μ μ Base: ħa.la.l t-$^{\mu}$$_{[Form9]}$	Affix-Max^{IO}	Anchor-Left^{BO}	Affix-to-Hσ	Integr^{BO}
μ μ μ b. √ [ħ.(ta.la)].l .			√(μ-) *(n-)	
μ μ μ b. [t.(ħa.la)].l .		*!	√(μ-) √(n-)	
μμ μ c. [(ħat.la)].l .			*!(μ-) *(n-)	
μ μ μ d. [ħ.(la.la)].l .	*!		√(μ-) √(n-)	*

In the next chapter, additional evidence for the PrStem is provided by an analysis of the stress system of a number of Arabic dialects. In conjunction with this analysis of the Arabic stress systems, a number of theoretical issues regarding heads of prosodic constituents and their projection on the grid will be discussed.

Chapter 4

Heads and Grid Prominence

In chapters 2 and 3, an account of word minimality has been offered that builds on the proposal that an intermediate level, that of the PrStem, is found between the PrWd and the foot in the Prosodic Hierarchy. To provide further support for the PrStem, I intend to show that this new metrical constituent plays an important role in longer forms, where the PrStem is not coextensive with the phonological word.

4.1 Stress as Prominence on the Grid

In their influential study of stress systems, Halle and Vergnaud (1987) propose that stress is a relation between strong and weak elements that is computed on an autosegmental plane or grid projected from the segments and associated skeletal slots. On this metrical grid, all stressable elements (i.e. syllabic segments that can bear stress) project a grid mark at the lowest level (line 0). These stress-bearing elements are organized into headed constituents either binary or unbounded, with the metrical groupings being directional and exhaustive, forcing the construction of degenerate unary constituents. Constituent heads then project a grid mark on the next level (level 1). In quantity-sensitive languages, a bimoraic syllable (in Halle and Vergnaud's terms, a syllable with a branching rime) also projects a grid mark on level 1. A single head at an edge then receives a grid mark on level 2 in accordance with the language's particular End Rule.

Halle and Vergnaud's model of stress as prominence on the grid is elaborated on further by Selkirk (1984), Hayes (1985, 1987, 1995), McCarthy and Prince (1986, 1988, 1990ab). They independently propose that relative prominence should be derived from the basic properties of syllables and foot structure. These relations are then directly mapped onto the grid, with heavy syllables and foot heads obligatorily projecting a grid mark at level 1 under compulsion from the Weight-to-Stress Principle (Prince 1990). A single foot head is then chosen to project a grid mark at level 2 in accordance with the language's End Rule.

At issue here is how to account for stress systems where iterative foot parsing and the location of heavy syllables play a central role in determining the position of main stress, yet where the predicted secondary stresses are absent. In Classical Arabic, for example, presence or absence of heavy syllables and their positions within the word are crucial in determining the location of main stress. Secondary stresses are absent, however, even in words with more than one heavy syllable. A similar pattern is found in Cairene Arabic. In this dialect, both the location of heavy syllables and iterative foot distribution determine the location of main stress. Again no secondary stresses are found in the final output. The question then is how to resolve the apparent conflict between the absence of prominence on the grid for some prosodic constituents with their role in positioning the main-stressed foot with respect to the edge of a PrWd.

In this chapter, I reanalyse the stress systems of a number of Arabic dialects in terms of the model developed here. I propose that these stress systems can be accounted for in a straightforward manner by assuming that headship within metrical constituents is often coextensive with but actually distinct from prominence on the grid.

4.2 The Weight-to-Stress Principle

Before reanalyzing the Arabic stress systems, I will begin by discussing the status of the Weight-to-Stress Principle in the model of prosodic structure proposed here. The standard interpretation of Weight-to-Stress within Optimality Theory is as a requirement imposed on foot structure and on grid prominence.

1. WEIGHT-TO-STRESS (Prince and Smolensky 1993:53)
   Heavy syllables are prominent in foot structure and on the grid.

Here I propose that Weight-to-Stress should be subdivided into two distinct requirements on heads: WEIGHT-TO-HEAD and STRESS-TO-HEAD. WEIGHT-TO-HEAD requires weight to be assessed in terms of the headship of metrical constituents, while STRESS-TO-HEAD restricts projection onto the grid to some specific type of head.

2. **WEIGHT-TO-H(PRCAT)**
   A bimoraic syllable is parsed as the head of some prosodic category.

3. **STRESS-TO-H(PRCAT)**
   Prominence is only assigned to the head of some prosodic category.

For example, WEIGHT-TO-H(FT) requires heavy syllables to be parsed as heads of feet:, while STRESS-TO-H(PRSTEM) only allows the head of a foot parsed by a PrStem to project onto the grid. WEIGHT-TO-H(PRSTEM), on the other hand, requires a heavy syllable to be uniquely parsed as the head foot of a PrStem, while STRESS-TO-H(FT) requires every foot head to project onto the grid, irrespective of weight. It is important to note that there is no potential conflict between the two types of constraint. In the next sections, analyses of a number of Arabic dialects will demonstrate the role played by these constraints in the stress system of languages.

4.2.1 Classical Arabic

Consider first the stress system of Classical Arabic. The data below are from McCarthy and Prince (1990a).

4. *Stress Placement*

Final	*Penult*	*Antepenult*
yaqúul	yaqúulu	kátaba
qaanúun	yaqúlna	kátabat
sirháan	qáalat	kátabuu
taržámt	rámaa	tárjama

The conditions on stress placement in Classical Arabic can be described as follows:

5. Stress a superheavy syllable at the right edge;
   Otherwise stress the rightmost nonfinal heavy syllable;
   Otherwise stress the initial syllable.

These conditions are even better illustrated, when we restrict our attention to words that are three syllables and longer, as shown below. The additional data is from McCarthy (1979).

6.

Initial	*Antepenult*	*Penult*
bálahatun	tárjama	kitáabun
mámlakatun	yusáariku	manaadíilu

In Classical Arabic, the location of main stress depends crucially on the position of heavy syllables within the PrWd, even though only the rightmost non-final one is stressed. When there is no heavy syllable in non-final position, an initial light syllable receives main stress.

The first problem to be addressed is how to ensure that a rightmost non-final heavy syllable is chosen as the main stressed foot over a word-initial disyllabic foot. If as is often assumed there is no secondary stress in Classical Arabic, then an additional problem is how to account for the absence of secondary stress in words with more than one non-final heavy syllable. As a solution to the first problem, I propose a constraint which requires heavy syllables to be parsed, not as the head of a foot (the standard definition of the WSP), but rather as the head of a PrStem.

7. **WEIGHT-TO-H(PRSTEM)**
A bimoraic syllable is parsed as the head foot of a PrStem.

Satisfaction of this constraint entails that a heavy syllable must be uniquely parsed as a foot that is itself parsed by a PrStem.

The initial main stress found in words without non-final heavy syllables, on the other hand, is accounted for by assuming that ALIGN-PRSTEM-LEFT, although dominated by WEIGHT-TO-H(PRSTEM), is still high-ranking in the language. The absence of main stress on final long vowels is assumed to follow from the domination of WEIGHT-TO-H(PRSTEM) by NONFINALHFT.

8. **ALIGN-PRSTEM-LEFT**
Align (PrStem, Left, PrWd, Left)
"The left edge of every PrStem coincides with the left edge of some PrWd."

9. **NONFINALHFT**
No PrWd is right-aligned with its head foot.

These proposals are illustrated in the tableau below. As shown in (10a), Align-PrStem-Left is categorically evaluated. Every PrStem which is not left-aligned with a PrWd counts as one violation of Align-PrStem-Left, irrespective of its position within the word.

10. NonfinalHFt >> Weight-to-H(PrStem) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates manaadiilu	Nonfinal-HFt	Weight-to-Head	Align-PrSt-Left	Parse-σ
μ μμ μμ μ a. ✓[ma.(naa)].[(dii).lu]			*	
μ μμ μμ μ b. [ma.(naa)].(dii).lu		*!		*

In words without non-final heavy syllables, on the other hand, satisfaction of Align-PrSt-Left results in the initial syllable receiving main stress.[1] Note that the ranking Parse-σ >> All-Ft-Left is assumed to result in a trisyllabic PrStem in odd-numbered words.

11. NonfinalHFt >> Weight-to-H(PrStem) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates šaǰaratuhu	Nonfinal-HFt	Align-PrSt-Left	Parse-σ	All-Ft-Left
μ μ μ μ μ a. ✓ [(ša.ǰa).ra].(tu.hu)				***
μ μ μ μ μ b. [(ša.ǰa)].(ra.tu).hu			*!	**
μ μ μ μ μ c. (ša.ǰa).[(ra.tu).hu]		*!		**

Consider now words which contain only one final closed syllable. Here I assume that the final syllable is monomoraic to satisfy undominated NoFinalCMora.

12. **NoFinalCMora**
    No PrWd final consonant is the head of a mora.

---

[1] The word [šaǰaratuhu] 'his tree (nom.)' is listed as a Cairene Classical Arabic form in the data on Cairene Arabic in Hayes (1995).

This is illustrated in the tableau below.

13. NoFinalCMora ; NonfinalHFt >> Weight-to-H(PrStem) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates mamlakatun	NoFinalC Mora	Weight-to-H(PrStem)	Align-PrSt-Left	Parse-σ
μμ μ μ μ a. √ [mam).la].(ka.tun)				
μμ μ μ μ b. [(mam].(la.ka).tun				*!
μμ μ μ μμ c. [(mam].(la.ka).(tun)	*!	*		
μμ μ μ μ d. (mam).[(la.ka).tun]		*!	*	

Observe that with respect to the form [mamlakatun], all of the structural constraints already introduced are satisfied by an initial main-stressed syllable, with the exception of All-Ft-Left.

Consider now the problem of how to ensure that only the main stressed foot will have prominence on the grid. In Halle and Vergnaud's (1987) framework, heavy syllables are assigned a grid mark on line 1 under compulsion of the WSP, with the exception of final heavy syllables which are made prosodically invisible through the extrametricality of the last segment in the word. Left-headed unbounded constituents are then constructed on line 0, with the constituent heads projecting a grid mark on line 1. The rightmost grid mark on line 1 then projects a grid mark on line 2. This is illustrated with the forms [yusáariku] and [ɓálaħatun]. The last segment is treated as extrametrical.

14	a. . * . . .	b. *	line 2
	(*) (* . .) .	(*)	line 1
	(1) (3 4 5)	(1 2 3 4)	line 0
	yu sa a r i k<u>	ɓa la ħa tu <n>	

To account for the lack of secondary stress, Halle and Vergnaud propose a rule which conflates lines 1 and 2 after main stress has been assigned. According to their proposal, when two lines in a metrical grid are conflated, a constituent on the lower line is preserved only if its head is also a head on the higher line. Crucially, the loss of grid mark on line 1 is assumed to entail both the loss of the head from which it was projected and the loss of the constituent itself.

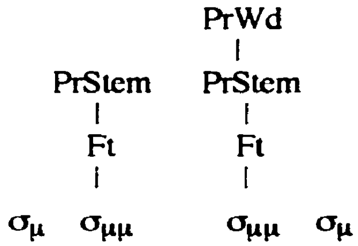
Conflation follows from the standard assumption that metrical constituents must have a head. Consequently the loss of a head position on the metrical grid results in the loss of the metrical constituent itself. This standard assumption is also part of the metrical theories independently proposed in Hayes (1995) and McCarthy and Prince (1986). Processes such as Conflation and constituent erasure, however, are intrinsically repair strategies that can only be part of a derivational framework. In Optimality Theory, such repair strategies have no possible status, since only the input and the output are available for evaluation.

The account proposed here takes the position that constituent heads and prominence on the grid are two distinct requirements. The lack of secondary stress in Classical Arabic is assumed to follow from a constraint requiring that only the head of a PrWd may project a grid mark on the grid at any level.

15. **STRESS-TO-H(PRWD)**
Prominence is only assigned to the head of a PrWd.

When a PrWd dominates more than one PrStem as shown in (16), only one can qualify as the head of the PrWd in order to satisfy MONOHEADEDNESS.[2]

16.



17. **MONOHEADEDNESS** (Crowhurst 1996)
Prosodic constituents are uniquely headed.

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[2] See the analysis of Guugu Yimidhirr in chapter 5 where the domination of MONOHEADEDNESS by FT-TO-PRSTEM ensures that both feet within a head PrStem will receive main stress.

In any language where Monoheadedness is undominated, the default option for the head PrStem would follow from the choice of either Align-PrSt-Left or Align-PrSt-Right by the grammar. However, in a stress system where the more specific requirement (Stress the rightmost non-final heavy syllable) is at one edge, yet the default location of main stress is at the opposite edge (Otherwise stress the initial syllabe), the position of the head PrStem is assumed to result from the satisfaction of a constraint demanding that of all the possible heads of a PrWd, the rightmost one be chosen.

18. **Rightmost**
    The rightmost PrStem is defined as the head of a PrWd.

Satisfaction of this constraint only requires that the rightmost PrStem qualify as the head of a PrWd. Rightmost is indifferent as to whether other PrStems within the word are also defined as PrWd heads. To have more than one PrStem as head of the PrWd, however would violate Monoheadedness.These arguments are illustrated in the tableau below.

19. Monoheadedness ; Rightmost ; NonfinalHFt >> Weight-to-H(PrStem) >>
    Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates manaadiilu	Mono- Headed	Rightmost	Weight- to-Head	Align- PrSt-L	Parse-σ
μ μμ μμ μ a. √[ma.(naa)].[(díi).lu]				*	
μ μμ μμ μ b. [ma.(náa)].[(díi).lu]	*!			*	
μ μμ μμ μ c. [ma.(náa)].[(dii).lu]		*!		*	

Satisfaction of Stress-to-H(PrWd), on the other hand, demands that only the head(s) of the PrWd be allowed to project on the metrical grid. This means that only the head syllable of the PrWd can project a grid mark on line 1. As the head foot of a PrStem, it also projects a mark on line 2. Finally, as the only head found on line 2, it is then assigned a grid mark on line 3.

20.	. . * .	line 3	H(PrWd)
	. . * .	line 2	H(PrStem)
	. . (*) .	line 1	H(Ft)
	μ μμ μμ μ		
	[ma.(naa)].[(dii).lu]		

Consider now a form which has no heavy syllables in non-final position. As illustrated in the earlier tableau (11), satisfaction of ALIGN-PRST-LEFT results in an initial main- stressed foot.

21.	*	line 3	H(PrWd)
	*	line 2	H(PrStem)
	(*)	line 1	H(Ft)
	μ μ μ μ μ		
	[(ša.ǰa).ra].(tu.hu)		

The benefits of subdividing the WSP into two distinct constraints are clearly seen from the analysis just presented. On the one hand, the constraint STRESS-TO-H(PRWD) eliminates the need for Conflation as a repair stragegy. On the other hand, the constraint WEIGHT-TO-H (PRSTEM) eliminates the need for unbounded constituents which have no place in restrictive theories of foot structure.[3]

To summarize, the analysis of the Classical Arabic stress system presented here offers support for a model of prosodic structure which extends the Prosodic Hierarchy to include a new metrical constituent, the PrStem, between the foot and the PrWd. An important aspect of this model is that headship follows directly from the Prosodic Hierarchy. Whether the head of some prosodic category is assigned prominence on the metrical grid or not, on the other hand, results from a specific type of constraint STRESS-TO-HEAD. Under this view, stress systems where syllable structure and foot distribution play a role in determining the location of main stress yet where secondary stress is absent are predicted by the theory rather than being problematic for it.

---

[3] In my analysis, the position of main stress in Classical Arabic is accounted for in a straightforward manner. The presence or absence of secondary stress in the language is a separate issue.

In the next two sections, an analysis of the stress system of Cairene Arabic and that of Palestinian Arabic will be presented based on the proposals introduced in this section. It will be shown that the stress sytems of these two dialects share many similarities with that of Classical Arabic, as would be expected from different dialects of the same language.

3.2.2 Cairene Arabic

Consider first the stress system of colloquial Arabic as spoken in Cairo. The data are taken from Hayes (1995) and include forms that are defined as 'Cairene Classical Arabic'. As in the other Arabic dialects, syllables in Cairene include light Cv, heavy CvC and Cvv, and superheavy CvCC and CvvC that are restricted to final position.

The stress pattern of Cairene Arabic as described in its first formal metrical account by McCarthy (1979) is as follows: stress a final superheavy syllable or a final Cvv in non-classical forms:[4]

22.	a. katábt	'I wrote'
	b. hajjáat	'pilgrimmages' Cl.
	c. gatóo	'cake'

Otherwise stress the penult, provided it is heavy:

23.	a. béetak	'your (m.sg.) house'
	b. katábta	'you (m.sg.) wrote' Cl.
	c. mudárris	'teacher'
	d. haaγáani	'these (m.dual)' Cl.

Otherwise, stress the penult or the antepenult, whichever is separated by an even number of syllables from the closest preceding heavy syllable, or if there is no such syllable from the beginning of the word.

24. *Penultimate Syllable*

a. fíhim	'he understood'
b. šajarátun	'tree (nom.)' Cl.

---

[4] According to Hung (1994), from a personal communication by McCarthy, final stressed vowels as in (22c) are most likely superheavy syllables with a final *-h*.

c. katabítu	'she wrote it (m.)'
d. šaǰaratuhúmaa[5]	'their (dual) tree (nom.)' Cl.
e. qattála	'he killed' Cl.
f. mudarrísit	'teacher (f.construct)'
g. ʔadwiyatúhu	'his drugs (nom.)' Cl.

25. *Antepenultimate Syllable*

a. ʕiŋkásara	'mother'
b. ʕadwiyatúhumaa	'his drugs (nom.)' Cl.
c. kátaba	'he wrote' Cl.
d. šaǰarah	'tree (clause-final)'
e. šaǰarátuhu	'his tree (nom.)' Cl.

As shown above, the position of heavy syllables within a word plays an important role in determining main stress. In contrast with Classical Arabic, however, main stress is never found farther left than the antepenult. I propose that the first and most crucial difference between the two dialects comes from the domination of ALIGN-PRST-LEFT by ALIGN-PRWD-RIGHT in Cairene Arabic.

26. **ALIGN-PRWD-RIGHT**
Align (PrWd, Right, PrStem, Right)
"The right edge of every PrWd coincides with the right edge of some PrStem."

The second difference between the two Arabic dialects comes from the different argument chosen by the nonfinality constraint. That is, in Cairene NONFINALITY requires for the PrWd head syllable to be non-final, rather that for the head foot to be non-final.

27. **NONFINALHσ**
No PrWd is right-aligned with its head syllable.

These proposals are illustrated in the tableau below. NONFINALHσ is left out of the tableau since it is never violated in the optimal outputs. The form in the tableau below is from Crowhurst (1996).

---

[5] The forms in both (24d) and (25b) from Mitchell (1960) appear with a long vowel word-finally. However, in Classical words, final Cvv is always counted as light. In fact, as noted by Hayes (1995), many are doubtful about the status of such syllables (Harrell 1960; Harm 1981).

28. Monoheadedness ; Rightmost ; NonfinalHσ >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates madrasatuhunna	Align-PrWd-Right	Weight-to-Head	Align-PrSt-Left	All-Ft-Left
μμ μ μ μ μμ μ a.✓ [(mad).ra].(sa.tu).[(hún).na]			*	******
μμ μ μ μ μμ μ b. [(mad)].[(ra.sa).tu].[(hún).na]			**!	*****

Note that undominated Rightmost ensures that the final PrStem resulting from satisfying Align-PrWd-Right is always parsed as the head of the PrWd. Whether the head foot is final or not, however, is determined in part by the location of heavy syllables within the word.

In forms ending with three light syllables,, foot distribution becomes crucial for the positioning of the main stress foot at the right edge, as shown in the two tableaux below.

29. Monoheadedness ; Rightmost ; NonfinalHσ >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates ʕiŋkasara	Align-PrWd-Right	Weight-to-H(PrSt)	Align-PrSt-Left	All-Ft-Left
μμ μ μ μ a. ✓ [(ʕiŋ)].[(ka.sa).ra]			*	*
μμ μ μ b. [(ʕiŋ).ka].[(sa.ra)]			*	**!

As shown in (29b), the choice of the optimal output lies squarely on the position of the second foot within the PrWd.

30. Monoheadedness ; Rightmost ; NonfinalHσ >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates šaǰaratuhu	Align-PrWd-Right	Align-PrSt-Left	Parse-σ	All-Ft-Left
μ μ μ μ μ a. √ [(ša.ǰa)].[(rá.tu).hu]		*		**
μ μ μ μ μ b. [(ša.ǰa).ra].[(tú.hu)]		*		***!
μ μ μ μ μ c. [ša.(ǰa.ra)].[(tú.hu)]		*		***!*

In (30a), the optimal candidate has its second foot two syllables away from the left edge violating All-Ft-Left twice. In (30b), there are three syllables between the second foot and the left edge of the PrWd. In (30c), the first foot is one syllable away from the left edge, while the second foot is three syllables away from the left edge, resulting in four violations of All-Ft-Left.

The elimination of the non-optimal candidates in (30b-c) has been shown to follow from the number of violations that apply to All-Ft-Left. This proposal, however, becomes problematic when we consider forms with an initial bimoraic foot. This is illustrated in the tableau below.

31. Monoheadedness ; Rightmost ; NonfinalHσ >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates ʔadwiyatuhu	Align-PrWd-Right	Weight-to-Head	Align-PrSt-Left	All-Ft-Left
μμ μ μ μ μ a. [(ʔad)].(wi.ya).[(tú.hu)]			*	***!*
μμ μ μ μ μ b. √ [(ʔad).wi].[(yá.tu).hu]			*	**
μμ μ μ μ μ c. [(ʔad).wi].[ya.(tú.hu)]			*	***!

If we simply assume that ALL-FT-LEFT is a gradiently violable constraint which demands perfect alignment with a designated edge, then according to tableau (31), the candidate output in (31b) should be the optimal choice. The correct output, however, is (31a). What differentiates the candidate in (31a) from those in (31b-c) is perfect adjacency between feet (a binary pattern), compared with the ternary pattern which characterizes (31b).

In metrical theory, foot distribution reflects two different processes: directionality and iterativity. Within Optimality Theory, the standard assumption has been that ALL-FT-LEFT reflects both processes through the fact that its violations are gradient rather than categorical. Any theory of stress systems that allows for ternary constituents, however, faces a problem similar to that found in tableau (31) in that maximally ternary constituents tend in some cases to reduce the number of ALL-FT-LEFT violations in a word. This is illustrated below.

32 a. [(σ σ) σ][(σ σ) σ] b. [(σ σ)][(σ σ)][(σ σ)]

33 b. [(σ σ) σ][(σ σ) σ][(σ σ)] b. [(σ σ)][(σ σ)][(σ σ)][(σ σ)]

In (32a), foot parsing results in only three violations of ALL-FT-LEFT, while (32b) results in six violations. Foot parsing in the ternary pattern in (33a) results in nine violations, while the binary pattern in (33b) results in exactly twelve violations.

Adopting the position taken in Kager (1996b), I propose that ALL-FT-LEFT should be subdivided into ALL-FT$_1$-LEFT >> ALL-FT$_2$-LEFT >> ALL-FT$_3$-LEFT etc. The crucial aspect of this subdivision is that ALL-FT-LEFT evaluates the distance of each foot to the left edge on a foot-by-foot basis. This means that, irrespective of the number of feet in a PrWd, a violation of ALL-FT$_1$-LEFT is always more costly than any number of violations of ALL-FT$_2$-LEFT, while any violation of ALL-FT$_2$-LEFT is counted as worse than two or more violations of subsequent feet. Similarly, ALL-FT-RIGHT evaluates the distance between each foot and the right edge of a PrWd, i.e. ALL-FT$_1$-RIGHT is the rightmost foot.

34. Monoheadedness ; Rightmost ; NonfinalHσ >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates ˀadwiyatuhu	Align- PrWd-Right	Weight- to-Head	Align- PrSt-Left	All-Ft- Left
μμ μ μ μ μ a. √[(ˀad)].(wi.ya).[(tú.hu)]			*	$\surd_1$ $*_2$ $***_3$
μμ μ μ μ μ b. [(ˀad).wi].[(yá.tu).hu]			*	$\surd_1$ $**!_2$
μμ μ μ μ μ c. [(ˀad).wi].[ya.(tú.hu)]			*	$\surd_1$ $**!*_2$

Observe that both (34b) and (34c) have more than one violation of All-Ft$_2$-Left, while in (34a) All-Ft$_2$-Left is violated only once. So, even though (34b) has a lesser number of violations for All-Ft-Left, it is still evaluated as less optimal than (34a).

3.2.3 Palestinian Arabic

Consider now the stress pattern of Palestinian Arabic which is illustrated below. The data are from Hayes (1995).

First, stress a final superheavy syllable.

35. *Final Superheavy Syllables*

a. darást	'I studied'
b. baabéen (--> babéen)	'two doors'
c. dukkáan	'shop'
d. mooladéen	'two feasts'

Otherwise stress the penult, provided it is heavy:

36. *Heavy Penultimate Syllable*

a. báarak	'he blessed'
b. máktab	'office'
c. yírši	'bribe (3 m.sg. imperf)'
d. katábna	'we wrote'
e. maktábna	'our offices'
f. mooládna (--> moládna)	'our feast'

g. bakarítna	'our cow'
h. baarakátna	'she blessed us'

In words ending with two light syllables the stress pattern is as follow: in disyllabic or trisyllabic words, stress the initial syllable.

37. *Disyllables and Trisyllables*

a. ʔána	'I'
b. kátab	'he wrote'
c. kátabu	'they wrote'

Otherwise stress the antepenult, provided it is heavy:

38. *Heavy Antepenultimate Syllable*

a. báarako	'he blessed him'
b. ʕállamat	'she taught'
c. ʔídʃaʕu	'pay (pl. imper.)'
d. makáatibi (--> makaatbi)	'my offices'

Otherwise, stress the preantepenultimate in four syllable words without heavy syllables or stress the antepenultimate.

39. *Preantepenultimate Syllable*

a. bákarito (--> bákarto)	'his cow'
b. dárabato (--> dárbato)	'she hit him'
c. šáǰaratun	'a tree' Cl.

40. *Antepenultimate Syllable*

a. ʕallámato	'she taught him'
b. maktábito (--> maktábto)	'his library'
c. šaǰarátuhu	'his tree' Cl.

Observe first that the head foot is only final in disyllabic words in Palestinian Arabic. In this regard, Palestinian Arabic differs from Cairene but is similar to Classical Arabic. The fact that main stress is never initial in words longer than four syllables, on the other hand, strongly suggests that ALIGN-PRWD-RIGHT is high-ranking in Palestinian Arabic. These proposals are illustrated in the following tableaux.

41. Monoheadedness ; Rightmost ; NonfinalHFt >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates šaǰaratuhu	Nonfinal-HFt	Align-PrWd-Right	Align-PrSt-Left	All-Ft-Left
μ μ μ μ μ a. √ [(ša.ǰa)].[(rá.tu).hu]			*	$\surd_1$ $**_2$
μ μ μ μ μ b. [(ša.ǰa).ra].[(tú.hu)]	*!		*	$\surd_1$ $***_2$
μ μ μ μ μ c. [(šá.ǰa).ra].(tu.hu)		*!		$\surd_1$ $***_2$

As noted before, Palestinian Arabic differs from Cairene in that the head foot cannot be final in a PrWd. This however does not explain why main stress is initial in words which contain four light syllables. Here I propose that the preantepenultimate stress follows from satisfying Align-PrWd-Right and Align-PrSt-Left. This is shown in the tableau below.

42. Monoheadedness ; Rightmost ; NonfinalHFt >> Align-PrWd-Right >> Weight-to-H(PrSt) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates šaǰaratun	Nonfinal-HFt	Align-PrWd-Right	Align-PrSt-Left	All-Ft-Left
μ μ μ μ a. √ [(šá.ǰa).(ra.tun)]				$\surd_1$ $**_2$
μ μ μ μ b. ša.[(ǰá.ra).tun]			*!	$*_1$
μ μ μ μ c. [(šá.ǰa).ra].tun		*!		$\surd_1$

In (42a), I assume that the PrStem parses two feet in order to satisfy both Align-PrWd-Right and Align-PrSt-Left. Such a two-footed structure, however, violates the constraint Ft-to-PrStem, which requires every foot parsed by a PrStem to be its head.

43. **Ft-to-PrStem**
Every foot dominated by a PrStem is parsed as its head.

The role played by Ft-to-PrStem is in evidence in another dialect, Egyptian Radio Arabic which differs from the other dialects in that all feet are stressed. In other words, Stress-to-H(Ft) is undominated in Egyptian Radio Arabic. Interestingly, in this particular dialect discussed in Harrell (1960), words ending in four light syllables have the position of main stress varying freely between the penultimate and the preantepenultimate syllable: [kàtabáhu] vs. [kátabàhu].

Even more interesting is the free variation found in trisyllabic words with an initial heavy syllable.

44. *Free Variation between the Penult and Antepenultimate Syllable*

a. háa.ði.hi	hàa.ðí.hi	'this'
b. múš.ki.la	mùš.kí.la	'problem'

Strikingly, there is no secondary stress on the penult when main stress is on the antepenult. Given that secondary stress is found on the penult in quadrisyllabic forms, the question here is what is particular to quadrisyllabic forms that the trisyllabic forms in (44) do not share.

The solution I propose lies in assuming that Ft-to-PrStem is in fact high-ranking in Egyptian Radio Arabic (and Palestinian Arabic). The question then is what would force the violation of Ft-to-PrStem in quadrisyllabic forms but not in trisyllabic forms. In his analysis of ternary systems, Kager (1996b) proposes the constraint Parse-2 to restrict sequences of unparsed syllables.

45. **Parse-2**
One of two adjacent stress units must be parsed by a foot.

This constraint, however, would parse both quadrisyllabic forms and trisyllabic forms as either two feet uniquely parsed by a PrStem: [(ká.ta)].[(bà.hu)] and [(hàa)].[(ðí.hi)], or as a two-footed PrStem: [(kà.ta).(bá.hu)] and *[(háa).(ðì.hi)]. Here I propose a different type of constraint, WeakParseCond, which I assume is undominated universally.[6]

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[6] This proposal is based on Prince's (1980) idea that no prosodic domain may end in more than two weak syllables.

46. **WEAKPARSECOND**
A mora in a non-head syllable is adjacent to at most one mora
in a non-head syllable.

This constraint requires that a mora not parsed by the head of a foot should be adjacent to at most one mora that is not the head of a foot. The role played by the WEAKPARSECOND in eliminating the unacceptable form *[(ká.ta).ba].hu in contrast with [(háa).ði].hi is shown below.

47. WEAKPARSECOND ; RIGHTMOST >> FT-TO-PRSTEM >> ALIGN-PRWD-RIGHT >>
WEIGHT-TO-H(PRSTEM) >> ALIGN-PRST-LEFT >> PARSE-σ >> ALL-FT-LEFT

Candidates katabahu	WEAKPARSE COND	FT-TO-PRSTEM	ALIGN-PRWD-R	ALIGN-PRST-LEFT	PARSE-σ
μ μ μ μ a.√[(kà.ta)].[(bá.hu)]				*	*
μ μ μ μ b. [(ká.ta).ba].hu	*!		*		
μ μ μ μ c. [(ká.ta).(bà.hu)]		*!			

48. WEAKPARSECOND ; RIGHTMOST >> FT-TO-PRSTEM >> ALIGN-PRWD-RIGHT >>
WEIGHT-TO-H(PRSTEM) >> ALIGN-PRST-LEFT >> PARSE-σ >> ALL-FT-LEFT

Candidates haaðihi	WEAKPARSE COND	FT-TO-PRSTEM	ALIGN-PRWD-R	ALIGN-PRST-LEFT	PARSE-σ
μμ μ μ a. √ [(hàa)].[(ðí.hi)]				*	
μμ μ μ b. [(háa).ði].hi			*!		*
μμ μ μ c. [(háa).(ðì.hi)]		*!			

In the analysis of variability of truncated names in Japanese, I proposed that variability in the choice of an optimal output follows from the variable rankings of two conflicting constraints within the constraint hierarchy. Here I propose that the variability in the choice of the optimal output in Egyptian Radio Arabic follows from the variable rankings of two constraints: NonfinalHFt and Ft-to-PrStem, within the hierarchy. The crucial rankings are illustrated in the hierarchical structure below.[7]

48. WeakParseCond ; Rightmost

NonfinalHFt-γ Ft-to-PrStem-β
\ /
Align-PrWd-Right

Ft-to-PrStem-γ NonfinalHFt-β
\ /
Weight-to-H(PrStem)
|
Align-PrSt-Left
|

This is illustrated in the two tableaux below.

Ft-to-PrStem >> Align-PrWd-Right >> NonfinalHFt
49. WeakParseCd >> --NonfinalHFt >> Align-PrWd-Right >> Ft-to-PrStem-- >> Weight-to-H(PrStem) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates I katabahu	WeakParse Cond	NonfinalH Ft	Align-PrWd-Right	Ft-to-PrStem
μ μ μ μ a. ✓ [(ká.ta).(bà.hu)]				*
μ μ μ μ b. [(ká.ta).ba].hu	*!		*	
μ μ μ μ c. [(kà.ta)].[(bá.hu)]		*!		

Candidates II katabahu	WeakParse Cond	Ft-to-PrStem	Align-PrWd-Right	Nonfinal HFt
μ μ μ μ a. [(ká.ta).(bà.hu)]		*!		
μ μ μ μ b. [(ká.ta).ba].hu	*!		*	
μ μ μ μ c. ✓ [(kà.ta)].[(bá.hu)]				*

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[7] For a more detailed discussion of a stress system with variable stress patterns, see the analysis of the optionally binary and ternary stress patterns of Estonian in chapter 5.

Ft-to-PrStem >> Align-PrWd-Right >> NonfinalHFt

50. WeakParseCd >> --NonfinalHFt >> Align-PrWd-Right >> Ft-to-PrStem-- >> Weight-to-H(PrStem) >> Align-PrSt-Left >> Parse-σ >> All-Ft-Left

Candidates haaðihi	WeakParse Cond	NonfinalH Ft	Align-PrWd-Right	Ft-to-PrStem
μμ μ μ a. √ [(háa).ði].hi				
μμ μ μ b. [(háa).(ðì.hi)]			*!	
μμ μ μ c. [(hàa)].[(ðí.hi)]		*!		
Candidates II katabahu	WeakParse Cond	Ft-to-PrStem	Align-PrWd-Right	Nonfinal HFt
μμ μ μ a. [(háa).ði].hi			*!	
μμ μ μ b. [(háa).(ðì.hi)]		*!		
μμ μ μ c. √ [(hàa)].[(ðí.hi)]				*

In conclusion, the different stress systems of a number of Arabic dialects have been accounted for by assuming a model of prosodic constituency where all metrical constituents are intrinsically associated with a head but where heads do not necessarily project a grid mark on the metrical grid. The main advantage of this model with regard to the stress systems of Arabic is that metrical constituency is not dependent on prominence on the grid. This means that the distribution of unstressed metrical constituents and the position of their heads within the PrWd can influence the position of main stress without having to posit defooting rules or reparsing rules, or in the case of optimality-theoretic analyses, without having to assume headless constituents. Furthermore, the proposal that not all metrical heads need obligatorily project a grid mark on the metrical grid allows us to eliminate Line Conflation as a repair strategy.

Another advantage of this model comes from the introduction of the PrStem in the Prosodic Hierarchy. Within the revised Prosodic Hierarchy, the only feet that are possible heads for the PrWd are those parsed as the head of a PrStem. As a result, every foot directly parsed by the PrWd will be ignored by the constraint RIGHTMOST.[8]

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[8] In the analysis presented above, the parsing of final superheavy syllables as illustrated in (35) is not discussed. Here I assume that these forms end in an empty-headed syllable resulting from a constraint which prohibits branching of a mora in a nonhead position (cf. Walker (1994); Sprouse (1996)).

Chapter 5

Binary and Ternary Stress Systems

In the study of word minimality presented in chapter 2 and chapter 3, both disyllabic and trisyllabic constituents have been argued to result from the satisfaction of a number of high-ranking structural constraints that are minimally violated in the general phonology of the language. In this chapter, I intend to show the central role played by these same structural constraints in the general phonology of three very different languages. First, I analyze the binary system of Guugu Yimidhirr. Then, the ternary system of Cayuvava is examined. Finally, I present an analysis of the variably binary and ternary stress patterns found in Estonian.

5.1 The Binary Stress System of Guugu Yimidhirr

Guugu Yimidhirr, an Australian language spoken in Queensland (Haviland 1979)[1] presents an interesting problem in that both morphology and phonology regularly refer to an initial prosodic domain that is precisely two syllables, irrespective of syllable weight. In contrast with the morphologically-defined word formation processes of Japanese and Arabic, there is no distinct morphological domain upon which a minimally disyllabic requirement can be imposed in Guugu Yimidhirr.

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[1] The analysis of Guugu Yimidhirr presented in this section is based entirely on the data and insights found in Kager (1996a). Although Kager's analysis is also within the framework of Optimality Theory, many of the conclusions reached here differ markedly from those presented in his paper (see §5.1.2).

5.1.1 The Initial Disyllabic Domain

Guugu Yimidhirr is a language with a contrast between short and long vowels. Both types of vowels are found in closed syllables, but short-vowelled closed syllables pattern with short-vowelled open syllables with regard to the stress system. Moreover, only coronal sonorants can be parsed as a syllable coda, and only glides and liquids can be final in a long-vowelled syllable.[2] Both obligatory onsets and optional codas are non-complex.

Main stress falls within the word-initial disyllabic domain. In addition, stress falls on every heavy syllable within this domain. In words that begin with a main stressed syllable, the remaining odd-numbered syllables have secondary stress. In words with main stress on the second syllable, the remaining even-numbered syllables receive secondary stress. Interestingly, whenever stress falls on two heavy syllables within the initial domain, the secondary stress pattern starts on the next syllable. In addition, secondary stressed syllables can be found as the head of what looks like a unary foot at the right edge of the PrWd (e.g. [máɾbugànbigù] 'still in the cave').

1. *Stress Patterns in Guugu Yimidhirr* (Kager 1996a)

#LL	ná.^{m}bal	'stone-ABS'
	máɾ.bu.gàn	'cave-ABS'
	dúɾ.bin.bì.gu	'Indian Head (place name)'
	máɾ.bu.gàn.bi.gù	'cave-LOC-EMPH' ('still in the cave')
#HL	gúu.gu	'language-ABS'
	búu.ɾa.yày	'water-LOC' ('in the water')
	búu.ɾa.yày.gu	'water-LOC-EMPH' ('still in the water')
	ḏáa.ba.ŋàl.ŋa.là	'ask-RED-IMP' ('keep asking')
#LH	ma.gíil	'branch-ABS'
	na.^{m}báal.ŋaŋ̱	'stone-ABL' ('from the stone')
	ma.gíil.ŋay.gù	'branch-PL-EMPH' ('just branches')
#HH	búu.ɾáay	'water-ABS'
	búu.ɾáay.bì.gu	'water-LOC-EMPH' ('still in the water')

---

[2] There are a few roots which end in a long-vowelled syllable closed by a nasal: e.g. ***bunuun*** 'one'.

The stress pattern of Guugu Yimidhirr reveals two important characteristics of the language. The first one is the initial disyllabic domain. The second one is the language's sensitivity to weight. That is, although the initial disyllabic domain may consist of both heavy and light syllables, a heavy syllable must still be parsed as the head of a foot. In fact, according to Haviland (1979), in words that begin with a heavy-heavy sequence, both syllables receive equal prominence.

Further evidence for the initial disyllabic domain in the language comes from the fact that, although Guugu Yimidhirr has a contrast between short and long vowels, the latter are restricted to the first two syllables.

2. *The Distribution of vowel length* (Kager 1996a)

a.	míil	'eye'	e.	dawáaɽ	'star'
b.	wáad̪a	'crow'	f.	gaᵐbúugu	'head'
c.	wáaɽigàn	'moon'	g.	bulbúuɽᵐbul	'pheasant'
d.	gúuɽumùgu	'meat hawk'	h.	dáaráalŋàn	'kangaroo'

There are, however, a few monosyllabic words in Guugu Yimidhirr.

3. 4 nouns: dii 'tea' (loan), miil 'eye', d̪uul 'guts', buuɾ 'bird's nest'
4 particles: ŋ̣aa 'that, there' (root /ŋ̣a/), yii 'this, there' (root /yi/), yuu 'yes',
aa (agreement).

Although these forms are rare, the lengthening of the function words (when in isolation) strongly suggests that word minimality in Guugu Yimidhirr can be satisfied by a bimoraic foot.

5.1.2 Disyllabicity in Optimality Theory

In McCarthy and Prince (1993a), the disyllabic shape of the reduplicant in Axininca Campa is argued to result from the satisfaction of a constraint requiring that the left and right edges of some morphological domain be aligned with the edges of two different syllables, DISYLL. Kager (1996a) in turn proposes that in order to account for the initial disyllabic constituent of Guugu Yimidhir the domain of application of DISYLL should be extended to allow for the alignement of edges of two prosodic constituents.

4. **DISYLL**
The left and right edges of the PrWd must coincide, respectively, with the left and right edges of *different* syllables.

DISYLL, however, can only impose some minimality requirement; it cannot restrict prosodic constituents to a maximally disyllabic shape. Kager must assume that a phonological word of more than two syllables is parsed as a recursive PrWd. The recursive structure is argued by Kager to result from the high-ranking of ALIGN-σ in the language.

5. **ALIGN-σ**
The right edge of every syllable coincides with the right edge of some PrWd.

The ranking DISYLL >> ALIGN-σ ensures that the latter constraint can never be fully satisfied in an optimal output. Violation of ALIGN-σ can be minimized, however, as long as PrWds are allowed to be recursive.

6. [[σ σ] σ...]

The prediction then is that these recursive structures should result in multiple violations of PARSE-σ. Kager, however, argues that the binary stress pattern of the language reflects the dominance of ALIGN-σ by FT-BIN and PARSE-σ, resulting in a double violation of ALIGN-σ for each recursive PrWd. In addition, Kager assumes that the high-ranking of Align-Wd: Align (PrWd, Left, Stem, Left) accounts for the word-initial position of the Head-PrWd.

7. [[[[(σ σ)] (σ σ)] (σ σ)]...]

Following Kiparsky (1991) and Kager (1993), Kager further assumes that final unary feet in forms like [máɾbugànbigù] and [búuɾayày] reflect the presence of an empty syllable at the end of the word, with which a binary foot can be formed. Catalexis in Guugu Yimidhirr follows from the ranking FT-BIN, Parse-σ >> ALIGN-RIGHT (Align(LexWd, Right, PrWd, Right)). Kager's proposal is shown in the following tableau. (The square brackets indicate PrWd boundaries.)

8. FT-BIN ; DISYLL >> PARSE-σ >> ALIGN-σ

Candidates buuɾayay	FT-BIN	DISYLL	PARSE-σ	ALIGN-σ
a. √ [[(búu.ɾa)].(yày.σ)]				**
b. [(búu).(ɾà.yay)]				***!
c. [[(búu).ɾa].yay]			*!*	*
d. [[(búu)].(ɾà.yay)]		*!		*
c. [[(búu.ɾa)].(yày)]	*!			*

Note that in order to get the correct result, the constraint ALIGN-σ must be assumed to allow for gradient violations. In (8a), each misaligned syllable is one syllable away from the right edge of some PrWd. In (8b), the leftmost sylllable is two syllables away from the edge, resulting in a third violation for ALIGN-σ. If ALIGN-σ violations were counted categorically, (8a) and (8b) would have two violations each, i.e. they each have two syllables that are not right-aligned with a PrWd edge.

9. FT-BIN ; DISYLL >> PARSE-σ >> ALIGN-σ

Candidates buuɾayaygu	FT-BIN	DISYLL	PARSE-σ	ALIGN-σ
a. √ [[(búu.ɾa)].(yày.gu)]				**
b. [[(búu).(ɾà.yay)].(gù.σ)]				***!*
c. [[[(búu)].(ɾà.yay).(gù.σ)]		*!		**
d. [[(búu).ɾa].(yày.gu)]			*!	**

As shown in (9b), prosodic constituents larger than two syllables create an unnecessary and fatal violation of ALIGN-σ.

Although Kager dismisses the idea of an intermediate prosodic unit between the foot and the PrWd, he acknowledges that there seems to be such a coherent domain of reference in the grammar of Guugu Yimidhirr. This domain is that of the most embedded PrWd, which he refers to as the Head-PrWd.[3]

First, the Head-PrWd is the only domain for main stress. Second, vowel length is only found within that initial domain. Furthermore, suffix-induced vowel lengthening and shortening only affect the second syllable of the Head-PrWd.

10. *Lengthening suffixes*

a.	/ŋalgal/	ŋalgaal-ŋu	'smoke-PURP'
b.	/min̪a/	min̪aa-ŋu	'meat-PURP'
c.	/wuluŋgur/	wuluŋgur-ŋu (*wuluŋguur-ŋu)	'lightning, flame-PURP'

11. *Shortening suffixes:*

a.	/gabiiɾ/	gabiɾ-in̪	'girl-ERG'
b.	/nubuun/	nubun-il	'one-ERG'
c.	/gaan̪aal/	gaan̪al-ay (*gan̪al-ay)	'older-sister-DAT'

Kager relates the attraction of main stress by heavy syllables to the undominated constraint: Weight-to-Stress Principle (WSP). He further assumes that in a doubly stressed sequence [HH], both feet must stand in the Head-PrWd because of undominated HdWd.

12. **WSP**
    Heavy syllables have maximal prominence.

13. **HdWd**
    The head of the PrWd is the innermost PrWd.

Note, however, that the latter constraint is introduced specifically to handle the position of main stress in Guugu Yimidhirr. There is no mention by Kager of any other language that would justify the postulation of HdWd as a universal well-formedness constraint.

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[3] Kager states in a footnote that there does not seem to be enough evidence cross-linguistically for extending the Prosodic Hierarchy. However, Kager does wonder, at some point in the analysis, as to whether the term 'Prosodic Stem' would not be more accurate than Head-PrWd.

Kager accounts for the secondary stress patterns by assuming two high-ranked constraints: RHTYPE=T which favors trochaic default feet, and HARMONY which demands that prominence of secondary stressed feet (trochaic or iambic) harmonizes with that of the Head-PrWd. That is, within the Head-PrWd, trochaic feet are optimal unless it leads to a violation of WSP. Secondary stressed feet take the same RHTYPE as the Head-PrWd, to satisfy high-ranking HARMONY.

Although Kager's analysis accounts for every aspect of the binary stress system of Guugu Yimidhirr, it has very little explanatory power with respect to language variability. One central aspect of Optimality Theory is that variability results from the reranking of universal constraints. The weakness of Kager's analysis is that almost every aspect of the binary pattern that characterizes the stress system of Guugu Yimidhirr is accounted for by some new constraint. In the next sections, I propose an analysis of the binary system of Guugu Yimidhirr which is predicated on the notion that variability results from language-specific rerankings of universal constraints.

5.1.3 The PrStem and Initial Disyllabicity

The analysis presented here reformulates Kager's insights in terms of the model of prosodic structure developed in this dissertation. For Kager, the position of the Head-PrWd results from a specific headedness requirement imposed by the constraint HDWD on recursive PrWds. In my analysis, the initial position of the head of the PrWd follows directly from assuming that ALIGN-PRSTEM-LEFT is undominated in the language, with the rightward directionality effects resulting from high-ranking ALL-FT-LEFT rather than from ALIGN-σ.

14. **ALIGN-PRSTEM-LEFT**
    Align (PrStem, Left, PrWd, Left)
        "The left edge of every PrStem coincides with the left edge of some PrWd."

The disyllabicity of the initial PrStem is accounted for by assuming that BRANCHHEAD is also undominated in the language.

15. **BRANCHHEAD**
The head of a PrStem is in a rhythmic relation with a non-head constituent at some level of analysis. (σ, Ft).

Next consider the position of heavy syllables within a word. Kager's WSP is reformulated in terms of the constraint WEIGHT-TO-H(PRSTEM). Recall that in chapter 4, this constraint was introduced to explain why main stress is preferably assigned to a non-final heavy syllable, irrespective of its position within the word in the Classical Arabic stress system.

16. **WEIGHT-TO-H(PRSTEM)**
A bimoraic syllable is parsed as the head of a PrStem.

The restriction of heavy syllables to the head of a PrWd in turn follows directly from the assumption that ALIGN-PRSTEM-LEFT is undominated in the grammar. The prediction is that in any language where WEIGHT-TO-H(PRSTEM) and ALIGN-PRSTEM-LEFT are undominated, heavy syllables will be restricted to the main-stressed foot. These proposals are illustrated in the tableau below with the form ***búuráaybìgu*** 'still in the water'.

17. ALIGN-PRST-LEFT ; BRANCHHEAD ; WEIGHT-TO-H(PRSTEM) >> PARSE-σ >> ALL-FT-LEFT

Candidates buuɾaaybigu	ALIGN-PRST-LEFT	BRANCH-HEAD	WEIGHT-TO-H(PRSTEM)	PARSE-σ
a. ✓ [(búu).(ɾáay)].(bì.gu)				
b. [(búu)].(ɾàay).(bì.gu)		*!	*	
c. [(búu).(ɾáay)].[(bì.gu)]	*!			

Satisfaction of WEIGHT-TO-H(PRSTEM) demands that every heavy syllable be parsed as the head foot of a PrStem. The location of main stress on both bimoraic syllables in the initial PsStem indicates that MONOHEADEDNESS must be dominated by WEIGHT-TO-H(PRSTEM).

Consider also the fact that head syllables receive secondary stress outside of the initial PrStem. These secondary stresses show that STRESS-TO-H(FT) is high-ranking in the language, with satisfaction of Stress-to-H(Ft) resulting in every foot head projecting a grid mark on level 1, whether they are parsed by a PrStem or not. In addition, domination of Monoheadedness by Weight-to-H(PrStem) ensures that every head foot in a PrStem will project a grid mark on level 2, and then on level 3.

18a.	*	*			line 3	H(PrWd)
	*	*			line 2	H(PrStem)
	(*)	(*)	(*	.)	line 1	H(Ft)
	μμ	μμ	μ	μ		
	[(buu).(ɾaay)].(bi.gu)					

In a word beginning with two heavy syllables, the maximally disyllabic shape of the initial PrStem follows from fully satisfying both Align-PrSt-Left and Weight-to-H(PrStem). In forms with only one initial heavy syllable, however, the disyllabic shape of the PrStem follows from satisfying BranchHead. This is illustrated below with the trisyllabic form [búuɾayày] 'water-LOC'.

19. Align-PrSt-Left ; BranchHead ; Stress-to-H(Ft) ; Weight-to-H(PrStem) >> Monoheadedness >> Parse-σ >> All-Ft-Left

Candidates buuɾayay	Align- PrSt-Left	Branch Head	Weight-to- H(PrStem)	Parse-σ
a. ✓ [(búu).ɾa].(yày.σ)				
b. [(búu)].(ɾà.yay)		*!		
c. [(búu)].[(ɾà.yay)]	*!	*!		
d. [(búu).ɾa].yay				*!

As shown by the output form in (19c), I adopt Kager's proposal that final unary feet are parsed as monomoraic disyllabic feet (σ_μ σ), violating NoHeadlessSyll. This proposal is discussed in more detail in the next section.

Consider now trisyllabic forms without heavy syllables like [wuluŋgur] 'lightning, flame'. BranchHead only requires that the head syllable or the head foot of a PrStem be in a rhythmic relation with a syllable in a non-head position. Maximally disyllabic domains in longer words would have to follow from some other constraint to rule out candidates like *[(wú.lu).ŋgur] and *[(búu).(ɾà.yay)]. To account for the maximally disyllabic PrStem, I propose that strict disyllabicity results from the interaction of BranchHead with two high-ranking constraints: Align-PrWd-Right which requires that a PrWd end in a foot, and Ft-to-PrStem which requires a foot parsed by a PrStem to be its head.

20. **Ft-to-PrStem**
    Every foot dominated by a PrStem is parsed as its head.

21. **Align-PrWd-Right**
    Align (PrWd, Right, Ft, Right)
    "The right edge of every PrWd coincides with the right edge of some foot."

Note that in a two-footed structure, there is a conflict between Monoheadedness and Ft-to-PrStem. Here I assume that the crucial ranking with respect to such structures is as follow: Weight-to-H(PrStem) >> Monoheadedness >> Ft-to-PrStem. The role played by these constraints and by Align-PrWd-Right is illustrated in the two tableaux below.

22. Align-PrSt-Left ; BranchHead ; Weight-to-H(PrStem) >> Monoheadedness >> Ft-to-PrStem ; Align-PrWd-Right >> Parse-σ >> All-Ft-Left

Candidates wuluŋgur	Weight-to-H(PrStem)	Mono-headed	Ft-to-PrStem	Align-PrWd-Right
a. ✓ [(wú.lu)].(ŋgùr.σ)				
b. [(wú.lu).(ŋgúr.σ)]		*!		
c. [(wú.lu).(ŋgùr.σ)]			*!	
d. [(wú.lu).ŋgur]				*!

In (22b-c), both feet are parsed by the PrStem. Satisfaction of Monoheadedness in (22b) results in a violation of Ft-to-PrStem, while in (22c) satisfaction of Ft-to-PrStem creates a fatal violation of Monoheadedness. The candidate in (22d) violates Align-PrWd-Right.

23. Align-PrSt-Left ; BranchHead ; Weight-to-H(PrStem) >> Monoheadedness >> Ft-to-PrStem ; Align-PrWd-Right >> Parse-σ >> All-Ft-Left

Candidates buuɾayay	Branch-Head	Weight-to-H(PrStem)	Mono-headed	Ft-to-PrStem
a. ✓ [(búu).ɾa].(yày.σ)				
b. [(búu)].(ɾà.yay)	*!			
c. [(búu).(ɾá.yay)]			*!	
c. [(búu).(ɾà.yay)]				*!

As shown in (23a), the optimal candidate satisfies the high-ranking structural constraints of the language, with the exception of All-Ft-Left.

In this model then, the restriction of main stress and of heavy syllables to the initial disyllabic constituent follows from satisfying the two undominated constraints Weight-to-H(PrStem) and Align-PrSt-Left. The strictly disyllabic shape of the initial constituent is the result of satisfying BranchHead and Monoheadedness without violating the lower-ranked structural constraints Ft-to-PrStem and Align-PrWd-Right.

5.1.4 Iambic Feet in a Trochaic System

An important aspect of the stress system of Guugu Yimidhirr is that it allows for either an iambic or a trochaic pattern depending on the prosodic shape of PrWds. More precisely, the rhythmic pattern of any PrWd is dependent on the presence of heavy syllables within the initial disyllabic domain. Whenever this initial domain is left-headed, subsequent feet are also left-headed. When the initial prosodic domain is right-headed, all following feet are right-headed. Following Kager (1996a), I assume that feet are trochaic, unless there is a conflict with the headedness of the initial prosodic domain.

Before discussing in more details my analysis of Guugu Yimidhirr's trochaic system, consider how metrical analyses have dealt with the problem of a language with variable foot-headedness within its stress system. To my knowledge, there is no recent analysis of Guugu Yimidhirr within the metrical framework. However, the stress system of Yidiɲ, a closely related language, presents a similar problem which has been extensively studied. The Yidiɲ stress system is described by Halle and Vergnaud (1987) as follows.[4]

24. Yidiɲ: Stress falls on even-numbered syllables, if the word contains an even-numbered syllable with a long vowel; otherwise, stress falls on odd-numbered syllables. (Hayes 1981; Dixon 1977)

Given the variability of foot-heads in Yidiɲ, Halle and Vergnaud propose that constituency on the metrical grid be implemented on two different planes simultaneously. On Plane 1, the line 0 constituents are right-headed; on Plane 2, they are left-headed. The inappropriate plane is deleted by a subsequent rule: whenever there is a constituent head dominating a long vowel on P1, P2 is deleted; otherwise, P1 is deleted. Crucially, in this model, headedness is dependent on constituency, but metrical constituents inherently have a head. This proposal, however, cannot be readily extended to the Guugu Yimidhirr stress system, most particularly when the initial prosodic domain contains two heavy syllables. According to Halle and Vergnaud's formulation, given that in an initial disyllabic domain containing two monosyllabic feet there will be both a constituent head dominating a long vowel on P1 and a constituent head dominating a long vowel on P2. One would then predict an iambic pattern, rather than the trochaic one found in these forms. An additional rule therefore is needed to ensure that whenever there are two potential heads within the initial disyllabic domain, it is P1 that deletes. That move, however, would require allowing for (HH) constituents.

A different proposal by Crowhurst and Hewitt (1995) relies instead on the presence of headless feet throughout most of the metrical derivation. Following Hammond (1989), Halle (1990), and Halle and Vergnaud (1987), they assume that metrical groupings and the assignment of stress-bearing heads to those metrical constituents are independent steps in a derivation. Crowhurst and Hewitt (1995) argue that there is a layer of feet assigned early in

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[4] See Hung (1994) for an analysis of Yidiɲ within the Optimality framework.

the derivation which is unheaded and insensitive to weight distinctions and which plays a role in the morphology. The assignment of metrical heads, on the other hand, result from quantity-sensitive rules which apply within the post-lexical clitic domain.

25 a. *Quantity-Sensitive Head Assignment*
Within a PrWd, assign a head to the syllable containing the rightmost long V.

b. *Yidiɲ Initial Head Assignment (default rule)*
Within a PrWd, assign a head to the initial syllable.

Again, an initial prosodic domain containing two monosyllabic feet is problematic for the proposed analysis, since both the rightmost heavy syllable and the initial syllable receive main stress in these forms.

These two metrical analyses crucially rely on the fact that in Yidiɲ underlying heavy syllables are always found in an even-numbered position. This is obviously not the case in Guugu Yimidhirr and that is where both proposals fail to account for its stress system.

Consider now Kager's (1996a) analysis of the stress system of Guugu Yimidhirr in an optimality-theoretic framework. Under OT, formulations of the type: "do this, except when" are treated as resulting from satisfying some structural constraint at the expense of a lower-ranked one. Thus, for Kager, foot-headedness within the Head-PrWd follows from the Weight-to-Stress Principle dominating FT-FORM[TROCHAIC]. Within the whole PrWd, satisfaction of the constraint HARMONY results in all additional feet sharing the same headedness as the main-stressed foot.[5]

26. **HARMONY** (Kager 1996a:15)
Feet have identical headedness within a PrWd.

Kager's proposal is based on two crucial assumptions: (a) that PARSE-σ is undominated in the language in order to account for an initial (LH) foot and (b) that minimal violation of ALIGN-σ forces the parsing of uneven trochaic feet (HL), even though bimoraic syllables

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[5] Kager notes that McCarthy and Prince (1986) propose a similar foot harmony process for their analysis of Yidiɲ stress.

can be parsed as a unique foot within the HdWd. Thus, in his analysis, both iambs and uneven trochees are allowed by the language.

In the next section I reformulate Kager's analysis of metrical prominence in Guugu Yimidhirr in terms of the model of prosodic structure developed in this dissertation.

5.1.5 Headedness and Grid Prominence

In Guugu Yimidhirr, the rhythmic pattern of a PrWd is dependent on the location of weight within the initial disyllabic domain. Note, however, that if the initial disyllabic domain is parsed as a PrStem as assumed here, then the iambic pattern cannot simply follow from the location of the heavy syllable. An LH constituent can be parsed as either a branching PrStem [σ_{μ}('$\sigma_{\mu\mu}$)] or an iambic foot [(σ_{μ}' $\sigma_{\mu\mu}$)]. What is striking about the iambic pattern is that, although a right-headed PrStem does not violate either WEIGHT-TO-H(PRSTEM) or FT-FORM[TROCHAIC], the optimal output results in the bimoraic syllable being parsed as the head of an iambic foot violating both high-ranking constraints.

To force an iambic pattern on the initial LH sequence, I propose that ALIGN-P-STEM-LEFT already introduced in the analysis of Japanese truncation is undominated in Guugu Yimidhirr.

27. **ALIGN-P-STEM-LEFT**
 Align (P-Stem, Left, Ft, Left)
 "The left edge of every P-Stem coincides with the left edge of some foot."

This constraint would thus dominate both WEIGHT-TO-H(PRSTEM) and FT-FORM[TROCHAIC] in the language. Following Kager, I assume the domination of FT-FORM[TROCHAIC] by HARMONY.

28. **HARMONY**
 Feet have identical headedness within a PrWd.

As a consequence of the latter constraint's domination of FT-FORM, any initial iambic foot resulting from satisfying ALIGN-P-STEM-LEFT and WT-IDENT will enforce further violations of Ft-Form[Trochaic] throughout the PrWd domain. These rankings are shown in tableau (29) below with the form [magíilŋaygù] 'branch-PL-EMPH' ('just branches').

29. Align-PrSt-Left ; BranchHead ; Align-P-Stem-Left ; Harmony >> Weight-to-H(PrStem) >> Ft-Form[Trochaic]

Candidates magiilŋaygu	Align-P- Stem-Left	Harmony	Weight-to- H(PrStem)	Ft-Form [Trochaic]
a. √[(ma.gíil)].(ŋay.gù)			*	**
b. [ma.(gíil)].(ŋày.gu)	*!			
c. [(ma.gíil)].(ŋày.gu)		*!	*	*

As shown by the candidate in (29a), satisfaction of Align-P-Stem-Left rules out an initial unfooted syllable, resulting in violations of both Weight-to-H(PrStem) and Ft-Form [Trochaic]. In words with a bimoraic syllable at the right edge, on the other hand, there is no need to assume, as does Kager, that the disyllabic constituent parses an uneven trochaic foot.

30. Align-PrSt-Left ; BranchHead ; Align-P-Stem-Left ; Harmony >> Weight-to-H(PrStem) >> Ft-Form[Trochaic]

Candidates buuɾayay	Align-P- Stem-Left	Harmony	Weight-to- H(PrStem)	Ft-Form [Trochaic]
a. √ [(búu).ɾa].(yày.σ)				
b. [(búu.ɾa)].(yày.σ)			*!	

In fact as shown by the non-optimal output in (30b), an uneven trochaic foot incurs a fatal violation of Weight-to-H(PrStem).

Finally consider the presence of catalectic syllables word-finally in a number of odd-numbered syllable words. Here I assume that the presence of a catalectic syllable at the right edge follows directly from satisfying Align-PrWd-Right. Without catalexis, the presence of only one initial PrStem in the language would leave an unfooted syllable to be parsed directly by the PrWd, violating both ALIGN-PRWD-RIGHT and PARSE-σ.

Supporting evidence for the catalexis analysis comes from the iambic stress pattern. Within this pattern, a final moraic syllable is never stressed. Note that under the assumption that non-moraic syllables are headless, the final moraic syllable is the only available foot head.[6]

Consider first a PrWd without a final catalectic syllable, as in the quadrisyllabic form shown below.

31a.	*	27b.*	*	line 2
	[. (*)] (. *)		[. (*)] (* .)	line 1
	μ μμ μ μ		μ μμ μ μ	
	[(ma.giil)].(ŋay.gu)		[(ma.giil)].(ŋay.gu)	

Every foot-head projects a line 1 grid mark. Satisfaction of HARMONY, however, requires that every foot have identical headedness, as illustrated by the non-optimal output in (27b). On line 2, there is a grid mark for every PrStem-head.

As shown by the metrical grid in (32), only moraic heads may project a line 1 grid mark. This requirement can be regarded as an instantiation of the *Continuous Column Constraint* of Halle and Vergnaud (1987), under the assumption that a mora is the head of a syllable.

32a.	*	28b.*	*	line 2
	[. (*)]		[. (*)] (. *)	line 1
	μ μμ μ .		μ μμ μ .	
	[(ga.^{m}buu)].(gu.σ)		[(ga.^{m}buu)].(gu.σ)	

If (gu) were treated as a unary foot, there would be no principled reason for the fact that the final syllable is unstressed in the iambic pattern but stressed in the trochaic pattern (cf. (wú.lu).(ŋgùɾ.σ) 'lightning, flame' and (máɾ.bu).(gàn.bi).(gù.σ) 'still in the cave'). Notice that forms like [búu.ɾáay.bì.gu] 'still in the water' offer clear evidence against any analysis

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[6] The analysis of Mohawk in §5.2 discusses in more detail this particular assumption. See also the analysis proposed by Cohn and McCarthy (1994) for the behavior of schwa in the stress system of Indonesian.

of *[ga.^{m}búu.gù] in terms of stress clash. On the other hand, by assuming that the head syllable of a disyllabic monomoraic foot cannot project a grid mark at level 1 whenever such a projection would result in a violation of undominated Harmony, we can provide a straightforward account for the lack of secondary stress on the final moraic syllable of odd-numbered words in the iambic stress pattern. These proposals are illustrated in the tableau below.

33. Align-PrSt-Left ; BranchHead ; Align-P-Stem-Left ; Harmony >> Weight-to-H(PrStem) >> Stress-to-H(Ft) >> Ft-Form[Trochaic]

Candidates ga^{m}buugu	Align-P-Stem-Left	Harmony	Stress-to-H(Ft)	Ft-Form [Trochaic]
a. ✓ [(ga.^{m}búu)].(gu.σ)			*	*
b. [(ga.^{m}búu)].(gù.σ)		*!		**

In (33a), the final unstressed foot of the optimal candidate output is assumed to satisfy Ft-Form[Trochaic]. This assumption follows directly from the position taken here that metrical constituent headedness and grid prominence are two interrelated but independent notions.

To sum up, in my analysis of the stress system of Guugu Yimidhirr, the location of main stress follows directly from the proposal that Align-PrStem-Left is undominated in the language. That the PrStem may contain two main-stressed feet, on the other hand, is assumed to follow from the domination of Monoheadedness by Weight-to-H(PrStem), while the iambic pattern is assumed to follow from the domination of both Weight-to-H(PrStem) and Ft-Form[Trochaic] by Align-P-Stem-Left. .

5.2 Ternary Stress Systems

In standard Optimality Theory, directionality effects in languages with binary stress systems are captured through a constraint that requires the left or right edge of every foot to coincide with the corresponding edge of some PrWd. Satisfaction of ALL-FT, however, is dependent on its interaction with two higher-ranked constraints FT-BIN and PARSE-σ. In most languages, ALL-FT translates into minimal (or gradual) violations in words longer than two syllables. Ternary stress patterns present an interesting problem for such a view of foot distribution in that optimal outputs created by ternary systems usually display numerous violations of PARSE-σ which do minimize violations of ALL-FT violations, but never result in full satisfaction of the latter constraint in words longer than four syllables.

In the model of prosodic structure developed here, the constraint ALIGN-PRSTEM-LEFT has been shown to provide a unified account for a number of phenomena in languages as diverse as Japanese, Arabic and Guugu Yimidhirr. Directionality of foot parsing, on the other hand, has been argued to follow from a version of ALL-FT-LEFT/RIGHT that requires the alignment constraint to be subdivided into ALL-FT_1, ALL-FT_2, ALL-FT_3,.. etc. (cf. Kager 1996b).

Neither ALIGN-PRSTEM nor ALL-FT requires that more than one foot be parsed by some PrStem in a PrWd, however. The Prosodic Hierarchy only requires that every PrWd have at least one PrStem as its head, and that every PrStem have at least one head foot. Any number of feet may be immediately dominated by the PrWd. So far in the study of stress systems presented in this thesis, the only constraint that has been argued to crucially interact with ALIGN-PRSTEM, resulting in minimal violation of the alignment constraint, is WEIGHT-TO-H(PRSTEM) in Arabic. In the next two sections, I will show that ternary stress systems present strong evidence that some languages must allow for PrWds with multiple PrStems.

5.2.1 Cayuvava

In order to illustrate how ternary stress systems are optimally generated in this model of prosodic structure, I begin with a fairly straightforward system, that of Cayuvava (Kager 1996b).[7]

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[7] The Cayuvava data is originally from Key (1961). The language's ternary pattern has been analyzed in metrical theory by Halle and Vergnaud (1987), Levin (1988), Dresher and Lahiri (1991), and Hayes (1995).

34. *Cayuvava Ternary Stress System*

a.	dá.pa	'canoe'
b.	tó.mo.ho	'small water container'
c.	a.rí.po.ro	'he already turned around'
d.	a.ri.pí.ro.to	'already planted'
e.	á.ri.hi.hí.be.e	'I have already put the top on'
f.	ma.rá.ha.ha.é.i.ki	'their blankets'
g.	i.ki.tá.pa.re.ré.pe.ha	'the water is clean'
h.	tá.a.di.ró.bo.βu.rú.ru.ce	'ninety-nine (first digit)'

Cayuvava is a language without vowel length distinction. Any vowel sequence represents two syllables. Main stress is initial in disyllabic and trisyllabic words and is found on the antepenultimate in longer words. When the word is long enough, stress falls on every third syllable counting leftward from the main stressed syllable.

5.2.1.1 Previous Analyses

Two recent analyses, that of Kager (1996b) and Green and Kenstowicz (1995), have reformulated traditional accounts of ternary stress systems within the optimality-theoretic framework. Kager adopts Hayes' (1995) view that ternary rhythm is achieved at the cost of exhaustivity with regard to syllable parsing. Green and Kenstowicz, by contrast, follow Halle and Vergnaud (1987) in postulating an additional type of foot: the amphybrach foot, in which the head is one syllable away from each foot edge.

In the serial framework of Hayes (1995), foot parsing is iterative and is assumed to examine a finite 'window' (syllable sequence) for each iteration.

35. *Foot Parsing Locality Parameter*

a. *Strong Local Parsing* When a foot has been constructed, align the window for further parsing at the next unfooted syllable.
(unmarked value of the parameter)

b. *Weak Local Parsing* When a foot has been constructed, align the window for further parsing by skipping over /˘/, where possible.
(marked value of the parameter)

Under this foot parsing algorithm, Strong Local Parsing results in a binary stress pattern, while Weak Local Parsing creates a ternary stress pattern. Hayes proposes the following analysis for Cayuvava.

36a. *Syllable Extrametricality* $\sigma \dashrightarrow \langle\sigma\rangle$ / ___$]_{word}$

b. *Foot Construction* Form syllabic trochees from right to left:
  - i. Employ weak local parsing.
  - ii. Degenerate feet are allowed in strong position.
  - iii. Footing is non-persistent.

c. *Word Layer Construction* End Rule Right

Strikingly, Cayuvava differs from most ternary systems (cf. Chugach and Estonian) in that adjacent feet never surface. Whenever the grouping of syllables into ternary constituents results in two left over syllables at an edge, the two syllables are never regrouped into a binary constituent (36d-g). Thus, in words consisting of 3n+2 syllables, we find a double upbeat: i.e. the first two syllables are stressless. In Hayes' framework, the initial double upbeat is derived from the assumption that foot construction is not persistent in the language (36biii).

37. *Persistent Footing*
If two stray syllables are left at the end of the initial parse,
they are regrouped into a syllabic trochee.

The end result of the leftward iterative foot parsing is the assignment of a degenerate unary foot at the left edge in 3n+2 words. When the word layer is constructed over the foot layer, this degenarate foot is deleted.

In Kager's constraint-based analysis, undominated FT-BIN ensures that no unary feet are ever created. Weal local parsing is reformulated as a constraint which forbids adjacent feet, with non-exhaustivity being enforced by the ranking *FTFT >> PARSE-σ.

38. ***FTFT**
Feet must not be adjacent.

The high-ranking of the constraint *FtFt, however, cannot explain the choice of (39a) over the ungrammatical (39b) which does not violate either *FtFt or All-Ft-Right.

39a. (tó.mo).ho b. * to.(mó.ho)

Neither Hayes and Kager can relate the choice of (39a) over (39b) through satisfaction of either the weak parsing parameter or the constraint *FtFt. Thus Hayes must appeal to the notion of extrametricality and assume that a word-final syllable is invisible to foot parsing. Similarly, Kager uses the OT version of extrametricality and proposes a dominance relation between Nonfinal and All-Ft-Right.

40. *FtFt ; Nonfinal >> Parse-σ >> All-Ft-Right

Candidates	*FtFt	Nonfinal	Parse-σ	All-Ft-R
a. ✓ a.ri.(pí.ro).to			***	*
b. (á.ri).(pí.ro).to	*!		*	****
c. (á.ri).pi.(ró.to)		*!	*	***

Kager's analysis adequately describes the stress system of Cayuvava. There is, however, little evidence provided that supports the introduction of *FtFt as a universal constraint, except to specifically address the question of how to explain the lack of foot adjacency that characterizes ternary stress patterns.[8]

In their analysis of ternary systems, Green and Kenstowicz also need some version of the *FtFt constraint which they formulate as *σ)(σ. In contrast with Kager, however, their analysis is based on the proposal that Ft-Bin should be decomposed into two distinct constraints: Min-2(μ,σ), which set a lower bound on foot size, and Lapse (Green 1995).

41. **Min-2μ**, **Min-2σ**: a metrical foot contains two moras or two syllables.
Lapse-μ, **Lapse-σ**: adjacent unstressed moras or syllables must be separated by a foot boundary.

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[8] The role played by Kager's *FTFT constraint is further examined in the account of the optionally ternary stress pattern of Estonian in §5.2.2.

Green and Kenstowicz generate the ternary stress pattern of Cayuvuva by assuming the following constraint ranking: Lapse-σ >> All-Ft-Right >> Parse-σ. Since there are no restrictions imposed on possible feet, Green & Kenstowicz propose that the way to satisfy Lapse-σ in five-syllabe words while minimizing All-Ft-Right violations is to assume that the main stressed syllable is parsed as the head of an amphibrach foot: [a.(ri.pí.ro).to]. This gives the wrong result, however, for longer words as shown below

42a. (tá.a).di.(ró.bo).βu.(rú.ru).ce b. * ta.(a.dí.ro).bo.(βu.rú.ru).ce

Green & Kenstowicz argue that the failure of the double amphibrach in nine-syllable words indicates that some additional constraint must dominate All-Ft. They assume a constraint which favors left-headed feet: Head-L. The amphibrach imposed on five-syllable words, however, becomes problematic if Head-L dominates All-Ft. Thus the need to introduce *σ)(σ as another high-ranking constraint in the stress system of Cayuvava. Again however, these constraints are not enough to account for the stress pattern in [ma.(rá.ha).ha.(é.i).ki]. Green and Kenstowicz must therefore add Main(Stress)-L to their analysis in order to generate the correct stress pattern in the seven-syllable word.

This analysis presents a number of problems. The loss of generality resulting from the decomposition of Ft-Bin makes foot parsing something much more like a guessing game than one would like on acquisition grounds. That is, the typology of possible feet includes now unary, binary, ternary and unbounded constituents, rather than being restricted to binary constituents. On empirical grounds, the fact that nearly every odd-numbered syllable word require the introduction of an additional constraint in order to be correctly generated brings into question the explanatory power of Green and Kenstowicz's model.[9]

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[9] Although Green and Kenstowicz (1995) also discuss the optional ternary system of Estonian, none of the three constraints introduced in order to specifically explain the ternary patterns in Cayuvava seems to play a role in the Estonian stress system. HEAD-L, however, is argued to play a role in the stress system of Piraha.

In the next section, an analysis of the stress system of Cayuvava is proposed that only requires the addition of one structural constraint and some reranking of the constraints already introduced for Arabic, Japanese and Guugu Yimidhirr in order to generate the ternary patterns of Cayuvava.

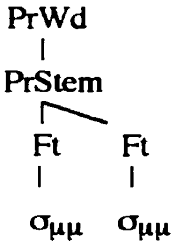
5.2.1.2 Ternary systems and the PrStem

At issue in this section is how to account for ternary systems in terms of the structural constraints already introduced in the preceding chapters. In the model of prosodic structure developed here, the most harmonic PrWd is assumed to follow from satisfying Align-PrStem, Parse-σ and All-Ft-Left/Right, with minimal violation of the latter constraint enforced in some contexts by the high-ranking of BranchHead. In longer words, minimal violation of Align-PrStem has been argued to result from satisfying fully Weight-to-H(PrStem). Here I propose that the ternary pattern of Cayuvava, in which ternary constituents iteratively parse the whole word, can be accounted for by assuming the domination of Align-PrStem by some constraint which requires the left edge of every foot to coincide with the left edge of some PrStem.

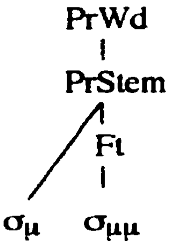
40. **Align-Ft-Left**
    Align (Foot, Left, PrStem, Left)
        "The left edge of every foot coincides with the left edge of some PrStem."

Satisfaction of this constraint requires two conditions to be met: (i) that every foot be parsed by a PrStem and (ii) that each foot be left-aligned with a PrStem. The candidates in (41) all violate Align-Ft-Left.

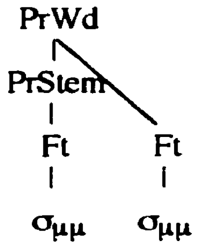
41 a.



b.



c.



For each of the candidates, the left edge of the final foot is not aligned with the left edge of the PrStem. By contrast, only (41a) violates FT-TO-PRSTEM.

42. **FT-TO-PRSTEM**
Every foot dominated by a PrStem is parsed as its head.

In a language where both ALIGN-FT-LEFT and FT-TO-PRSTEM are high-ranking, the prosodic structure in (41a) is the least harmonic candidate. The candidate in (41b), on the other hand, violates ALIGN-FT-LEFT, but would satisfy ALIGN-FT-RIGHT. Crucial for this analysis of the ternary pattern of Cayuvava is that the prosodic structure in (41c), in which a foot is parsed directly by the PrWd, always violates ALIGN-FT-LEFT/RIGHT. The claim is that in languages where ALIGN-FT dominates ALIGN-PRSTEM, the result is that each foot is dominated by a different PrStem.[10]

Consider at this point the stress system of Cayuvava. It is clear from forms such as *(dápa)* and *(tómo)ho* that feet are trochaic. In addition, the leftward directionality effect of foot distribution and the initial double upbeat in some forms strongly suggest that ALIGN-PRSTEM-RIGHT dominates PARSE-σ in the language.

43. **ALIGN-PRSTEM-RIGHT**
Align (PrStem, Right, PrWd, Right)
"The right edge of every PrStem coincides with the right edge of some PrWd."

Observe how main stress is always three syllables from the right edge, even when strict disyllabicity could be obtained.

44a. a.(rí.po).ro b. *(á.ri).(pó.ro)

Kager argues that such forms present strong evidence for undominated NONFINALHFT. In contrast with Kager's proposal, I argue that the nonfinality of main stress is an effect of ALIGN-FT-LEFT and ALIGN-PRSTEM-RIGHT rather than NONFINALHFT. This is illustrated in the two tableaux below.

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[10] In the analysis of Japanese truncation, ALIGN-FT-LEFT, although low-ranking, never receives more than one violation. That is, the optimal output had at most one foot that was not left-aligned with a PrStem, either by being part of a bipodal PrStem or by being parsed directly by the PrWd.

Note that All-Ft-Right evaluates how far each foot is from the right edge. That is, All-Ft$_1$-Right is the rightmost foot.

45. Ft-to-PrStem ; Align-Ft-Left >> Align-PrSt-Right >> Parse-σ >> All-Ft-Right

Candidates tomoho	Align-Ft-Left	Align-PrSt-Right	Parse-σ	All-Ft-Right
a. √ [(tó.mo).ho]				$*_1$
b. [to.(mó.ho)]	*!			$\surd_1$
c. [(tó.mo)].ho		*!	*	$*_1$

In the optimal candidate, All-Ft-Right is the only violated constraint. In a disyllabic form such as [(dá.pa)], on the other hand, all the constraints in the tableau are satisfied fully.

As illustrated in the tableau below with the parsing of a four syllable word, the domination of Parse-σ by both Align-Ft-Left and Align-PrSt-Right results in an initial syllable directly parsed by the PrWd.

46. Ft-to-PrStem ; Align-Ft-Left >> Align-PrSt-Right >> Parse-σ >> All-Ft-Right

Candidates ariporo	Align-Ft-Left	Align-PrSt-Right	Parse-σ	All-Ft-Right
a. √ a.[(rí.po).ro]			*	$*_1$
b. [(á.ri)].[(pó.ro)]		*!		$\surd_1$ $**_2$
c. [(á.ri)].(pó.ro)	*!	*		$\surd_1$ $**_2$
d. [(á.ri).(pó.ro)]	*!			$\surd_1$ $**_2$
e. [(á.ri).po].ro		*!	*	$**_1$

The final foot in (46c) violates Align-Ft-Left, since it is parsed directly by the PrWd. In (46d), Align-Ft-Left is violated because the rightmost foot cannot be left-aligned with the PrStem. In (46a) the optimal candidate violates lower-ranked Parse-σ and All-Ft-Right.

The next tableau illustrates the constraint rankings involved in the optimal parsing of a five-syllable word. As noted before, what is most striking about $3n + 2$ syllable words is that they always surface with a double upbeat. This initial double upbeat, I have argued, follows directly from the satisfaction of Align-PrStem-Right.

47. Ft-to-PrStem ; Align-Ft-Left >> Align-PrSt-Right >> Parse-σ >> All-Ft-Right

Candidates aripiroto	Align-Ft-Left	Align-PrSt-Right	Parse-σ	All-Ft-Right
a. √ a.ri.[(pí.ro).to]			**	$*_1$
b. (á.ri).[(pí.ro).to]	*!			$*_1$ $***_2$
c. [(á.ri)].[(pí.ro).to]		*!		$*_1$ $***_2$
d. [(á.ri).pi].[(ró.to)]		*!		$√_1$ $***_2$

In the optimal candidate in (47a) both Align-Ft-Left and Align-PrSt-Right are satisfied fully. Interestingly, in all the forms reviewed so far, no optimal candidate violates Align-PrSt-Right. This is not the case, however, in words with more than five syllables. The problem here is how to ensure that in such words no more than two syllables will be left unparsed.

In his analysis of ternary systems, Kager (1996b) propose the constraint Parse-2 to restrict sequences of unparsed syllables. This constraint is argued to completely eliminate the need for Parse-σ. According to Kager, in Cayuvava, Parse-2 is dominated by both *FtFt and Nonfinal.

48. **Parse-2**
One of two adjacent stress units must be parsed by a foot.

In chapter 4, I proposed a different type of constraint, WeakParseCond, which is assumed to be undominated universally, to restrict the number of unparsed syllables in PrWds.

49. **WeakParseCond**
A mora in a non-head syllable is adjacent to at most one mora
in a non-head syllable.

In a leftward trochaic system like Cayuvava, WeakParseCond only allows double upbeats at the left edge.[11] As noted by Hayes (1995), in languages where every foot is assigned some stress, main stress on the fourth syllable from the right edge seems to be completely unattested (**[(á.ri).po].ro*).[12] This would follow directly from the WeakParseCond. These proposals are illustrated in the three tableaux below.

50. WeakParseCond ; Ft-to-PrStem ; Align-Ft-Left >> Align-PrSt-Right >> Parse-σ >> All-Ft-Right

Candidates arihihibee	WeakParse Cond	Align-Ft- Left	Align-PrSt- Right	Parse-σ
a. ✓ [(á.ri).hi].[(hí.be).e]			*	
b. a.ri.hi.[(hí.be).e]	*!			***
c. a.(rí.hi).[(hí.be).e]		*!		*

As shown in (50b) above and (51d) below, although Parse-σ is low-ranking in the system, the undominated status of the WeakParseCond ensures that any syllable not parsed as the head of a foot will not be adjacent to more than one mora in a non-head syllable.

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[11] Note that the optimal candidate output in (47) does not violate the WeakParseCond, since each mora in a non-head syllable is adjacent to only one other mora in a non-head syllable.

[12] At least in languages without headless syllables. See the analysis of Mohawk in §6.2 for a detailed discussion of the role played by headless syllables in stress systems.

51. WeakParseCond ; Ft-to-PrStem ; Align-Ft-Left >> Align-PrSt-Right >> Parse-σ >> All-Ft-Right

Candidates ikitaparerepeha	WeakParse Cond	Align-Ft-Left	Align-PrSt-Right
a. ✓ i.ki.[(tá.pa).re].[(ré.pe).ha]			*
b. [(í.ki)].[(tá.pa).re].[(ré.pe).ha]			**!
c. (í.ki).[(tá.pa).re].[(ré.pe).ha]		*!	**
d. i.[(kí.ta).pa].[(ré.re).pe].ha	*!		**

In (51b), the non-optimal output is eliminated through a fatal violation of Align-Ft-Left, while in (51c), the parsing of three PrStems results in a fatal violaton of Align-PrSt-Right. In the next tableau below, a nine syllable word enforces the parsing of three PrStems in order to satisfy the undominated WeakParseCond and high-ranking Align-Ft-Left.

52. WeakParseCond ; Align-Ft-Left >> Align-PrSt-Right >> Parse-σ >> All-Ft-Right

Candidates taadiroboβururuce	WeakParse Cond	Align-Ft-Left	Align-PrSt-Right
a. ✓ [(tá.a).di].[(ró.bo).βu].[(rú.ru).ce]			**
b. ta.(á.di).[(ró.bo).βu].[(rú.ru).ce]		*!	*
c. ta.a.di.ro.bo.βu.[(rú.ru).ce]	*!		

Thus, in the model of prosodic structure developed here, the ternary patterns of Cayuvava are given a straightforward account simply by assuming an alignment constraint requiring the coincidence of edges between a foot and a PrStem. An important advantage presented by this analysis over previous rule-based and constraint-based analyses (e.g. the Weak Local Parsing of Hayes (1995) and the *FtFt constraint of Kager (1996b) respectively) is that the ternary system of Cayuvava can be explained without resorting to some constraint or condition on foot parsing that is specific to ternary patterns. In the model proposed here, the difference between binary and ternary patterns is accounted for by the crucial ranking of two alignment constraints: ALIGN-FT-LEFT >> ALIGN-PRST-RIGHT in a ternary system like Cayuvava and ALIGN-PRST-LEFT >> ALIGN-FT in a binary system like Guugu Yimidhirr. In the next section, the variable ternary and binary systems of Estonian are examined.

4.2.2 Estonian

The complex stress patterns of Estonian present an interesting challenge to any theory of metrical parsing. The Estonian stress system is optionally binary or ternary, with a three-way distinction of syllable weight, i.e. short, long, and overlong syllables. In Estonian, main stress is found on the first syllable of the phonological word. Secondary stress is also largely predictable, although it can be variably ternary or binary, depending on word length and syllable weight. Exceptions to initial main stress are found in some loan words, and there is a restricted set of stems and affixes that carry or trigger idiosyncratic secondary stress.[13]

Estonian is sensitive to the weight of syllables in that a syllable containing a heavy diphthong or a syllable closed by two consonants is stressed at the right edge of a PrWd, while a light syllable is not. The fact that CvC is counted as light, while CvCC is heavy, also indicates that final consonants are 'extrametrical' in the language. Sensitivity to syllable weight, however, is sometimes lacking word-medially. In the binary pattern, for example, the secondary stress system parses all non-final feet into strictly disyllabic domains. This means that closed syllables may be parsed either in the strong or in the weak position of a disyllabic foot, depending on their position within the string. In the optional ternary pattern, on the other hand, secondary stress falls on every third syllable from the initial main stress, but closed syllables cannot be left unfooted. (The data are from Kager 1996b.)

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[13] Hint (1973) groups these exceptions together referring to them as morphologically bound stress. Hint also argues that every morphologically bound stress begins its own phonological word (Hayes 1995:16).

53.	*Binary Stress in Estonian*	*Ternary Stress in Estonian*	
a.	pá.lat.t		'piece, part.sg.'
b.		pí.mes.ta.v	'blinding'
c.	ká.va.làt.t		'cunning, part.sg.'
d.	ré.te.lì.le		'ladder, all.sg.'
e.	té.ra.và.mal.t	té.ra.va.màl.t	'more skillful, gen.sg.'
f.	pá.ri.màt.tel.t		'the best, abl.pl.'
g.	pí.mes.tà.va.le	pí.mes.ta.và.le	'blinding, ill.sg.'
h.	pí.mes.tà.vas.se	pí.mes.ta.vàs.se	'blinding, ill.sg.'
i.	pí.mes.tàt.tu.te		'the dazelled, gen.pl.'
j.	ú.lis.tà.va.maì.t	ú.lis.ta.và.mai.t	'...'
k.	'ɤp.pet.tà.jat.tèk.s	ɤp.pet.ta.jàt.tek.s	'...'
l.	ó.sa.và.ma.lè.ki	ó.sa.va.mà.le.ki	'also more skillful, abl.sg.'
m.	hí.li.sè.mat.tè.le	hí.li.se.màt.te.le	'later, all.pl.'
n.	vá.ra.sèi.mat.tè.le		'earliest, all.pl.'
o.	'ɤp.pet.tùs.te.lè.ki		'lessons, too, all.pl.'
p.	ú.sal.tàt.ta.vàt.mat.tèk.s	'...'	

The fact that only open syllables can be skipped in the ternary pattern has been offered as evidence that closed syllables are treated as bimoraic by the stress system of Estonian.

Another particularly interesting aspect of Estonian is the presence of a third weight distinction, that of *overlong* syllables. Overlength is characterized as a heavy syllable which receives some extra duration: Cvv: (káu:kèle), CvC: (júl:kèsse), CvCC: (kínt:lùstelèki) and CvvC: (töös:kùstesse). Such overlong syllables are only found word-initially. As with the words beginning with a syllable of ordinary length duration, the secondary stress pattern of words with initial overlength has an optional ternary or binary pattern in some contexts.

54.	*Binary Stress System*	*Ternary Stress System*	
a.	vánk:.rìt.t		'carriage, part.sg.'
b.	káu:.kè.le [14]		'far away'
c.	jál:.kè.test	jál:.ke.tèst	'trick, ell.pl.'

---

[14] Eek (1975) allows a ternary variant for the form in (54b). In Hint (1973), only the binary pattern is allowed for this type of form (Hayes 1995:321). While my analysis is based mostly on the patterns allowed by Hint, the ternary pattern for the form in (54b) can be accounted for with only a small modification of one of the constraints involved.

d.	júl:.kès.se		'bold, ill.sg.'
e.	trúu:.tù.se.lè.ki	trúu:.tu.sè.le.ki	'. . .'
f.	hái:.kùs.test.t	hái:.kus.tèst.t	'desease, ell.pl.'
g.	töös:.kùs.tes.se	töös:.kus.tès.se	'industry, ill.sg.'
h.	áu:.sàt.te.le	áu:.sat.tè.le	'honest, all.sg.'
i.	téot:.tàt.tut.tèl.t	téot:.tat.tùt.tel.t	'backe, abl.pl.'
j.	kínt:.lùs.te.lè.ki	kínt:.lus.tè.le.ki	'. . .'
k.	káu:.kèt.tes.sè.ki	káu:.ket.tès.se.ki	'. . .'

As noted before, one of the most puzzling aspects of Estonian is the seeming absence of sensitivity to weight displayed by foot parsing in the binary stress pattern. Monosyllabic feet are only found word-initially or word-finally. In fact, an important feature of overlong syllables is that they always begin a new phonological word. Furthermore, words with initial overlength allows for a following closed syllable to be left unfooted in the ternary pattern (töös:kùstesse). By contrast, only an open syllable can be skipped by foot parsing when following some disyllabic foot in the ternary pattern (*pímestattùte vs. pímestavàle). A non-final closed syllable that is not preceded by an overlong syllable is always parsed by a disyllabic foot (pímestàttute).

5.2.2.1 The Stress System of Estonian

Consider foot parsing in Estonian in words without overlong syllables. Monosyllabic feet are only found word-finally and they always take the form of a superheavy syllable, i.e. they end in two consonants or in a heavy diphthong and a consonant. On the other hand, ordinary closed syllables in final position are always treated as light. To account for the fact that a final consonant does not add to the weight of a preceding syllable, I assume that the constraint NoFinalCMora is undominated in Estonian (cf. the analysis of Arabic final consonants in chapters 3 and 4).

55. **NoFinalCMora**
No PrWd final consonant is the head of a mora.

This proposal allows for a final bimoraic syllable to be parsed as the head of a disyllabic foot $[('\sigma_{\mu\mu}.\sigma)]$. The assumption here is that all feet are disyllabic in Estonian. The status of overlong syllables is discussed in the final section.

Next consider the initial position of main stress and the rightward directionality effect found in the binary stress pattern. This suggests that Align-PrStem-Left and All-Ft-Left are high-ranking in the language.

56. **Align-PrStem-Left**
    Align (PrStem, Left, PrWd, Left)
    "The left edge of every PrStem coincides with the left edge of some PrWd."

57. **All-Ft-Left**
    Align (Foot, Left, PrWd, Left)
    "The left edge of every foot coincides with the left edge of some PrWd."

The optional ternary stress pattern, on the other hand, strongly suggests that Align-Ft-Left dominates Align-PrStem-Left in Estonian.

58. **Align-Ft-Left**
    Align (Foot, Left, PrStem, Left)
    "The left edge of every foot coincides with the left edge of some PrStem."

Words containing less than five syllables present an interesting problem in that they show no variability with regard to the binary and ternary stress pattern, i.e. there is no optional ternary pattern. By assuming that Parse-σ also dominates Align-PrStem-Left such lack of variability can be straightforwardly accounted for.

59. Align-Ft-Left >> Parse-σ >> Align-PrSt-Left >> All-Ft-Left

Candidates retelile	Align-Ft-Left	Parse-σ	Align-PrSt-Left	All-Ft-Left
μ μ μ μ a. ✓ [(ré.te)].[(lì.le)]			*	**
μ μ μ μ b. [(ré.te)].(lì.le)	*!			**
μ μ μ μ c. [(ré.te).li].le		*!		

As shown in (59b), the domination of Align-PrStem-Left by Align-Ft-Left forces the parsing of the final foot by a second PrStem. Note that the double upbeat at the right edge in (59c) also violates undominated WeakParseCond.

60. **WeakParseCond**
A mora in a non-head syllable is adjacent to at most one mora
in a non-head syllable.

The crucial role played by this constraint in the stress system of Estonian will be examined in the section on overlong syllables.

Next consider a form with a final superheavy syllable. As noted above, final CvCC syllables are assumed to surface as a disyllabic foot $(\sigma_{\mu\mu}.\sigma)$ in Estonian. This is shown in the tableau below, in which the form *kavalatt* is treated as a four syllable word.

61. WeakParseCond; NoFinalCMora ; Align-Ft-Left >> Parse-σ>> μ-Max^{IO} >> Align-PrStem-Left >> All-Ft-Left

Candidates kavalatt	NoFinalCμ	Align-Ft-Left	μ-Max^{IO}	Align-PrSt-Left
μ μ μμ a. ✓ [(ká.va)].[(lát.t)]				*
μ μ μμ b. [(ká.va)].[(làt)]	*!			*
μ μ μ c. [(ká.va).lat]			*!	

In (61b), the final bimoraic syllable violates undominated NoFinalCMora, while in (61c), the loss of the mora associated with the geminate results in a violation of μ-Max^{IO}. Note that parsing the final syllable in (61c) as monomoraic does not result in a violation of the faithfulness constraint Wt-Ident^{IO} which requires every segment linked to one mora in the input to be associated with one mora in the output.

As shown by the next tableau, the optimal candidate for a trisyllabic word ending in an ordinary closed syllable does not violate either μ-Max^{IO} or Align-PrStem-Left.

62. WeakParseCond; NoFinalCMora ; Align-Ft-Left >> Parse-σ >> μ-Max^{IO} >> Align-PrStem-Left >> All-Ft-Left

Candidates pimestav	NoFinalCμ	Align-Ft-Left	Parse-σ	Align-PrSt-Left
μ μ μ a. ✓ [(pí.mes).tav]				
μ μ μμ b. [(pí.mes)].[(tàv.v)]				*!
μ μ μμ c. [(pí.mes)].[(tàv)]	*!			

Note that the gemination of the final consonant in the non-optimal candidate (62b) also results in an unnecessary violation of NoHeadlessSyll.

What is striking about the candidates in tableau (62) is that the first closed syllable is always parsed in the weak position of the main-stressed foot. In the analysis of Arabic, foot parsing was shown to be dependent on language-specific rankings of the weight constraints which resulted in heavy closed syllables word-internally and in light closed syllables word-finally. Here I propose that the weight of coda consonants is in part dependent on some language-specific ranking beween the high-ranking structural constraints and the weight constraints. The ranking of the weight constraints with respect to each other is given below.

63. MoraicCoda >> NoFinalCMora >> NoHeadlessSyll >> NoSharedMora >> μ-Max^{IO} >> NoCMora

In the following sections, the interaction between the structural constraints and the weight constraints is examined in detail.

5.2.2.2 Binary and Ternary Stress Patterns

In Estonian, NoSharedMora is dominated by NoFinalCMora. Word-internally, however, some other constraint must interact with NoSharedMora to enforce violations of the latter constraint. Here I propose that NoSharedMora violations follow in part from the optimization of foot parsing. That is, in contrast with what has been assumed in the previous tableaux, the optional binary pattern in Estonian is assumed to follow from the high-ranking of All-Ft-Left. This same high-ranking is viewed as responsible for the weight variability of closed syllables, word-internally.

64. WeakParseCond ; NoFinalCMora ; Align-Ft-Left >> Parse-σ >> All-Ft-Left >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left

Candidates paremattelt	Align-Ft-Left	All-Ft-Left	NoShared Mora	Align-PrSt-Left
µ µ µ µ a. ✓ [(pá.re)].[(màt.telt)]		√$_1$ *$_2$	**	*
µ µ µµ µµ b. [(pá.re)].[(màt)].[(tel.t)]		√$_1$ **!$_2$		**
µ µ µ µµ b. [(pá.re).mat].[(tèl.t)]		√$_1$ **!$_2$	*	*

In the optimal output, the parsing of the closed syllables as light ensures that All-Ft$_2$-Left is minimally violated. In (64b), on the other hand, both closed syllables are parsed as a bimoraic foot, resulting in an additional violation of All-Ft$_2$-Left. In (64c), the fatal violation of All-Ft$_2$-Left, results from having the first closed syllable parsed directly by the PrStem. The high-ranking of All-Ft-Left thus imposes a binary pattern on five syllable words with a closed syllable in third position, irrespective of whether the closed syllable is treated as heavy or light in the candidate outputs.

Following Broselow et al. (1997), I assume that an input moraic consonant when sharing a mora with a preceding vowel in the output does not result in a violation of Wt-Ident. The faithfulness constraint only requires that a segment linked to one mora in the input be in a corresponcence relation with a segment also linked to a mora in the output --- the number of segments sharing that particular mora in the output is irrelevant. The fact that the consonant still surfaces as a geminate, however, seems to indicate that some sort of preservation of structure is at work here. For this analysis, I will simply assume that not to parse the second half of a geminate violates undominated Max^{IO}.

Observe now that even in a five syllable word with only open syllables outside of the initial disyllabic foot, only the binary pattern is optimal, i.e. it violates ALL-FT$_2$-LEFT minimally. This is shown in the tableau below.

65. WEAKPARSECOND ; NOFINALCMORA ; ALIGN-FT-LEFT >> PARSE-σ >> ALL-FT-LEFT >> NOSHAREDMORA >> μ-MAX^{IO} >> ALIGN-PRST-LEFT

Candidates pimestavale	ALIGN-FT-LEFT	ALL-FT-LEFT	NOSHARED MORA	ALIGN-PRST-LEFT
µ µ µ µ µ a. ✓ [(pí.mes)].[(tà.va).le]		$\surd_1$ $*_2$	*	*
µ µ µ µ µ b. [(pí.mes).ta].[(và.le)]		$\surd_1$ $**!_2$	*	*
µ µµ µ µ µ c. [pi.(més)].[(tà.va).le]	*!	$*_1$ $**_2$		*

The question here is, given that in (64c) the third closed syllable is treated as light, i.e. exactly like the third open syllable in (65b), then what would ensure that the ternary pattern is optional for the latter but impossible for the former?

In the analysis of the stress system of Egyptian Radio Arabic I assumed that variability in the choice of an optimal output follows directly from the variable rankings between two constraints within the constraint hierarchy. Here I propose that the optionally binary and ternary stress patterns result from the variable rankings of ALL-FT-LEFT within the constrain hierarchy. The dactyl effect found in the ternary pattern of five syllable words, on the other hand, would follow from the high-ranking of a constraint requiring that a foot be final in a PrWd.

66. **ALIGN-PRWD-RIGHT**
Align (PrWd, Right, foot, Right)
"The right edge of every PrWd coincides with the right edge of some foot."

The constraint rankings that are relevant to this analysis of the stress system of Estonian would be as follow.

67. WeakParseCond ; NoFinalCMora ; Align-Ft-Left
|
Parse-σ

All-Ft-Left-γ |
\ /
NoSharedMora
|
μ-Max^{IO}
|
Align-PrSt-Left
|
Align-PrWd-Right

| All-Ft-Left-β
\ /

This is illustrated in the two tableaux below.

68. WeakParseCond ; NoFinalCMora ; Align-Ft-Left >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates I pimestavale	Align-Ft-Left-γ	All-Ft-Left	Align-PrSt-Left	Align-PrWd-R
μ μ μ μ μ a. √ [(pí.mes)].[(tà.va).le]		$\surd_1$ $*_2$	*	*
μ μ μ μ μ b. [(pí.mes).ta].[(và.le)]		$\surd_1$ $**!_2$	*	
Candidates II pimestavale	Align-Ft-Left	Align-PrSt-Left	Align-PrWd-R	All-Ft-Left-β
μ μ μ μ μ a. [(pí.mes)].[(tà.va).le]		*	*!	$\surd_1$ $*_2$
μ μ μ μ μ b. √ [(pí.mes).ta].[(và.le)]		*		$\surd_1$ $**_2$

As shown above, whenever All-Ft-Left-γ is bypassed and Align-PrSt-Left ties with one violation for each candidate output, the choice of the optimal output falls on Align-PrWd-Right. Note that all the candidate outputs tie with one violation each for NoSharedMora in order to satisfy Align-Ft-Left.

Consider now the more problematic case displayed in the tableau below. As shown in the lower tableau, in a five syllable word with a closed syllable in third position, both the ternary pattern in (69b) and the binary pattern in (69c) results in a fatal violation of NoSharedMora. This results in the choice of *[(pí.mes)].[(tàt)].[(tù.te)] as the optimal output.

69. WeakParseCond ; NoFinalCMora ; Align-Ft-Left >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates I pimestattute	Align-Ft-Left-γ	All-Ft-Left	NoShared Mora	Align-PrSt-Left
μ μ μ μ μ a. ✓ [(pí.mes)].[(tàt.tu).te]		$\surd_1\ *_2$	**	*
μ μ μ μ μ b. [(pí.mes).tat].[(tù.te)]		$\surd_1\ **!_2$	**	*

Candidates II pimestattute	Align-Ft-Left	NoShared Mora	Align-PrSt-Left	All-Ft-Left-β
μ μ μμ μ μ a.✓[(pí.mes)].[(tàt)].[(tù.te)]		*	**	$\surd_1\ *_2$
μ μ μ μ μ b. [(pí.mes).tat].[(tù.te)]		**!	*	$\surd_1\ **_2$
μ μ μ μ μ c. [(pí.mes)].[(tàt.tu).te]		**!	*	$\surd_1\ **_2$

What this means is that although optimal foot parsing has been shown to result in disyllabic feet for most of the data, we need to assume that BranchHead is high-ranking in the grammar's hierarchy to ensure that closed syllables will not be parsed as a bimoraic foot, either word-internally or word-finally.

70. **BranchHead**
The head of a PrStem is in a rhythmic relation with a non-head constituent at some level of analysis. (σ, Ft).

The proposal that the obligatory binary pattern in five syllable words with a closed syllable in third position follows directly from the domination of NoSharedMora by BranchHead and Parse-σ is illustrated in the tableau below. Note that everytime there is a closed syllable in third or fourth position in longer words, Align-PrWd-Right becomes irrelevant with regard to the choice of the optimal output. It it thus not included in the tableaux.

71. WeakParseCond ; NoFinalCMora ; Align-Ft-Left >> BranchHead >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates I pimestattute	Branch-Head	All-Ft-Left-γ	NoShared Mora	Align-PrSt-Left
μ μ μ μ μ a. ✓ [(pí.mes)].[(tàt.tu).te]		$\surd_1$ $*_2$	**	*
μ μ μ μ μ b. [(pí.mes).tat].[(tù.te)]		$\surd_1$ $**!_2$	**	*

Candidates II pimestattute	Branch-Head	Parse-σ	NoShared Mora	All-Ft-Left-β
μ μ μ μ μ a. ✓ [(pí.mes)].[(tàt.tu).te]			*	$\surd_1$ $*_2$
μ μ μμ μ μ b. [(pí.mes)].[(tàt).tu].te		*!	**	$\surd_1$ $*_2$
μ μ μ μ μ c. [(pí.mes).tat].[(tù.te)]			**!	$\surd_1$ $**_2$
μ μ μμ μ μ d. [(pí.mes)].[(tàt)].[(tù.te)]	*!		*	$\surd_1$ $**_2$

The parsing of a six syllable word with a closed syllable in third position presents further evidence for the proposal offered above.

72. WeakParseCond ; NoFinalCMora ; Align-Ft-Left >> BranchHead >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates I hilisemattele	Branch-Head	All-Ft-Left	NoShared Mora	Align-PrSt-Left
μ μ μ μ μ μ a.√[(hí.li)].[(sè.mat)].[(tè.le)]		√$_1$ *$_2$ **$_3$	*	**
μ μ μ μ μ μ b. [(hí.li).se].[(màt.te).le]		√$_1$ **!$_2$	*	*

Candidates II hilisemattele	Parse-σ	NoShared Mora	Align-PrSt-Left	All-Ft-Left
μ μ μ μ μ μ a. [(hí.li)].[(sè.mat)].[(tè.le)]		*	**!	√$_1$ *$_2$ **$_3$
μ μ μ μ μ μ b. √[(hí.li).se].[(màt.te).le]		*	*	√$_1$ **$_2$
μ μ μ μμ μ μ c. [(hí.li).se].[(màt).te].le	*!		*	√$_1$ **$_2$

In the next section, the status of overlong syllables and their behavior with regard to the stress system is discussed.

5.2.2.3 Overlong Syllables

Consider now words with overlong syllables in initial position. Most analyses of overlength in Estonian are built on the idea that overlong syllables may be treated on a par with disyllabic feet. For Kager (1996b), the assignment of two grid marks to overlong syllables is one way to treat them as if they were disyllabic. Hayes (1995), in turn, chooses to view overlong syllables as trimoraic, with the added option of treating them as disyllabic (Hayes 1995:325).

73. $[[\mu\ \mu]\ [\mu]\ ]_\sigma$

Overlong syllables in Estonian historically derive from disyllabic sequences (Tauli 1954; Mürk 1981). Overlong syllables also differ from ordinary heavy syllables in that they are felt by native speakers to have 'extra heavy stress'. They also have special pitch patterns (Hayes 1995). In addition, the fact that overlong syllables are always initial in a phonological word is assumed in most analyses to mean that any non-initial overlong syllable must begin a PrWd.

Accordingly, I propose to characterize overlong syllables as superheavy syllables, i.e. every overlong syllable has the form CvCC or CvvC in the input, even those without a final consonant. For example, I assume that a word like [ruu:tuseleki] has the lexical form [ruuwtuseleki], while the word [jul:kesse] has the lexical form [jullkesse]. Note that whether we assume for the geminated consonant to be associated with one mora or with two skeletal slots in the lexicon will not make any difference since the geminated consonant always closes a bimoraic syllable in the output form.

The result is that every overlong syllable will be parsed as an initial disyllabic foot ($\sigma_{\mu\mu}.\sigma$), as illustrated by the parsing of the data below.

74.	*Binary Stress System*	*Ternary Stress System*	
a.	(ván.k).(rìt.t)		'carriage, part.sg.'
b.	(káu.w).(kè.le)		'far away'
c.	(jál.l).(kè.tes).t .	(jál.l).ke.(tès.t)	'trick, ell.pl.'
d.	(júl.l).(kès.se)		'bold, ill.sg.'
e.	(trúu.w).(tù.se).(lè.ki)	(trúu.w).tu.(sè.le).ki	'. . .'
f.	(hái.y).(kùs.test).t	(hái.y).kus.(tèst.t)	'desease, ell.pl.'
g.	(töö.s).(kùs.tes).se	(töö.s).kus.(tès.se)	'industry, ill.sg.'
h.	(áu.w).(sàt.te).le	(áu.w).sat.(tè.le)	'honest, all.sg.'
i.	(téo.t).(tàt.tut).(tèl.t)	(téo.t).tat.(tùt.tel).t	'backe, abl.pl.'
j.	(kín.t).(lùs.te).(lè.ki)	(kín.t).lus.(tè.le).ki	'. . .'
k.	(káu.w).(kèt.tes).(sè.ki)	(káu.w).ket.(tès.se).ki	'. . .'

Now consider the stress pattern of words with an initial overlong syllable. Again, words with less than five syllables cannot take the optional ternary patterns. As shown by the two tableaux below, satisfaction of NoFinalCMora and of Max^{IO} results in the absence of ternary patterns in words with overlong syllables.

75. WeakParseCond ; Max^{IO} ; NoFinalCMora ; Align-Ft-Left >> BranchHead >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates vankritt	Max^{IO}	NoFinal Cμ	Align-Ft- Left	All-Ft- Left-γ	NoShared Mora
μμ μμ a. ✓ [(ván.k)].[(rìt.t .)]				**	
μμ μμ b. [(van.k).(rit.t)]			*!	**	
μμ μμ c. [(van.k).rit]		*!			
μμ μ d. [(van.k).rit]	*!				*

Recall that in the previous section, I noted that the loss of the second half of a geminate seems to be preserved whether the first half of the geminate heads its own mora or shares it with the preceding vowel. In (75d) then, it is the loss of the consonant not of the mora that results in a fatal violation of Max^{IO}.

Note that in the non-optimal outputs (75b-c), the WeakParseCond is satisfied since the two moras in a non-head syllable are adjacent to a mora in the head syllable. Crucially in (75c), both moras of the non-head syllable are adjacent to no more than one mora in a non-head syllable.

As shown in (76b) below, in a four syllable word that ends in an ordinary open syllable, the ternary pattern does incur a fatal violation of WeakParseCond, whenever the closed syllable is bimoraic. That is, the second mora of the non-head syllable is adjacent to two moras that are not parsed by a head syllable. In (76c), on the other hand, the parsing of the closed syllable as monomoraic satifies the WeakParseCond, but results in a fatal violation of Parse-σ.

76. WeakParseCond ; Max^{IO} ; NoFinalCMora ; Align-Ft-Left >> BranchHead >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates jullkesse	WeakParse Cond	Align-Ft- Left	Parse-σ	NoShared Mora
μμ μ μ a. √ [(júl.l)].[(kès.se)]				*
μμ μμ μ b. [(júl.l).kes].se	*!		*	
μμ μ μ b. [(júl.l).kes].se			*!	*

Consider now the stress patterns of five and six syllable words with an overlong syllable. In contrast with words beginning with an ordinary disyllabic foot, initial overlong syllables allow for a heavy syllable to be parsed directly by a PrStem, as illustrated in the tableaux below.

77. WeakParseCond ; Max^{IO} ; NoFinalCMora ; Align-Ft-Left >> BranchHead >> Parse-σ >> All-Ft-Left-γ >> NoSharedMora >> μ-Max^{IO} >> Align-PrSt-Left >> Align-PrWd-Right >> All-Ft-Left-β

Candidates I haiykustesse	WeakParse Cond	All-Ft- Left	NoShared Mora	Align- PrSt-Left
μμ μ μ μ a. √ [(hái.y)].[(kùs.tes).se]		$\surd_1\ {*}_2\ {**}_3$	**	*
μμ μμ μ μ b. [(hái.y).kus].[(tès.se)]		$\surd_1\ {**!}_2$	*	*

Candidates II haiykustesse	WeakParse Cond	NoShared Mora	Align- PrSt-Left	All-Ft- Left
μμ μ μ μ a. [(hái.y)].[(kùs.tes).se]		**!	*	$\surd_1\ {*}_2\ {**}_3$
μμ μμ μ μ b. √ [(hái.y).kus].[(tès.se)]		*	*	$\surd_1\ {**!}_2$

Observe that with regard to a PrStem that contains an initial overlong syllable, every mora in the non-head syllable is adjacent to a head syllable. In other words, the WEAKPARSECOND is satisfied in both the binary and the ternary pattern in forms that are five syllables or longer.

78. WEAKPARSECOND ; MAX^{IO} ; NOFINALCMORA ; ALIGN-FT-LEFT >> BRANCHHEAD >> PARSE-σ >> ALL-FT-LEFT-γ >> NOSHAREDMORA >> μ-MAX^{IO} >> ALIGN-PRST-LEFT >> ALIGN-PRWD-RIGHT >> ALL-FT-LEFT-β

Candidates I kint lusteleki	WEAKPARSE COND	ALL-FT-LEFT	NOSHARED MORA	ALIGN-PRST-LEFT
μμ μ μ μ μ a.√[(kín.t)].[(lùs.tes)].[(lè.ki)]		$\surd_1\ *_2\ **_3$	**	*
μμ μμ μμ μ μ b. [(kín.t).lus].[(tès).le].ki		$\surd_1\ **!_2$		*
Candidates II {kin} lusteleki	WEAKPARSE COND	PARSE-σ	NOSHARED MORA	ALIGN-PRST-LEFT
μμ μ μ μ μ a. [(kín.t)].[(lùs.tes)].[(lè.ki)]			**	**!
μμ μμ μ μ μ b. √ [(kín.t).lus].[(tès.le).ki]			**	*
μμ μμ μμ μ μ c. [(kín.t).lus].[(tès).le].ki		*!	*	*

As was the case for words without overlong syllables, the parsing in (78c) of a non-final closed syllable as a bimoraic foot in the ternary pattern results in a fatal violation of PARSE-σ. This results in the choice of the ternary pattern falling back to ALIGN-PRST-LEFT.

We are left with one residual problem. As Kager (1996b) notes, there seems to be some preference for the ternary pattern with word-initial overlength when the result is the parsing of a light syllable in the weak position of a PrStem and of a heavy syllable as the head of a non-final foot. In fact, in some words with initial overlong syllables, only the ternary pattern is found.

82. *Obligatory Ternary Pattern*

a. *[(káh.t)].[(lè.vai).le]	[(káh.t).le].[(vài).le]	'doubtful, all.pl.'
b. *[(kɤh.t)].[(lè.jat)].[(tèk.s).]	[(kɤh.t).le].[(jàt).teks]	'hesitant, transl.pl.'
c. *[(kúl.t)].[(sè.mat)].[(tè.le)]	[[(kúl.t).se].[(màt.te).le]	'more golden, all.pl'
d. *[(káu.w)].[(kè.mat)].[(tès.se)]	[[(káu.w).ke].[(màt.tes).se]	'far away, ill.pl.'

There is at least one example in Hayes (1995:319), however, that shows an optional binary pattern for a similar form: [(tɤe.s)].[(tù.set)].[(tà.ki)] and [(tɤe.s).tu].[(sèt.ta).ki]. These two forms suggest that the obligatory ternary pattern must be lexically specified somehow. I have no clear answer, however, as to why this lexical specification would be found only in words with overlong syllables and only when the overlong syllable is followed by a sequence of open + closed syllables.

In conclusion, the analysis of the stress system of Estonian presents a striking example of the explanatory power of a theory that takes non-uniformity as a central aspect of grammars. The notion of minimal violation as a means for ensuring sructural well-formedness allows for a unified account of variable weight in consonants. The claim that language variation results from the reranking of one or two constraints, on the other hand, offers a straightforward account of the restrictions imposed on the optional binary and ternary stress patterns in Estonian. I have shown here that variability between ternary and binary stress patterns follows from two aspects of the language: (i) the undominated status of ALIGN-FT-LEFT and (ii) the variable ranking of ALL-FT-LEFT in the grammar's hierarchy.

One of the most interesting results achieved here, however, is how the interaction between NOSHAREDMORA, ALL-FT-LEFT and BRANCHHEAD allows for an analysis of Estonian that completely eliminates the need for the highly-marked ('LH) and ('HH) trochaic feet. The proposal that BRANCHHEAD and PARSE-σ dominate both NOSHAREDMORA and ALL-FT-LEFT was shown to be crucial to the parsing of closed syllables in the ternary pattern.

Chapter 6

The Prosodic Stem and Syllable Weight

In this chapter, two languages, one with an iambic stress system (Chugach) and the other with a trochaic stress system (Mohawk) are under analysis. It will be shown that these two languages demonstrate a strong preference for a main-stressed foot that uniquely dominates a heavy syllable. In optimality-theoretic terms, both languages treat a bimoraic $(\sigma_{\mu\mu})$ foot as more harmonic than either an uneven foot $(\sigma_{\mu}{}'\sigma_{\mu\mu})$ in the case of the iambic system or a disyllabic foot $({}'\sigma_{\mu}\sigma_{\mu})$ in the case of the trochaic system.

6.1 Chugach

Chugach is one of two major dialects of Pacific Yupik (also called Alutiiq). It is an iambic system with rightward directionality and a ternary stress pattern (Hayes 1995; Rice 1992).[1] Although the language has both long vowels and diphthongs, only word-initial closed syllables are treated as bimoraic by the stress system. Words with only light syllables show a distinct ternary pattern in that the second syllable is stressed, and additional stresses fall on every third syllable thereafter. In contrast with the ternary stress system of Cayuvava, maximal foot parsing in Chugach takes precedence over ternary rhythm, shown in (1b, e).[2]

1. *Only Light Syllables*

a.	a.tá.ka	'my father'
b.	a.kú.ta.mə́k	'kind of food (abl.sg.)'
c.	a.tú.qu.ni.kí	'if he (refl.) uses them'

---

[1] The Pacific Yupik data, taken from Hayes (1995) and Rice (1992), is originally from Leer (1985a, 1989). The language's stress pattern has also been analyzed within the metrical framework by Hammond (1990), Halle (1990), Hewitt (1991) and Kager (1993).

[2] Although schwa seems to bear stress in Chugach, this only happens in closed syllables. In open syllables, schwa is either deleted or devoiced, with stress showing up leftward within the foot (Leer 1985a).

d. pi.sú.qu.ta.qú.ni	'if he (refl.) is going to hunt'
e. ma.ŋáX̧su.qu.tá.qu.ní	'if he (refl.) is going to hunt porpoise'

In words beginning with a long vowel or closed syllable, the first syllable is stressed and additional stresses fall on every third syllable thereafter. Again, double upbeats are avoided.

2. *Initial Heavy Syllable Only*

a. pín.ka	'mine (pl.)'
b. án.ŋa.qá	'my older brother'
c. án.či.qu.kút	'we'll go out'
d. náa.qu.ma.lú.ku	'apparently reading it'
e. át.ma.ku.táX̧tu.tə́n	'you're going to backpack'
f. át.saX̧su.qú.ta.qu.ní	'if he (refl.) is going to get berries'

Both long vowels and diphthongs interfere with the ternary stress pattern in that they are obligatorily stressed. Word-internally, closed syllables do not pattern with bimoraic vowels in that regard. Interestingly, long vowels and diphthongh in post-initial position enforce initial stress by triggering gemination in a preceding open syllable, as shown in the forms in (3c) and (3e). (The geminated consonant is in bold.)

3. *Non-initial Heavy Syllables*

a. náa.qáa	'she's reading it'
b. kál.máa.nuk	'pocket'
c. nú**y**.yái	'her hair'
d. án.či.quá	'I'll go out'
e. čá**s**.sáa.ʁi	'I'll go out'
f. íq.ɬuk.qíi.ŋa	'she lied to me'
g. át.max.čí.quá	'I will backpack'
h. mu.lú.kúut	'if you take a long time'
i. u.lú.tə.ku.tá.ʁáa	'he is going to watch her'
j. án.ku.táX̧tuá	'I'm going to go out'

Chugach presents an interesting problem for any framework which assumes that the uneven iamb is the most harmonic foot of an iambic stress system. Although the head of every disyllabic foot in Chugach is subject to Iambic Lengthening, heavy syllables are obligatorily parsed as a unique foot. This was first noted in Leer (1985), who demonstrated that consonant fortition in Yupik correlates with a foot-initial boundary.[3] In Chugach, every heavy syllable is described as beginning with a fortis consonant. Another problem that has already been mentioned is that, although the language allows for long vowels, closed syllables are treated as heavy only in word-initial position.

6.1.1 Previous Analysis

Consider Hayes' (1995) metrical analysis of the iambic system of Chugach. In order to explain the variable weight of closed syllables, Hayes simply assumes that the domain of application of the Weight-by-Position rule can be restricted to the initial syllable. The parsing of heavy syllables as a unique foot, however, presents more of a challenge for Hayes' model, since both (LH) and (H) are perfect iambs.

Hayes proposes the following analysis for the ternary stress pattern of Chugach.

4a. *Foot Construction* Form iambs from left to right, under weak local parsing; footing is persistent.

b. *Iambic Lengthening*

$$\begin{array}{llccl} & & (. & *) & \\ & & \sigma & \sigma & \\ & & | & |\ \backslash & \\ \emptyset \dashrightarrow \mu & / & \mu & \mu & \_\_ \end{array}$$

The assumption that footing is persistent, in conjunction with the parsing of (LH) feet as a perfect iamb, is problematic for any metrical analysis of Chugach because it cannot explain the requirement that every underlying heavy syllable should be parsed as a unique foot. Consider for example, quadrisyllabic forms that have both initial and final heavy syllables (cf. [át.max.čí.quá]). Foot construction as constrained by Weak Local Parsing derives the incorrect form [(át).max.(či.quá)]. In order to derive [(át).(max.čí:).(quá)], Hayes must

---

[3] Fortition is described as complete lack of voicing in voiceless consonants and preclosure. Preclosure results in extra length for the fortis consonants as compared with their lenis counterparts.

assume that the third syllable is heavy before foot construction applies. To ensure that the third syllable in such forms is heavy, Hayes relies on two surface characteristics of stressed words in Chugach: the lengthening of heads in disyllabic feet and consonant fortition in foot-initial position. (Fortition is shown in bold character.)[4]

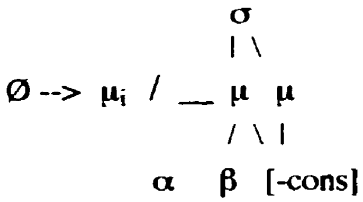
5. (án).či.(**q**uá)
(án).či.(**q**u.kút)
(a.tú:).qu.(**n**i.kí)

(**k**ál).(**m**áa).nuk
(áat).(**m**ax.čí:).(**q**uá)
(íq).ɬuk.(**q**íi).ŋa

(**n**áa).qu.(**m**a.lú:).ku
(án).(**k**u.táX).(**t**uá)
(áku).tar.(**t**u.nír).tuq

Hayes' analysis relates the fortition of a consonant at the left of a heavy syllable and the lengthening of the preceding vowel to a rule that inserts a mora to the left of an underlying Cvv syllable prior to foot construction.

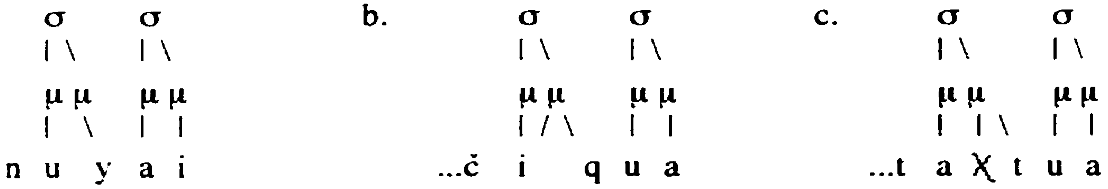
6. *Pre-Long Strengthening*



Conditions: (a) μ_i links to β where basic syllabification permits
(b) Otherwise, μ_i links to both α and β.

Pre-Long Strengthening is formulated so as to account for both simple gemination in forms like /nu.yai/ --> [núy.yaí] and the lengthening found in forms like /at.max.či.qua/ --> [át.max.čí:.quá]. When the mora is inserted after an initial Cv syllable, Weight-by-Position allows the added mora to link only to the geminated consonant. In word-internal position, the inserted mora must be linked to both the onset consonant and the preceding vowel. The same process is assumed to apply to closed syllables preceding any Cvv syllable.

7a.



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[4] Even though no phonetic contrast holds between fortis and lenis initially, Leer describes all word-initial consonants as fortis.

As shown in (8), foot construction then applies and parses every bimoraic syllable as a foot. Following foot construction, persistent footing reparses stray syllables in the weak position of a following monosyllabic foot.

8a.	(nuy).(**y**ai)	(at).max.(či:).(**q**ua)	(an).ku.(taX).(**t**ua)
b.	(**n**uy).(**y**ai)	(at).(**m**ax.či:).(**q**ua)	(an).(**k**u.taX).(**t**ua)

As shown in (8b), fortition also applies in word-initial position and at the left edge of a disyllabic foot. This is viewed by Hayes as the result of a late phonetic rule.

9. *Phonetic Foot-initial Lengthening*
Realize a non-moraic foot-initial consonant as slightly longer and more fortis.

Hayes defends the view that iambic lengthening in disyllabic feet results from the application of two distinct rules: Pre-Long Strengthening which applies before foot construction and Iambic Lengthening which applies late in the derivation. In a similar way, fortition is the result of two different processes: Pre-Long Strengthening for underlying heavy syllables and Foot-initial Lengthening which applies at the phonetic level.

Even more problematic, however, is the generation of trisyllabic forms with one light syllable caught between two heavy syllables (cf. [án.či.quá]). The application of Pre-Long Strengthening should make the medial syllable bimoraic, resulting in three bimoraic feet. To eliminate such forms, Hayes proposes that a sequence of three stressed syllables is ill-formed because of a double clash. Whenever foot construction creates such a sequence of stresses, the ill-formed sequence is repaired through destressing and subsequent loss of the degenerate syllable.

10a.						
	* * *		* . *		* . *		* . *
	(an).(či:.)(**q**uá)	-->	(an).(či)(**q**uá)	-->	(an). či.(**q**uá)	-->	(an).(**č**i.quá)
	Foot Construction		Destressing		Loss of Degenerate Foot		Persistent Footing

Persistent footing results in a final (LH) foot. A shown above, such foot parsing incorrectly predicts that the onset consonant of the initial monomoraic syllable of the (LH) foot should be strenghtened by foot-initial fortition. The form (án).či.(**q**uá), however, only shows fortition on the final heay syllable. Hayes must therefore assume that footing is persistent only in the initial stages of foot construction in Yupik and that persistent footing cannot adjust metrical structures resulting from destressing. How persistent footing can distinguish between the result of foot construction and that of destressing is not examined.

In the next section, an analysis of Chugach is presented that relies on the notion that the PrStem is the head of the PrWd. Phonological processes that are sensitive to foot structure but which do not influence foot parsing, such as Consonant Fortition and Iambic Lengthening, are outside of the domain of this analysis.

6.1.2 The Chugach Stress System and the PrStem

Now consider the ternary stress pattern of Chugach within the model of prosodic structure presented here. As demonstrated in the analysis of the stress system of Cayuvava, a ternary pattern, this time with rightward rather than leftward directionality, can be attributed in part to the domination of Align-Ft-Left over Align-PrStem-Left. In addition, the avoidance of a final double upbeat clearly demonstrates that Parse-σ crucially dominates Align-PrStem-Left in Chugach. These proposals are illustrated in the tableau below.

11. Align-Ft-Left ; Parse-σ >> Align-PrSt-Left

Candidates akutamək	Align-Ft-Left	Parse-σ	Align-PrSt-Left
μ μ μ μ a. ✓ [(a.kú)].[(ta.mə́k)]			*
μ μ μ μ b. [(a.kú)].(ta.mək)	*!		
μ μ μ μ c. [(a.kú).ta].mək		*!	

In longer even-numbered words the domination of Align-Ft-Left over Align-PrSt-Left results in a ternary pattern.

12. ALIGN-FT-LEFT ; PARSE-σ >> ALIGN-PRST-LEFT

Candidates pisuqutaquni	ALIGN-FT-LEFT	PARSE-σ	ALIGN-PRST-LEFT
μ μ μ μ μ μ a. √ [(pi.sú).qu].[(ta.qú).ni]			*
μ μ μ μ μ μ b. [(pi.sú)].(qu.tá).(qu.ní)	*!*		
μ μ μ μ μ μ c. [(pi.sú).[(qu.tá)].[(qu.ní)]			**!
μ μ μ μ μ μ d. [(pi.sú)].[(qu.tá).qu].ni		*!	*

Since Chugach is an iambic language, the final double upbeat would not violate the WEAKPARSE COND.

13. **WEAKPARSECOND**
A mora in a non-head syllable is adjacent to at most one mora
in a non-head syllable.

Odd-numbered syllable words, on the other hand, offer evidence of the role played by ALL-FT-RIGHT in the choice of the optimal output, as shown below.

14. WEAKPARSE COND ; ALIGN-FT-LEFT ; PARSE-σ >> ALIGN-PRST-LEFT >> ALL-FT-RIGHT

Candidates atuquniki	ALIGN-FT-LEFT	PARSE-σ	ALIGN-PRST-LEFT	ALL-FT-RIGHT
μ μ μ μ μ a. √ [(a.tú).qu].[(ni.kí)]			*	√$_1$ ***$_2$
μ μ μ μ μ b. [(a.tú)].[(qu.ní).ki]			*	*$_1$! ***$_2$

In (14a), the optimal candidate output satisfies ALL-FT$_1$-RIGHT since the rightmost syllable is perfectly aligned with the right edge of the PrWd. The candidate in (14b), on the other hand, has a syllable between the PrWd right-edge and the rightmost foot, resulting in a fatal violation of ALL-FT$_1$-RIGHT.

Consider now the problem posed by the obligatory bimoraicity of an initial closed syllable and by the fact that long vowels in second position trigger gemination in an initial open syllable.

15a. [(čás)].[(sáa).ʁi] b. *[(ča.sáa).ʁi]

In the analyses of Arabic and Guugu Yimihdirr, the constraint Weight-to-H(PrStem) was introduced in order to explain the requirement that main stress is preferably assigned to a heavy syllable.

16. **Weight-to-H(PrStem)**
A bimoraic syllable is parsed as the head of a PrStem.

This constraint requires a bimoraic syllable to be parsed as the head foot of a PrStem, rather than as the head syllable of a foot. The prediction then is that, even within an iambic system, a bimoraic syllable cannot be optimally parsed as the head of a disyllabic foot when Weight-to-H(PrStem) is undominated in the constraint system.

The fact that gemination rather than vowel lengthening applies to the initial syllable is assumed to follow from the dominance of Wt-Ident over Integr^{IO}, as shown in the tableau below.

17. WeakParse Cond ; Wt-Ident ; Weight-to-H(PrStem) ; Align-Ft-Left ; Parse-σ >> Integr^{IO} >> Align-PrSt-Left >> All-Ft-Right

Candidates časaaʁi	Weight-to-H(PrStem)	Align-Ft-Left	Wt-Ident	Parse-σ	Integr^{IO}
μμ μμ μ a. ✓ [(čás)].[(sáa).ʁi]					*
μ μμ μ b. [(ča.sáa).ʁi]	*!				
μμ μμ μ c. [(čaa)].[(sáa).ʁi]			*!		
μ μμ μ d. ča.[(sáa).ʁi]				*!	

In (17c), the non-optimal candidate violates WT-IDENT, since the input monomoraic vowel is bimoraic in the output. In the optimal ouput (17a), the second mora is assigned to a copy of the preceding consonant, resulting in a violation of INTEGR^{IO}.

Consider now the obligatory bimoraicity of closed syllables in initial position. Every other closed syllable is viewed as monomoraic for the purpose of foot parsing. This word-initial effect, however, cannot be the result of satisfying either ALIGN-FT-LEFT or PARSE-σ, as shown by a form like [án.či.qu.kút] 'we'll go out'. ALIGN-FT-LEFT and PARSE-σ are satisfied in both forms in (18).

18a. [(án).či].[(qu.kút)]   b. *[(an.čí)].[(qu.kút)]

The obligatory parsing of an initial closed syllable as a bimoraic foot, I propose, follows from a requirement that a PrWd be left-aligned with the head of a foot.

19. **ALIGN-PRWD-LEFT**
    Align (PrWd, Left, Hσ, Left)
    "Every PrWd is left-aligned with some head syllable."

Under the assumption that FT-FORM[IAMBIC] is undominated in Chugach, the only way to satisfy ALIGN-PRWD-LEFT is for the initial syllable to be parsed as a bimoraic foot.[5]

Note that ALIGN-PRWD-LEFT crucially dominates ALIGN-PRST-LEFT, as illustrated in the tableau below.

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[5] In Kager (1996a), the obligatory parsing of a heavy syllable at the right edge of the PrWd is simply stated as ALIGN-H "The right edge of every PrWd coincides with the right edge of some heavy syllable." In his analysis of the incomplete phase in Rotuman, on the other hand, McCarthy (1995), formulates the constraint INC-PH as: Align (StemInc.Ph, Right [σ]Ft, Right) (or Align (StemInc.Ph, Right, μμ, Right), i.e. "Every incomplete-phase stem ends in a monosyllabic foot (or heavy syllable)".

20. WEAKPARSE COND ; WT-IDENT ; WEIGHT-TO-H(PRSTEM) ; ALIGN-FT-LEFT ; PARSE-σ >> INTEGR^{IO} >> ALIGN-PRWD-LEFT >> ALIGN-PRST-LEFT >> ALL-FT-RIGHT

Candidates atmaktaX̧utən	ALIGN- PRWD-LEFT	ALIGN- PRST-LEFT	ALL-FT-RIGHT
μμ μ μ μ μ μ a. √ [(át).ma].[(ku.táX)].[(tu.tə́n)]		**	$\surd_{1}$ $**_{2}$ $***_{3}$
μ μ μ μ μ μ b. [(at.má).ku].[(taX̧.tú).tən]	*!	*	$*_{1}$ $****_{2}$
μμ μ μ μ μ μ c. [(át)].[(ma.kú).taX].[(tu.tə́n)]		**	$\surd_{1}$ $***!_{2}*****_{3}$
μμ μ μ μ μ μ d. [(át)].[(ma.kú)].[(taX̧.tú).tən]		**	$*!_{1}$ $***_{2}*****_{3}$

Furthermore, by assuming the dominance of WT-IDENT and INTEGR^{IO} over ALIGN-PRWD-LEFT, one predicts that lengthening and gemination will never apply to satisfy the alignment constraint. Only a non-moraic input segment is allowed to receive a mora in the output so as to satisfy ALIGN-PRWD-LEFT.

21a. [(a.tú).qu].[(ni.kí)]   b. *[(at).tu].[(qu.ní).ki]

The parsing of forms containing both long vowels and an initial closed syllable are illustrated in the two tableaux (22) and (23) below.

22. WEAKPARSE COND ; WT-IDENT ; WEIGHT-TO-H(PRSTEM) ; ALIGN-FT-LEFT ; PARSE-σ >> INTEGR^{IO} >> ALIGN-PRWD-LEFT >> ALIGN-PRST-LEFT >> ALL-FT-RIGHT

Candidates atmaxčiqua	WEIGHT-TO- H(PRSTEM)	ALIGN-FT- LEFT	ALIGN- PRWD-LEFT	ALIGN- PRST-LEFT
μμ μ μ μμ a.√ [(át)].[(max.čí)].[(quá)]				**
μμ μ μ μμ b. [(át).max].[(či.quá)]	*!			*
μμ μ μ μμ c. [(át).max].[či.(quá)]		*!		*
μ μ μ μμ d. [(at.máx).či].[(quá)]			*!	*

In (22b), the non-optimal output parses the final diphthong as the head of a disyllabic foot rather than as the head foot of a PrStem, incurring a violation of WEIGHT-TO-H(PRSTEM). In (22c), on the other hand, the left-edge of the final foot does not coincide with that of the PrStem, resulting in a fatal violation of ALIGN-FT-LEFT. Finally in (22d), the non-optimal ouput violates ALIGN-PRWD-LEFT, since the initial closed syllable is in the weak position of a disyllabic foot. Another possible candidate [(át).max].či.[(quá)] incurs a fatal violation of PARSE-σ.

23. WEAKPARSE COND ; WT-IDENT ; WEIGHT-TO-H(PRSTEM) ; ALIGN-FT-LEFT ; PARSE-σ >> INTEGR^{IO} >> ALIGN-PRWD-LEFT >> ALIGN-PRST-LEFT >> ALL-FT-RIGHT

Candidates iqɬukqiiŋa	WEIGHT-TO-H(PRSTEM)	WT-IDENT	ALIGN-PRWD-LEFT	ALIGN-PRST-LEFT
μμ μ μμ μ a. ✓ [(íq).ɬuk].[(qíi).ŋa]				*
μμ μ μμ μ b. [(íq)].[(ɬuk.qíi).ŋa]	*!			*
μ μ μμ μ c. [(iq.ɬúk)].[(qíi).ŋa]			*!	*

In this analysis, the bimoraic status of initial closed syllables and the obligatory gemination process found in the initial input sequence CvCvv fall together in that they both follow from fully satisfying the two constraints WEIGHT-TO-H(PRSTEM) and ALIGN-PRWD-LEFT.

Finally, with regard to the equal prominence assigned by the stress system to every PrStem, I propose that this pattern follows from the domination of MONOHEADEDNESS by PRSTEM-TO-PRWD.

24. **PRSTEM-TO-PRWD**
Every PrStem is parsed as the head of a PrWd.

25. **MONOHEADEDNESS**
Prosodic constituents are uniquely headed.

The assumption here is that satisfaction of PRSTEM-TO-PRWD results in the PrWd being assigned two grid marks at level 3.

26.	*		*		line 3	H(PrWd)
	*	.	*	.	line 2	H(PrStem)
	(*)	.	(*)	.	line 1	H(Ft)
	μμ	μ	μμ	μ		
	[(íq).ɬuk].[(qíi).ŋa]					

The constraint system pertaining to this analysis of the stress in Chugach is shown below.

27. Undominated: FT-BIN, WEAKPARSECOND, FT-FORM[IAMBIC], WEIGHT-TO-H(PRSTEM), ALIGN-FT-LEFT, PARSE-σ, WT-IDENT, PRSTEM-TO-PRWD
Dominated: MONOHEADEDNESS ; INTEGR^{IO} >> ALIGN-PRWD-LEFT >> ALIGN-PRSTEM-LEFT >> ALL-FT-RIGHT

Observe that all of the crucial constraints proposed to account for the ternary stress system of Chugach are part of the small set of constraints that has already been proposed to explain both the binary pattern of Guugu Yimdhirr and the ternary pattern of Cayuvava.

28. *Cayuvava*
ALIGN-FT-LEFT >> ALIGN-PRSTEM-RIGHT >> PARSE-σ >> ALL-FT-RIGHT.

29. *Guugu Yimidhirr*
ALIGN-PRSTEM-LEFT ; PARSE-σ >> ALL-FT-RIGHT >> ALIGN-FT-RIGHT.

In addition to the variable rankings of the constraints above, differences between the three languages have been shown to follow from the choice of FT-FORM, the arguments chosen by the constraint WEIGHT-TO-HEAD and STRESS-TO-HEAD, and the interaction of faithfulness constraints with the general phonology of the language, i.e. with the constraints on the prosodic shape of metrical constituents (including syllables) and on their distribution within larger prosodic constituents.

6.2 Mohawk

We turn now to the analysis of the trochaic stress system of Mohawk, a Northern Iroquoian language spoken mainly in New York, Ontario and Québec. The problem presented by

Mohawk is twofold. First, the process of Tonic Lengthening (i.e. the lengthening of a main stressed open syllable) in a trochaic language that otherwise gives the appearance of being quantity-insensitive (i.e. no long vowels underlyingly, closed syllables that behave as light except when stressed, and an obligatorily disyllabic minimal word). Second, the variable visibility of epenthetic syllables with regard to the stress system. The behavior of the three different epenthetic vowels in Mohawk is described below.

6.2.1 Epenthesis and the Stress System of Mohawk

According to Michelson (1989), there are three distinct epenthetic vowels *e, a, i,* in Mohawk.[6] The first two behave in the same manner with regard to stress: invisible to it when in an open syllable; visible to it in a closed syllable. The major difference between the two with regard to stress is found in a sequence of two adjacent epenthesized syllables in a word. In such cases, the first one is usually visible to the stress system. However, if *a* is one of the two epenthesized vowels, it is always the one participating in the stress system.

By contrast, the prothetic vowel *i* is always stressed and obligatorily found in initial position in words with only one non-epenthetic syllable. The data are from Piggott (1995). Underlined segments represent epenthetic vowels.

30. *The Distribution of prothetic [i]*

a.	k-yʌ-s	[íkyʌs]	'I put it'
b.	k-tat-s	[íktats]	'I offer it'
c.	k-ek-s	[í:keks]	'I eat'
d.	s-riht	[íse̲riht]	'Cook!'
e.	t-n-ehr-ʔ	[íte̲nehre̲ʔ]	'you and I want'

Epenthetic *e* is found in three different contexts, as noted by Michelson (1989). In the first context, *e* is inserted between a consonant and *n*, *r*, or *w*.

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[6] According to Michelson, both epenthetic *e* and *a* have the same phonetic realization as their underlying counterparts.

31.	a.	k-runyu-s	[ke̱rúnyus]	'I sketch'
	b.	ʌ-k-r-ʌ-ˀ	[ʌ́ke̱rʌˀ]	'I will put into a container'
	c.	te-k-rik-s	[téke̱riks]	'I put them together'
	d.	t-ʌ-k-ahsutr-ʌ-ˀ	[tʌkahsúte̱rʌˀ]	'I will splice it'
	e.	w-akra-s	[wáke̱ras]	'It smells'

The second context involves a sequence of three consonants, the first of which cannot be *h* or *ˀ* and the second of which cannot be *h* or *s*. The epenthetic vowel is inserted between the first consonant and the following cluster. (The grave accent represents a falling tone.)

32.	a.	k-theˀt-haˀ	[ke̱thè:thaˀ]	'I pound, am pounding'
	b.	wak-nyak-s	[wakényaks]	'I get married'
	c.	s-rho-s	[sé̱rhos]	'you coat it with something'
	d.	te-k-ahsutr-haˀ	[tekahsuté̱rhaˀ]	'I splice it'
	e.	s-k-ahkt-s	[skáhke̱ts]	'I got back'

Third, the epenthetic vowel is inserted between a consonant and a word-final glottal stop. Note, however, that closed syllables of the type Ce̱ˀ are alway treated as light.

33.	a.	ʌ-k-arat-ˀ	[ʌká:rate̱ˀ]	'I lay myself down'
	b.	ro-kut-ot-ˀ	[rokú:tote̱ˀ]	'he has a bump on his nose'
	c.	waˀ-t-k-atat-nak-ˀ	[waˀtkatáte̱nake̱ˀ]	'I scratched myself'
	d.	t-ʌ-k-rik-ˀ	[tʌ́ke̱rike̱ˀ]	'I will put together side by side'
	e.	o-nraht-ˀ	[óne̱rahte̱ˀ]	'leaf'

With regard to *a* 'the joiner', Michelson states that it is inserted between two consonants at a morpheme boundary within the verb base: e.g. between an incorporated noun root and a following derivational suffix. In contrast with *e*, the joiner may break up clusters that are normally allowed in Mohawk.

34.	a.	te-k-aˀshar-rik-s	[tekaˀshá:ra̱riks]	'I put the knives side by side'
	b.	ka-naw-ku	[kaná:wa̱ku]	'in the swamp'
	c.	wak-iˀtuhkw-rho-s	[wakiˀtuhkwá̱rhos]	'I have a fever'
	d.	k-r-kw-as	[ke̱rá̱kwas]	'I take it out of something'
	e.	te-kahruw-nyu	[tekahruwá̱nyu]	'many objects put in your path'

Epenthetic *a* can also be found idiosyncratically within morphemes which cannot be analyzed synchronically into smaller morphemes. That is, there are some cases of non-moraic *a* which cannot be treated as instances of the joiner.

6.2.2 The Principle and Parameter Approach

A comprehensive analysis of the stress system in Mohawk within the Principle and Parameter framework has been proposed in Piggott (1995).[7] His analysis is based on the assumption that 'weightless' (i.e. non-moraic) syllables are part of the inventory of possible syllables. Piggott's proposal assumes that 'unlicensed' consonants can be parsed by an empty-headed syllable and that epenthetic vowels are inserted as late as possible in the phonology.[8]

To account for the prosodic invisibility of epenthesized syllables not closed by a consonant, stress in Mohawk is argued to be sensitive to moras rather than syllables, i.e. non-moraic (epenthetic) syllables are ignored. Piggott argues that the head foot in Mohawk is the moraic trochee and that coda consonants are assigned a mora by the Weight-by-Position rule before stress assignment, irrespective of whether the syllable head is itself moraic or not.[9]

35. *Weight-by-Position*
A 'coda' consonant is assigned a mora in the course of syllabification (parameter).

To account for the regular penultimate stress, Piggott proposes that a non-iterative trochaic stress foot be assigned to the right-edge. Given that the mora is the stress-bearing element in Mohawk, non-moraic syllables are skipped by the stress foot, resulting in trisyllabic feet, as shown in (36) with the forms *w-akra-s* 'it smells' and *o-nraht-* ˀ'leaf':

36a. (wá.ke̲.ras) b. (ó.ne̲.rah).te̲ˀ

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[7] Kager (1993) also offers an analysis of Mohawk which assumes the presence of 'weightless' syllables in the language. See Piggott (1992) for a discussion of Mohawk minimal word.

[8] This lateness to rule application is related by Piggott (1995) to the economy principle of grammar in Chomsky (1992), called Procastinate.

[9] Recall, however, that a final glottal stop does not add weight to a syllables.

Piggott assumes that non-moraic syllables within a foot are later prosodically licensed by adjunction to the head of the foot, a structure similar to the one proposed by Dresher and Lahiri (1991) for the Germanic foot.

One problematic aspect of Piggott's analysis, however, is the lack of stress on closed syllables in final or penultimate position when followed by a non-moraic syllable. If coda consonants are moraic and stress is assigned to a moraic trochee at the right edge, the expectation is that the rightmost bimoraic syllable will be assigned main stress.

37a. *wa.ke̲.(rás) b. *o.ne̲.(ráh).te̲ˀ

The moraic trochee analysis also runs into problems with the minimal word requirement. One would expect any form that contains a closed syllable to satisfy the minimality requirement in Mohawk. Such expectation is contradicted by the data in (37).

38. a. k-yʌ-s [íkyʌs] c. s-riht [íse̲riht]
b. k-ek-s [í:keks] d. t-n-ehr-ˀ [íte̲nehre̲ˀ]

To account for the consistent lack of stress on a rightmost closed syllable, Piggott assumes a nonfinality condition requiring that the head syllable of a foot not be final. However, this condition has to apply to the metrical grid rather than to the PrWd itself in order to generate the correct result, since an epenthetic syllable is invisible to this condition (e.g. in *óne̲rahte̲* ˀ 'leaf'). Piggott thus assumes the avoidance condition of Idsardi (1992).

39. *Avoid* (x #

This is illustrated in (40) below.

    (x #   (x #
40a. * se̲.riht   * te̲.neh.re̲ˀ
  (x   . #   (x   . #
b. i.se̲.riht   i.te̲.neh.re̲ˀ

By using grid marks rather than moras to account for the nonfinality effect, Piggott can account for both the lack of stress on the rightmost closed syllable and for the assignment of a prothetic vowel. Since the mora is argued to be the stress-bearing unit in Mohawk, only moraic syllables can project a line 0 grid mark.

Another important aspect of Piggott's analysis is the treatment of the interaction of epenthesized syllables with the stress system of Mohawk. To explain the variable visibility of the three epenthetic vowels, Piggott adopts the derivational model of Lexical Phonology (Kiparsky 1982; Mohanan 1986). This model has at least two well-defined levels at which epenthetic vowels may be inserted: the lexical and the postlexical levels. Piggott proposes that epenthetic vowels are inserted as late as possible in the derivation. The assumption is that only vowels inserted at the lexical level are assigned a mora.

Under this view, the visibility of epenthetic closed syllables follows directly from the application of Weight-by-Position before foot assignment rather than from the insertion of the epenthetic vowel. The prothetic vowel, however, is inserted lexically to satisfy the minimality requirement. Early insertion is also triggered by any sequence of two epenthetic syllables. Assuming some notion of government between syllable positions (Kaye 1990; Charette 1991), Piggott argues that non-moraic syllables must be licensed (i.e. governed) by a moraic syllable to their right.[10] In a sequence of two non-moraic syllables, the first one is not properly governed. A prosodic structure with two adjacent non-moraic syllables is thus ill-formed and must be repaired before stress assignment can apply. This is done through the early insertion of a vowel in the head position of the non-moraic syllable. On the one hand, epenthetic [e] is inserted at the post-lexical level. On the other hand, the joiner [a], being morphologically conditioned, is inserted lexically but after stress assignment. Thus, the choice of [a] over [e] in sequences containing both follows from the assumption that [a] is inserted at the lexical level, while [e] is inserted at the post-lexical level.

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[10] As noted by Piggott, both Kaye (1990) and Charette (1991) assume that satisfaction of Proper Government is determined from right to left. This proposal is consistent with the claim that final weightless syllables are always properly governed.

Finally, Piggott proposes an account of Tonic Lengthening based on Prince's (1990) Trochaic Rhythmic Harmony Scale, in which a trochee containing one heavy syllable or two light syllables is rated higher than an uneven (HL) trochee. Piggott adopts the Harmonic Scale but ranks H as more harmonic than LL, his proposal being that Tonic Lengthening is a repair strategy used to better satisfy the Harmonic Scale.

41. *Trochaic Enhancement*
Transfer weight from the dependent to the head of the trochee.

This analysis also accounts for the lack of lengthening in stressed syllables followed by an epenthetic [e] since the 'weightless' syllable has no mora to transfer to the head syllable.

As noted before, there are some problematic aspects to Piggott's analysis. The main problem to his approach is the assumption that stress in Mohawk is sensitive only to moras and that it ignores non-moraic syllables. This results in the parsing of trisyllabic feet and the assumption that nonfinality of the main-stressed foot applies to the metrical grid rather than to the PrWd itself. In addition, by treating Tonic Lengthening as a phonological process that applies to an already constructed disyllabic foot rather than as a condition imposed on foot parsing, the obligatory bimoraicity of the main-stressed foot cannot be reducible to either word minimality or foot parsing. In the next sections, an optimality-theoretic analysis is proposed that characterizes the trochaic stress system of Mohawk in terms of structural constraints on prosodic constituents. I will focus on the epenthetic schwa and prothetic [i].

6.2.3 Tonic Lengthening in a 'Quantity-Insensitive' Language

Consider first the stress system of Mohawk in words without epenthetic vowels. A word has only one stress that regularly surfaces on the penultimate syllable. In an open syllable, a main-stressed vowel in penultimate position is always lengthened.

42. *Basic Stress Pattern*

a.	k-atirut-haˀ	[katirúthaˀ]	'I pull it'
b.	wak-ashet-u	[wakashé:tu]	'I have counted it'
c.	k-akʌˀrokew-as	[kakʌˀroké:was]	'I am dusting'
d.	k-hyatu-s	[khyá:tus]	'I write'
e.	s-ho-ahkt-u	[shóhktu]	'he went back'

The absence of secondary stresses indicates that Align-PrStem-Right is high-ranking in the language, while the absence of main stress on a final closed syllable follows from NonfinalHFt .

43. **NonfinalHFt**
No PrWd is right-aligned with its head foot.

The obligatory bimoraicity of the stressed syllable, on the other hand, can be given a very simple explanation by assuming that lengthening follows directly from trying to minimize violations of a structural constraint that requires the head syllable of a PrWd to be final.

44. **AlignHσ**
A PrWd is right-aligned with its head syllable.

These proposals are illustrated in the following tableau.

45. NonfinalHFt ; Align-PrSt-Right >> AlignHσ >> Parse-σ

Candidates k-akʌˀrokew-as	Nonfinal-HFt	Align-PrSt-Right	AlignHσ	Parse-σ
µ µ µ µµ µ a.✓ ka.(kʌˀ.ro).[(ké:).was]			*	*
µ µ µ µ µ b. ka.(kʌˀ.ro).[(ké.was)].	*!		*	*
µ µ µµ µ µ c. (ka.kʌˀ).[(ró:).ke].was		*!	**	*
µ µ µ µ µ d. (ka.kʌˀ).[(ró.ke).was]			**!	

In (45b) and (45d), the parsing of a disyllabic main stressed foot results in two violations of AlignHσ. In (45b), the alignment of the disyllabic foot with the right edge of the PrWd also creates a fatal violation of NonfinalHFt. In (54a), the penultimate vowel is lengthened in order to minimize violation of AlignHσ without violating undominated NonfinalHFt. To lengthen the main stressed syllable in (45c), on the other hand, creates a fatal violation of Align-PrSt-Right.

The problem to be addressed at this point is how to ensure that the assignment of a mora to a coda consonant is more optimal than to lengthen a vowel. Following Broselow et al. (1997), I assume that languages in which coda consonants never contribute to syllable weight, except under pressure from higher-ranked constraints, have the following ranking.

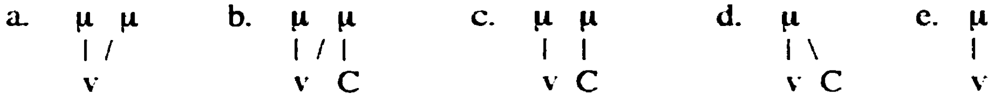
46. MoraicCoda >> NoCMora >> NoSharedMora

In Mohawk, both vowel length and weighted coda consonants are restricted to the main stressed foot. This should follow from the domination of both NoSharedMora and Wt-Ident^{IO} by AlignHσ. Given the fact, however, that there is no evidence for underlying long vowels in the language, I propose that both the lack of long vowels and the weightless coda consonants result from the satisfaction of a constraint which requires that every moraic segment be uniquely dominated by the head mora. In other words, a segment cannot be in any way associated with a mora in a non-head position.

47. **Segment-to-Mora**
Every segment dominated by a mora is uniquely parsed as its head.

The candidates in (48) illustrate the prosodic structure of moraic segments. Note that of all the candidates only (48d-e) satisfy Segment-to-Mora fully by being dominated only by the head mora.

48



In (48a) and (48c), at least one segment is linked to a non-head mora, while in (48b), both segments are linked to a non-head mora. Note that both (48b) and (48d) violate NoShared Mora, while only (48c) violates NoCMora.

The role played by Segment-to-Mora with respect to closed syllables is illustrated below.

49. NonfinalHFt ; Align-PrSt-Right >> AlignHσ >> Segment-to-Mora >>
NoCMora >> NoSharedMora

Candidates k-runyu-s	Align- PrSt-Right	AlignHσ	Segment- to-Mora	NoCMora
μμ μ a. ✓ ke̱.[(rún).yus]		*	*	*
μμ μ b. ke̱.[(rú:n).yus]		*	**!	

As shown in (49c), it is more optimal to assign a mora to a coda consonant, which results in one violation of Segment-to-Mora, than to lengthen a monomoraic vowel in a closed syllable, which satisfies NoCMora but results in two violations of Segment-to-Mora.

Consider now the disyllabic requirement imposed on minimal words as shown in the data in (30), given again below.

50. *The Distribution of prothetic [i]*

a.	k-yʌ-s	[íkyʌs]	'I put it'
b.	k-tat-s	[íktats]	'I offer it'
c.	k-ek-s	[í:keks]	'I eat'
d.	s-riht	[íse̱riht]	'Cook!'
e.	t-n-ehr-ˀ	[íte̱nehre̱ˀ]	'you and I want'

In the preceding chapters, such a disyllabic requirement has been argued to result from the satisfaction of BranchHead which demands the head of a prosodic constituent to be in a rhythmic relation with some prosodic constituent in a non-head position. In Mohawk, however, undominated NonfinalHFt is enough to force both the insertion of a prothetic vowel and its lengthening, at least in words without epenthetic syllables. This is illustrated in the tableau below.

51. NonfinalHFt >> Dep^{IO} >> Align-PrSt-Right >> AlignHσ >> Segment-to-Mora >> NoCMora

Candidates k-ek-s	Nonfinal- HFt	Dep^{IO}	Align- PrSt-Right	AlignHσ	Segment- to-Mora
μμ μ a. ✓ [(í:).keks]		*		*	*
μ μ b. [(í.keks)]	*!	*		*	
μμ c. [(keks)]	*!				*

To summarize, in words without epenthetic vowels, bimoraicity of the main stressed syllable follows from the interaction between two structural constraints: undominated NonfinalHFt and high-ranking AlignHσ.

6.2.4 Epenthesis in Mohawk

Consider now the role played by the epenthetic vowels in the positioning of main stress. Whenever an open epenthetic syllable is found in the penult, the result is the retraction of the main stress to the penultimate syllable. Furthermore, the main stressed syllable is never lengthened before epenthetic [e].

52.	a.	k-runyu-s	[kerúnyus]	'I sketch'
	b.	ʌ-k-r-ʌ-ʔ	[ʌ́kerʌʔ]	'I will put into a container'
	c.	te-k-rik-s	[tékeriks]	'I put them together'
	d.	t-ʌ-k-ahsutr-ʌ-ʔ	[tʌkahsúterʌʔ]	'I will splice it'
	e.	w-akra-s	[wákeras]	'It smells'

I propose that the answer as to why epenthetic vowels cannot receive main stress lies in their non-moraic status. In my analysis of nominal stems in Arabic, it was assumed that the obligatory parsing of a floating mora by the consonantal root follows from a faithfulness constraint which requires every mora in the input to be associated with an output segment: μ-Max^{IO}. In contrast with Wt-Ident^{IO}, which forbids both lengthening and shortening, and Segment-to-Mora, which only forbids lengthening, μ-Max^{IO} blocks the loss of an input mora, although the constraint can be satisfied through the transfer of a mora from a vowel to a coda consonant.

53. **μ-MAX^{IO}**
Every mora of S_1 has a correspondent linked to a segment in S_2.

The counterpart of μ-MAX^{IO} is μ-DEP^{IO} which requires that every mora in the output be associated with a segment in the input.

54. **μ-DEP^{IO}**
Every mora of S_2 is linked to a segment with a correspondent in S_1.

Any mora linked to a coda consonant satisfies μ-DEP^{IO}, and so does a lengthened vowel. Any mora associated with an epenthetic vowel, on the other hand, results in a violation of the faithfulness constraint. These arguments are illustrated in the tableau below.

55. NONFINALHFT >> μ-DEP^{IO} ; DEP^{IO} >> ALIGN-PRST-RIGHT >> ALIGNHσ >> SEGMENT-TO-MORA >> NOCMORA

Candidates t-ʌ-k-ahsutr-ʌ-ʔ	NONFINAL-HFT	μ-DEP^{IO}	ALIGNHσ	SEGMENT-TO-MORA
μ μ μ μ a. (tʌ.kah).[(sú.te).rʌ ʔ]			**	
μ μ μ μμ μ b. tʌ.(kah.su).[(té:).rʌ ʔ]		*!*	*	*
μ μ μμ μ c. (tʌ.kah).[(su:.te).rʌ ʔ]			**	*!

In (55b), the association of moras to the epenthetic vowel in order to minimize violations of ALIGNHσ results in a fatal violation of μ-DEP^{IO}. To lengthen the preceding moraic vowel as in (55c), results in a tie with (55a) with respect to ALIGNHσ, while adding a fatal violation for SEGMENT-TO-MORA.

Consider now the augmentation of monosyllabic forms that contain epenthetic [e]. Alderete (1995) proposes a constraint HEAD-DEP to explain the lack of visibility of epenthetic vowels with regard to the stress system.

56. **Head(PCat)-Dep**
Every segment contained in a prosodic head in S_2 has a correspondent in S_1,

That is, any prosodic head in the output must be in a correspondence relation with a head segment in the input. However, the constraint Head-Dep cannot explain why [i] is inserted to augment a subminimal word, when another epenthetic vowel is already available, since both violate the prosodic constraint.

57.

Candidates s-riht	NonFinal-HFt	Head-Dep	AlignHσ	NoCMora
a. μ μ [(í. se̲).riht]		*	**!	*
b. μμ [se̲.(riht)]	*!			
c. μμ μ [(se̲:).riht]		*	*	*

Alderete's solution adopts McCarthy's (1995) proposal that there are prosodic faithfulness constraints which place segments in a correspondence relation mediated by their prosodic structure. My analysis, on the other hand, assumes that Mohawk syllabifiation disfavors the association of moras with segments which have no correspondent in the input, μ-Dep^{IO}.

58. NonFinalHFt >> μ-Dep^{IO} ; Dep^{IO} >> Align-PrSt-Right >> AlignHσ >> Segment-to-Mora >> NoCMora

Candidates s-riht	NonFinal-HFt	μ-Dep^{IO}	AlignHσ	Segment-to-Mora
a. μ μ [(í. se̲).riht]		*	**	
b. μμ se̲.[(riht)]	*!			*
c. μμ μ [(se̲:).riht]		**!	*	*

Consider now the behavior of epenthetic vowels in closed syllables, as presented in the data below.

59.	a.	k-theˀt-haˀ	[ke̲thè:thaˀ]	'I pound, am pounding'
	b.	wak-nyak-s	[waké̲nyaks]	'I get married'
	c.	s-rho-s	[sé̲rhos]	'you coat it with something'
	d.	te-k-ahsutr-haˀ	[tekahsuté̲rhaˀ]	'I splice it'
	e.	s-k-ahkt-s	[skáhkte̲s]	'I got back'

As noted before, a closed epenthetic syllable is prosodically visible in penultimate position. Here I propose that the undominated constraint MoraicCoda forces the insertion of a mora in a headless closed syllable.

60. NonFinalHFt ; MoraicCoda >> μ-Dep^{IO} ; Dep^{IO} >> Align-PrSt-Right >> AlignHσ >> >> NoCMora >> NoSharedMora

Candidates te-k-ahsutr-haˀ	MoraicCoda	μ-Dep^{IO}	AlignHσ	Segment-to-Mora
μ μ μ μμ μ a. √ te.(kah.su).[(té̲r).haˀ]			*	**
μ μ μ μ b. (te.kah).[(sú.te̲r).haˀ]	*!		**	
μ μ μ μ μ c. (te.kah).[(sú.te̲r).haˀ]			**!	

Observe that in the case of a closed syllable, only the mora associated with the epenthetic vowel would result in a violation of μ-Dep^{IO}. If we assume that the initial mora is also linked to the coda consonant, however, μ-Dep^{IO} is satisfied fully in both (60a) and (60c). This is reflected in the number of violations of Segment-to-Mora in (60a).

Now consider some forms with a word-final epenthetic syllable, and in the case of (61c-f), with an additional word-internal epenthetic [e].

61. *Word-Final Epenthetic Syllable*

a.	ʌ-k-arat-ˀ	[ʌká:rate̲ˀ]	'I lay myself down'
b.	ro-kut-ot-ˀ	[rokú:tote̲ˀ]	'he has a bump on his nose'

c.	waʔ-t-k-atat-nak-ʔ	[waʔtkatáte̲nake̲ʔ]	'I scratched myself'
d.	t-ʌ-k-rik-ʔ	[tʌ́ke̲rike̲ʔ]	'I will put together side by side'
e.	yo-t-r-ʔ	[yóːte̲re̲ʔ]	'It's in the dish/glass'
f.	o-nraht-ʔ	[óne̲rahte̲ʔ]	'leaf'

The problem presented by the word-final epenthetic syllables is threefold: (a) the absence of main stress on the penultimate syllable; (b) the lengthening of a main stressed vowel in the antepenultimate syllable; and (c) the lack of lengthening when stress is four syllables from the right edge.

Here I propose to explain all of these generalizations by assuming an undominated constraint that requires a non-moraic syllable to be parsed in the weak position of a foot.

62. **NonHeadCond**
A headless syllable is parsed in the non-head position of a foot.

Crucially, any headless syllable that is parsed directly by a PrStem or a PrWd violates the NonHeadCond. That only the penultimate epenthetic vowel may receive a mora, on the other hand, follows from satisfying the constraint NoGlottalMora. As noted by Piggott (1995), syllables closed by a glottal stop are never treated as heavy in Mohawk. Here I assume that the domination of NoGlottalMora by MoraicCoda forces the glottal stop to link to the Root node of the preceding vowel. When the glottal stop links to a moraic vowel, however, the result is assumed to result in a violation of NoGlottalMora in order to satisfy both μ-Max^{IO} and Max^{IO}.

These proposals are illustrated in the tableau below. Note again that in the evaluation of All-Ft-Right, All-Ft$_1$-Right evaluates the rightmost foot.

63. NonfinalHFt ; MoraicCoda ; NonHeadCond >> μ-Dep^{IO} ; Dep^{IO} >> Align-PrSt-Right >> AlignHσ >> Segment-to-Mora >> NoCMora >> NoSharedMora >> All-Ft-Right

Candidates yo-t-r-ˀ	NonHead Cond	μ-Dep^{IO}	NoGlottal Mora	AlignHσ
μμ μ a. ✓ [(yó:)(te̱.re̱ˀ)][11]		*		**
μ b. [(yó.te̱).re̱ˀ]	*!			**
μ μ c. [(yó.te̱).re̱ˀ]		*	*!	**
μ μ μ c. [(í.yo).(te̱.re̱ˀ)]		**!		***

64. NonfinalHFt ; MoraicCoda ; NonHeadCond >> μ-Dep^{IO} ; Dep^{IO} >> Align-PrSt-Right >> AlignHσ >> Segment-to-Mora >> NoCMora >> NoSharedMora >> All-Ft-Right

Candidates t-ʌ-k-rik-ˀ	NonHead-Cond	μ-Dep^{IO}	NoGlottal Mora	AlignHσ
μ μ a. ✓ [(tʌ́.ke̱).(ri.ke̱ˀ)]				***
μ μ μ b. tʌ.[(ké̱.ri).ke̱ˀ]		*!		**
μ μμ c. (tʌ.ke̱).[(ri:).ke̱ˀ]	*!			*
μ μ d. [(tʌ́.ke̱).ri].ke̱ˀ	*!			***

As shown in the tableaux above, any headless syllable parsed directly by the PrStem or the PrWd incurs a fatal violation of undominated NonHeadCond.

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[11] Here I assume that the head syllable of a foot must itself have a head: i.e. a mora.

65. NonFinalHFt ; MoraicCoda ; NonHeadCond >> μ-Dep^{IO} ; Dep^{IO} >> Align-PrSt-Right >> AlignHσ >> Segment-to-Mora >> NoCMora >> NoSharedMora >> All-Ft-Right

Candidates t-n-ehr-ˀ	NonHead- Cond	μ-Dep^{IO}	Align- PrSt-Right	AlignHσ
μ μ a. ✓ [(í.te̲).(neh.re̲ˀ)]		*		***
μ μμ b. [(i.te̲)].[(néh).re̲ˀ]	*!	*		*
μ μμ c. te̲.[(néh).re̲ˀ]	*!*	*		*

Here, the behavior of both the epenthetic vowel [e] and the prothetic vowel [i] in Mohawk is accounted for with the introduction of two constraints on the parsing and licensing of headless syllables: NonHeadCond and μ-Dep^{IO}. In addition, the weight constraints have been shown to crucially interact with some high-ranking structural constraints, resulting in a bimoraic syllable as the main-stressed foot in a language without underlying weight contrasts.

Conclusion

In this dissertation, I have shown that the introduction of the Prosodic Stem (PrStem) as a new metrical constituent within the Prosodic Hierarchy allows for a more restrictive theory of metrical constituents. By assuming that the main-stressed foot is immediately dominated by a PrStem, a number of different prosodic shapes imposed on metrical constituents and a number of different stress systems could be analyzed using a very limited set of constraints on the prosodic shape and distribution of metrical constituents.

In chapter 2, I have argued that the difference between shortened names and word clippings lies in large part in a distinction between bound stems and free words. That is, in truncated stems that are obligatorily followed by an affix, structural constraints are imposed on both the truncated stem and the affix simultaneously. In other words, the solution as to why shortened names are restricted to a bimoraic foot shape lies in part in the optimality-theoretic notion that the prosodic shapes of phonologically-empty morphemes result from the satisfaction of high-ranking structural constraints, rather than from lexically-specified prosodic requirements imposed on those morphemes. I have presented a unified account of the minimal and maximal prosodic shapes of both truncated forms and word clippings in terms of 'the emergence of the unmarked' which relies on the proposal that a number of the structural constraints of the language impose some prosodic requirement on the PrStem. In chapter 3, this model of prosodic structure has been extended to include the root-and-pattern system of the nominal and verbal stems in Arabic.

The study of the stress systems of a number of Arabic dialects in chapter 4 has shown that the role played by the PrStem with respect to minimality requirements can be extended to include longer words which are not coextensive with the whole word. An important aspect of this model is that the Prosodic Hierarchy encodes both headship and prosodic domination. Whether the head of some prosodic category is assigned prominence on the metrical grid or not, on the other hand, has been argued to result from a constraint which imposes restrictions on the type of heads that may project on the grid. In this view, stress systems where syllable structure and foot distribution play a role in determining the location of main stress yet where secondary stress is absent are predicted by the theory rather than being problematic for it.

The concerns of chapter 5 are in showing the central role played by the PrStem in the general phonology of three very different languages. In the model of prosodic structure developed here, it is proposed that the difference between binary and ternary patterns can be accounted for in a straightforward manner by the crucial reranking of a very limited set of structural constraints. The advantage offered by the introduction of the PrStem within the Prosodic Hierarchy is that it accounts for the fact that, in both the binary system of Guugu Yimidhirr and the ternary system of Cayuvava, the preferred metrical grouping is larger than the main-stressed foot of the language. Chapter 6, on the other hand, has demonstrated the role played by the PrStem in languages where the main-stressed foot of choice is smaller than what appears to be the most harmonic foot for either the quantity-sensitive iambic system of Chugach or the quantity-insensitive trochaic system of Mohawk.

Finally, this thesis has shown how Optimality Theory seems particularly well-suited to deal with the non-uniformity of various phenomena. Central to this framework is the notion that high-ranking structural constraints may be minimally violated in some contexts in order to satisfy higher-ranked structural or faithfulness constraints.This has been clearly demonstrated in the study of non-uniform phenomena such as truncation in Japanese and in the study of the variability in stress patterns and in syllable weight that may be found within a single language and across languages.

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