A PROSODIC THEORY OF PROMINENCE AND RHYTHM

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To my parents, for putting up with me.

And to my step-parents, for putting up with them.

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ABSTRACT

Building on earlier work, notably Kager (1993, 1995) and framed in Optimality Theory (Prince & Smolensky 1993), this thesis presents a theory of foot structure in which the asymmetric maximal expansions of iambic and trochaic feet (cf. the Iambic / Trochaic Law: ITL, e.g. Hayes 1995) are accounted for by a single constraint, HEAD GOVERNMENT (Mellander 2001c, 2002b). The present analysis devotes special attention to a class of quantitative processes in trochaic systems which generate uneven (<u>H</u>L) trochaic feet. In contrast to previous analyses (e.g. Hayes 1995), such processes are shown to be of *phonological* rather than phonetic nature in certain languages, and the ramifications of this conclusion are explored with regard to a variety of issues in prosodic theory.

The evidence for the phonological status of (<u>H</u>L)-creating processes comes from published data on Mohawk, Selayarese, Gidabal, and Oromo, as well as original field data from Central Slovak. Following Piggott (1998, 2001) and Mellander (2001a, c, 2002b), these processes are seen to follow from HEAD PROMINENCE, a constraint which requires greater relative intrinsic prominence in the head of a prosodic constituent. Since HEAD PROMINENCE is sensitive to *intrinsic* prominence, its effects are shown to hold irrespective of derived prominence resulting from the application of stress rules. HEAD PROMINENCE is also shown to play a central role in accounting for diphthongal quantity-prominence relations, where cross-linguistic patterns of long vowel diphthongization in bimoraic syllables mirror those of (<u>H</u>L)-creating processes in disyllabic feet.

In contrast to previous work on HEAD GOVERNMENT (Mellander 2001c, 2002b), the absence of languages which *require* violations of this constraint implies that it is universally undominated, contra the standard Optimality Theoretic assumption of universal constraint violability. This view is also supported by the analysis of ternary stress systems, where the absence of unattested quaternary and quinternary systems relies crucially on the inviolability of HEAD GOVERNMENT.

A final aspect of this thesis is the development of a preliminary model to explain asymmetries in structure and markedness between iambic and trochaic systems, including distributional asymmetries, Iambic Lengthening, and the ITL. Based on work by Van de Vijver (1998) this approach abandons traditional symmetric notions of iambicity and trochaicity in favour of an asymmetric pair of constraints — PEAK-FIRST and *EDGEMOST. Iambic / trochaic asymmetries consequently emerge as artefacts of constraint interaction and require no additional theoretical machinery.

RÉSUMÉ

Basée sur des analyses antérieures, notamment celles de Kager (1993, 1995), et située dans le cadre de la Théorie de l'optimalité (Prince et Smolensky 1993), cette thèse présente une théorie de la structure des pieds métriques qui rend compte des expansions maximales asymétriques des pieds métriques iambiques et trochaïques (re : la Loi des iambes et des trochées, p. ex. Hayes 1995) au moyen d'une contrainte unique, HEAD GOVERNMENT (Mellander 2001c, 2002b). La présente analyse porte une attention toute spéciale à une classe de processus quantitatifs dans les systèmes trochaïques qui génèrent des pieds trochaïques inégaux (HL). Par opposition aux analyses précédentes (p. ex. Hayes 1995), je démontre que ces processus sont de caractère *phonologique* plutôt que phonétique dans certaines langues, et j'explore les ramifications de cette conclusion à l'égard de plusieurs aspects de la théorie prosodique.

Les preuves du statut phonologique des processus qui créent les pieds (HL) proviennent de données publiées sur le mohawk, le selayarese, le gidabal, et l'oromo, de même que de données originales du slovaque du centre. En ligne avec Piggott (1998, 2001) et Mellander (2001a, c, 2002b), ces processus s'expliquent en tant que conséquence de HEAD PROMINENCE, une contrainte qui exige que la proéminence intrinsèque relative soit plus importante dans la position de tête d'un constituant prosodique. En raison du fait que HEAD PROMINENCE soit sensible à la proéminence *intrinsèque*, ses effets s'appliquent sans égard à la proéminence dérivée par l'application de règles d'accentuation. Je démontre aussi que HEAD PROMINENCE joue un rôle central dans l'analyse de ce qui a trait aux faits relatifs aux relations entre la quantité et la proéminence des diphtongues, où les patrons de diphtongaison des voyelles longues dans des syllabes bimoraiques constituent l'image miroir des processus qui créent les pieds (HL) dans des pieds bisyllabiques.

Par contraste avec le travail précédemment effectué sur HEAD GOVERNMENT (Mellander 2001c, 2002b), l'absence de langues qui *exigent* la violation de cette contrainte implique que celle-ci est universellement non-dominée, ce qui va à l'encontre du postulat généralement admis dans la Théorie de l'optimalité, qui stipule que toute contrainte peut être violée. Cette position est également appuyée par l'analyse des systèmes d'accentuation ternaires, où l'absence de systèmes quaternaires et quinternaires non-attestés dépend, de façon cruciale, de l'inviolabilité de HEAD GOVERNMENT.

Cette thèse comporte un dernier aspect, soit le développement d'un modèle préliminaire servant à expliquer les asymétries de structure et de marque rencontrées entre les systèmes iambiques et trochaïques, incluant les asymétries de distribution, l'allongement iambique et la Loi des iambes et des trochées. Basée sur le travail de Van de Vijver (1998), cette approche abandonne les notions symétriques traditionnelles d'iambicité et de trochaïcité en faveur d'une paire de contraintes asymétriques — PEAK-FIRST et *EDGEMOST. Par conséquent, les asymétries iambique/trochaïque émergent en tant qu'artefacts de l'interaction des contraintes, n'exigeant ainsi aucun mécanisme théorique supplémentaire.

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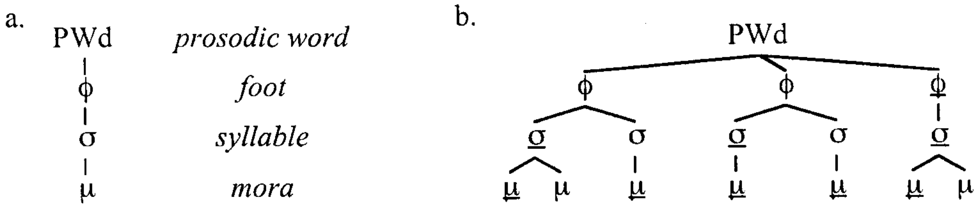
1. INTRODUCTION

1.1 Prosodic Theory

The rhythmic structure of human language cannot be observed directly, and thus any investigation into this realm must rely uniquely on indirect evidence such as stress patterns, quantitative processes, and other manifestations of linguistic rhythm. Drawing on the range of observable evidence both within particular languages and across languages, prosodic theory — first articulated by Liberman (1975) and Liberman & Prince (1977) — reveals generalisations which find explanation in abstract structural relationships between various prosodic constituents. The general goal of this thesis is to contribute to the ongoing task of identifying, characterizing and refining these relationships in order to advance our understanding of the prosodic structure of language.

As a point of departure, we adopt the standard position, due to Selkirk (1980), that the formal expression of linguistic rhythm is best understood in terms of hierarchically organised prosodic domains. The four units of prosodic structure that this thesis concerns itself with are given in (1)a below.

(1) Hierarchical Prosodic Structure



These units are hierarchically ordered — normally in a strict dominance relation — and form constituents at each level. Each constituent contains an obligatory strong position, or head (underlined) and optional weak or dependent positions, as shown in (1)b above.

Rhythmic prominence or *stress* (manifested acoustically in terms of increased duration, intensity, or pitch) is assigned to strong positions, with increasingly greater prominence falling on positions which are strong at higher prosodic levels (Liberman 1975; Liberman & Prince 1977; Hayes 1981, 1984, 1995; Prince 1983; Selkirk 1984a; Hyman 1985; Halle & Vergnaud 1987, Idsardi 1992, Halle & Idsardi 1995 and many others). To illustrate, the structure in (1)b receives prominence according to the metrical grid in (2)a below, where relative prominence at different points in the prosodic hierarchy is represented by the relative height of the columns.

(2) Prominence on the metrical grid

a.

```
LEVEL 3:                 *
LEVEL 2:     *       *   *
LEVEL 1:     *     * * * *
LEVEL 0:     * * * * * * *
```

b.

$$\begin{array}{lllll} |\phi & & \phi & & \underline{\phi}\ \ |_{PWd} \\ (\underline{\sigma} & \sigma)_{\phi} & (\underline{\sigma} & \sigma)_{\phi} & (\underline{\sigma}\ \ )_{\phi} \\ [\underline{\mu}\ \mu]_{\sigma} & [\underline{\mu}]_{\sigma} & [\underline{\mu}]_{\sigma} & [\underline{\mu}]_{\sigma} & [\underline{\mu}\ \mu]_{\sigma} \end{array}$$

The corresponding hierarchical bracketing notation is given in (2)b. Notice that the prosodic word contains three feet, five syllables and seven moras. Parentheses and square brackets will be used throughout the thesis to indicate foot and syllable constituents, respectively, although syllable boundaries will be omitted where not crucial to the discussion at hand in order to facilitate readability. Instead, the capital letters H and L will be used to represent heavy (bimoraic) and light (monomoraic) syllables, respectively, so that structures corresponding to the three feet in (1)b and (2)b can be represented succinctly as follows: ($\underline{\text{H}}$L) ($\underline{\text{L}}$L) ($\underline{\text{H}}$).

Cross-linguistically, stress systems generally exhibit an interesting asymmetry between quantity and headedness, known as the *Iambic / Trochaic Law* (hereafter ITL). According to the ITL, stress systems which exploit trochaic (left-headed) feet prefer these feet to be quantitatively even, i.e. ($\underline{L}$L), *($\underline{H}$L).[1] Conversely, systems which exploit iambic (right-headed) feet prefer these feet to be quantitatively uneven, i.e. (L$\underline{H}$), *(L$\underline{L}$). The formal analysis of the set of observations collectively referred to as the ITL has received much attention in the recent phonological literature (Hayes 1985, 1987, 1995; McCarthy & Prince 1986; Prince 1992; Kager 1993, 1995, 1999; Polgárdi 1995; Alber 1997, Van de Vijver 1998 and others) and is a major theme of this thesis.

Much of the recent work on the ITL has appealed to so-called *quantity-insensitivity* in certain trochaic systems which fail to observe the quantitative requirements of the ITL for trochaic systems by admitting quantitatively uneven feet. Kager (1992) and Fitzgerald (to appear) have cast doubt on the existence of quantity-insensitivity, however, by demonstrating that the stress systems of such languages respond to quantitative distinctions in other ways. In response to this, Alber (1997) demonstrates that gradient effects of quantity-sensitivity can be accounted for through constraint interaction, while a rhythmically-based alternative to the ITL has been proposed by Kager (1993, 1995), where such systems are analysed formally in terms of *syllabic* rhythm, in contrast to *moraic* rhythm in other trochaic languages.

While such developments have liberated syllabic trochee systems from the problematic notion of quantity-insensitivity, they have not addressed the issue of quantitative processes in these systems which generate uneven ($\underline{H}$L) trochees from underlying /LL/ or /HH/ sequences. Such processes have been largely disregarded as surface phonetic phenomena rather than as a shift in underlying phonological structure (Hayes 1995), but in recent years mounting evidence that such processes cannot be explained in purely phonetic terms has created the need for a theory of foot structure which provides for the existence of such processes as *phonological* rather than phonetic

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[1] Here and throughout I use an asterisk to indicate ungrammaticality.

in nature (Piggott 1998, 2001; Mellander 2001a, see §2-3). Pursuant to this goal, a central claim of this thesis is that a relation holds between head and dependent positions within prosodic constituents, according to which the *intrinsic prominence* of heads should exceed that of dependents. This concept is expressed in (3) below.

(3) HEAD PROMINENCE(PCat$_n$) (HD-PROM: Piggott 1998, 2001; Mellander 2001a, c, 2002b; cf. Head-Dependent Asymmetry: example (53) on page 43 below)
The head of a prosodic category is intrinsically prominent.

Since HD-PROM is concerned with relative *intrinsic* prominence within prosodic constituents, it is independent of derived rhythmic prominence which is normally assigned to all heads (e.g., through stress rules). HD-PROM evaluates the relative prominence of elements within a prosodic constituent, and demands that greater relative prominence be manifested on the constituent-head while lesser relative prominence be manifested on dependent elements. By adopting this notion of *intrinsic prominence*, HD-PROM follows previous work on the selection and assignment of phonological heads, and reflects the view that elements with certain structural and/or featural properties are better heads (McCarthy & Prince 1986; Prince 1992; Prince & Smolensky 1993), while those lacking such properties are better dependents. In §2-6, intrinsic prominence of syllables within feet is measured in terms of quantity (cf. PEAK-PROMINENCE: Prince & Smolensky 1993; WEIGHT-TO-STRESS PRINCIPLE: example (8) on page 79; STRESS-TO-WEIGHT PRINCIPLE: Riad 1992), while in §4 intrinsic prominence of moras within syllables is measured in terms of sonority (cf. Sonority Sequencing: Clements 1990; NUCLEAR HARMONY CONSTRAINT (HNUC): Prince & Smolensky 1993). The generalisability of an abstract notion of 'prominence' over quantity in feet and sonority in syllables is made explicit by Prince & Smolensky (1993:39). Finally, he utility of measuring prominence in terms of *nasality* is explored in an analysis of Sardinian (§6.3.4 starting on page 202).[2]

Building on a proposal by Mellander (2001c), the integration of HD-PROM into a general theory of foot structure is accomplished by restricting the maximal expansion of feet. This is achieved by means of a single constraint on the structural relationship between heads and dependents within a foot, given in (4) below.

(4) HEAD GOVERNMENT (HD-GOV: Mellander 2001c, 2002b; cf. Kager 1993, 1995)[3]
Dependent elements within a foot must be governed by the foot-head, which is:
a. strictly adjacent to governed positions, and
b. associated with an edge-adjacent syllable.

HD-GOV ensures that feet be maximally bisyllabic, normally, and effectively limits moraic feet to maximal binarity in trochaic systems and maximal ternarity in iambic systems (see §2.3.3 for discussion). HD-GOV accounts for the observed cross-linguistic limitations on foot shape in so-called 'bounded' stress systems, and can be extended to 'unbounded' (§2.4) and ternary (§6) stress systems as well. The cross-linguistic absence

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[2] It is likely that intrinsic prominence can be measured in terms of tone as well. Yip (2000) has identified a general dispreference for even tonal prominence in a disyllabic sequence in Wuming Zhuang, which is resolved by increasing the tonal prominence of the first (head) syllable. While an analysis in terms of HD-PROM seems promising, it is not explored in this thesis.

[3] The formulations of HEAD GOVERNMENT in Mellander (2001c, 2002b) lack condition (4)b, since these analyses assume RHTYPE=T/I (see example (70) on page 56) throughout, while the present work abandons this constraint in §5. It may nevertheless be possible to ultimately do away with condition (4)b although this option is not explored here. Note also that the use of the term 'government' here differs from that employed in the framework of Government Phonology (GP: Kaye, Lowenstamm & Vergnaud. 1990), where the direction of government is fixed as either head-initial (constituent government) or head-final (inter-constituent government).

of stress systems which are incompatible with the requirements of Hd-Gov is consistent with the assumption that Hd-Gov is universally inviolable, a departure from standard Optimality Theory (see below).

1.2 Optimality Theory

This thesis adopts the general framework of Optimality Theory (OT: Prince & Smolensky 1993) as the theoretical vehicle for expressing generalisations and asserting claims. OT assumes a universal set of ranked violable constraints against which potential output candidates are evaluated. Within the grammar of a specific language, the constraint ranking is normally fixed, while cross-linguistic variation is expressed in terms of differential constraint rankings across grammars. The evaluation of candidates against constraints is illustrated in *tableaux*, with constraints on the horizontal axis extending rightward from highest-ranked to lowest-ranked, and with candidates on the vertical axis. This is illustrated in (5) below.

(5) Sample OT Tableau

Input: /input/	**Constraint 1**	**Constraint 2**	**Constraint 3**
a. ☞ Candidate a.		*	
b. Candidate b.	*!		*
c. Candidate c.		**!	
… Candidate …		*	*!

The underlying representation or input is enclosed in slashes and violations to particular constraints are indicated with an asterisk. An exclamation mark indicates that a candidate is removed from further consideration because it is outperformed on a given constraint by at least one other candidate. Once a candidate is eliminated, subsequent cells are shaded but violations continue to be assessed. When all but one candidate have been ruled out, the remaining candidate is selected as *optimal*, and is indicated by the pointing hand. The range of cross-linguistic variation in OT is expressed through *factorial typologies*, the typology of grammars generated by the *n* factorial possible rankings of *n* constraints.

An important challenge for linguistic theory in general — and OT in particular — is the problem of overgeneration, that is, theories which predict cross-linguistically unattested patterns. Overgeneration represents the failure of a theory to make correct predictions with respect to a body of data, and is thus a problem for the theory unless other explanations can be found.[4] On this front, the thesis makes a contribution in the area of syllable-internal quantity-prominence relations. Of the four theoretically possible diphthong types generated by the two descriptive parameters *heavy/light* and *rising/falling*, only three are attested as the systematic manifestation of diphthongs in systems with phonemic quantity. By assuming HD-PROM in conjunction with other constraints, the thesis (§5) provides a principled formal account for the absence of the light falling diphthong by demonstrating that in the case of a falling prominence profile, a bimoraic (heavy) realisation is always superior, regardless of constraint ranking.

A final innovation of this thesis in the realm of OT builds on the work of Van de Vijver (1998), who captures the asymmetric properties of iambic and trochaic stress systems through the interaction of *asymmetric* paired constraints, i.e. paired constraints which are not mirror-image opposites and thus yield asymmetric effects according to their relative ranking. In previous OT analyses, the constraints determining iambicity / trochaicity (cf. RHTYPE: Prince & Smolensky 1993) yield symmetric effects regardless of which constraint is more highly ranked. Iambic / trochaic asymmetries must then be

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[4] See Myers (2002) and Hyman (2001) for analyses of typological gaps in terms of phonetic and perceptual considerations, which discriminate against certain constraint rankings in diachronic sound change.

encoded separately with constraints which make specific reference to iambicity / trochaicity, e.g. UNEVEN-IAMB (Kager 1999:151). In the case of *asymmetric* paired constraints, however, systematic differences between iambic and trochaic systems emerge as an artefact of constraint interaction and need not be encoded as separate constraints. The thesis (§5) exploits this model to account for ITL effects as well as other iambic / trochaic asymmetries at the moraic and syllabic levels alike. Since within languages, rhythm remains consistent at both levels, it appears that separate constraints on rhythmic organisation at the moraic and syllabic levels are unmotivated.

1.3 Thesis Overview

The remainder of this thesis is organised into five content chapters and a final chapter summarizing the thesis and its conclusions.

§2 examines the basic inventory of foot types, reviewing current proposals by Hayes (1995) and Kager (1993, 1995), and ultimately adopting a view where the maximal expansion of feet is determined through a uniform structural relation — called HD-GOV — between the foot head and dependent positions (Mellander 2001c).

Special attention is devoted to quantitative processes and their role in optimizing foot shape as suggested by the fact that the occurrence of specific quantitative processes correlates with particular system types. While (LL)-creating processes are restricted to *moraic* trochee systems in order to satisfy the requirement of strict binarity in these systems, (HL)-creating processes occur exclusively in *syllabic* trochee systems where such structures would not violate HD-GOV due to the broader range of possible foot shapes afforded by syllabic analysis.

(HL)-creating processes are seen to follow from HD-PROM, which requires constituent heads to have greater intrinsic prominence (manifested here as syllable quantity) than dependents (Piggott 1998; Mellander 2001a, c). Accordingly, (HL)-creating quantitative processes are seen as *phonological* rather than phonetic in nature, contra the standard view (e.g. Hayes 1995). This analysis is corroborated by a careful examination of systems exhibiting such processes, which identifies at least three languages — Mohawk, Selayarese, and Central Slovak — where a phonetic analysis of quantity shift is untenable.

Finally, an extension of the analysis to so-called 'unbounded' stress systems reveals that such patterns can be accounted for straightforwardly under HD-GOV, without appealing to larger prosodic constituents. This result removes the empirical basis for the violability of HD-GOV, a problematic result for Optimality Theory, which requires all constraints to be violable.

§3 consists of a detailed examination into Trochaic Shortening, a specific type of (HL)-creating quantitative process whereby an underlying /HH/ sequence undergoes shortening of the second syllable and is realised as an uneven (H̲L) trochaic foot. Three languages exhibit Trochaic Shortening — Central Slovak, Gidabal, and Oromo — and the chapter develops analyses for each, whereby the process is seen to be driven by HD-PROM.

Special emphasis is placed on Slovak, for which shortening has previously been analysed in strictly linear — and crucially *not* prosodic — terms, based on complete quantity-insensitivity in the stress system (Kenstowicz & Rubach 1987; Rubach 1993). An investigation of the primary descriptive literature on Slovak, however, reveals that synchronic Trochaic Shortening is restricted to Central Slovak dialects, and that it is precisely these dialects which evidence aspects of quantity-sensitivity in stress assignment (Stanislav 1958, 1967). Moreover, judgements by a Central Slovak native speaker reveal clear quantity sensitivity in secondary stress. Taken together, these facts provide a solid basis for an analysis of Trochaic Shortening as a prosodically-driven phenomenon (Bethin 1998; Mellander 2001a).

§4 explores the effects of HD-PROM at the moraic level, specifically across the bimoraic domain of heavy syllables. In conjunction with TROCHAIC DEFAULT, a constraint which demands initial prominence in binary domains (cf. McCarthy & Prince 1986), HD-PROM accounts for synchronic processes of long vowel diphthongization as well as the asymmetric weight typology of diphthongs, cross-linguistically. The analysis also provides a principled account for a universal ban on light falling diphthongs. Since in the case of falling diphthongs, constraint reranking fails to yield different outputs, there is simply no ranking for which a light falling diphthong would be the optimal candidate. Such a mechanism obviates the need to posit a universally inviolable constraint to account for this ban (cf. Rosenthall 1994).

§5 examines a number of iambic / trochaic markedness asymmetries as well as asymmetries in canonical foot shape, and accounts for them through the interaction of asymmetric constraints. Following Van de Vijver (1998), the analysis assumes two constraints, one requiring initial prominence within a rhythmic domain and one banning edgemost prominence. In binary domains, initial prominence is invariably optimal regardless of the constraint ranking (cf. TROCHAIC DEFAULT in §5). This is because in a binary domain the ban on edgemost prominence is equally violated whether prominence is initial or final, leaving the preference for initial prominence to play the decisive role in selecting the output. This mechanism also accounts for the attested range of ternary patterns, and the frequency of Iambic Lengthening processes — an issue which was left unaddressed in §2.

Finally, the analysis also derives the effects of the *Iambic / Trochaic Law* (e.g. Hayes 1995) — an ostensible rhythmic universal which favours even quantity in trochaic groupings, e.g. ($\underline{L}$L) and uneven quantity in iambic groupings, e.g. (L$\underline{H}$). Quantitative evenness is seen to reflect underlying structural binarity — i.e. two moras: (LL) = (μμ) — which is realised with initial prominence as discussed above. Conversely, quantitative unevenness is seen to reflect *ternarity* at an underlying structural level — i.e. three moras: (LH) = (μμμ) — which surfaces as iambic on a disyllabic parse under constraint interaction. This view runs counter to most current proposals on the *Iambic / Trochaic*

Law (Prince 1992; Kager 1993; Hayes 1995), where iambicity / trochaicity is seen to determine quantity and not vice versa as argued here.

§6 extends the analysis to account for ternary stress systems, along similar lines to those of Dresher & Lahiri (1991). Through adjunction of a third element to the foot-head, ternary feet satisfy both HD-GOV and HD-PROM. On this view, additional adjoined elements — which would produce unattested quaternary or quinternary constituents — do not occur because such elements do not increase the well-formedness of the foot with respect to HD-PROM. The marked status of ternary stress systems is partially explained by the statistical improbability of the specific constraint rankings necessary to produce such systems relative to other rankings which yield binary stress. Analyses along these lines are provided for five ternary systems.

§7 offers a summary of the main arguments and findings of the thesis as well as concluding remarks which include directions for future research.

2. QUANTITATIVE PROCESSES AND THE FOOT INVENTORY

2.1 Introduction

The foot inventory in prosodic theory refers to the relatively small range of constituent types which organise syllables into prosodic words across the world's languages. The precise formal expression of the foot inventory and the factors that govern its implementation have been the focus of much discussion in recent years, and the present chapter is an attempt to shed new light on the debate by taking a closer look at *quantitative processes* — shifts in syllable weight between underlying and surface (or input and output) forms. It is well-established in the phonological literature that syllable quantity plays a central role in prosodic organisation in the vast majority of languages, and quantitative processes have been argued to reinforce prosodic organisation by creating rhythmically-desirable quantitative shapes (e.g. Prince 1992; Kager 1993, 1995; Mester 1994; Hayes 1995). Taking this assumption as a point of departure, we examine a number of quantitative processes in various languages and the forces which have been argued to drive them, starting with the *Iambic/Trochaic Law* (ITL, e.g. Hayes 1995).

2.1.1 The Iambic / Trochaic Law (ITL)

Early studies of rhythm perception (Woodrow 1909, 1951; cf. Bell 1977; Rice 1992) demonstrated a propensity for human subjects to parse a series of stimuli into binary groupings. The perceived groupings differed as the stimuli were manipulated in a number of different ways: intensity, pitch, duration of stimuli, duration between stimuli, etc. One of the more interesting findings of these experiments has become known as the *Iambic/Trochaic Law*, taken by Hayes (1995) and others to be a fundamental principle of rhythmic organisation in human language. Hayes' formulation is given in (1) below.

(1) Iambic/Trochaic Law (Hayes 1995:80; cf. Bolton 1894:232)

   a. Elements contrasting in intensity naturally form groupings with initial prominence.

   b. Elements contrasting in duration naturally form groupings with final prominence.

Extra-linguistic evidence for the ITL from other cognitive domains including verse and music is summarized by Hayes (1995:80-1; see also §4.2.3 below, starting on page 126).

While the ITL clearly does not hold in many languages for strings of syllables, it has been argued to hold at the level of foot structure (Hayes 1985, 1987, 1995; cf. Kager 1993, 1995, 1999; McCarthy & Prince 1986; Prince 1992). On this view, prominence-initial (trochaic) systems are understood to differ from prominence-final (iambic) systems as in (2) below.

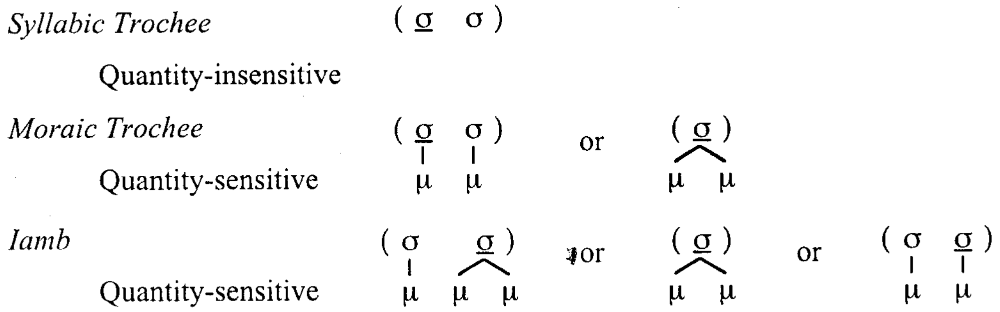
(2) Iambic/Trochaic Law (Kager 1993:382)

   a. Trochaic systems have durationally even feet.

   b. Iambic systems have durationally uneven feet.

The proposal in (2) links iambicity to durational unevenness and trochaicity to durational evenness, respectively. This generalisation can be observed in the basic inventory of bounded foot types. Hayes (1995) exploits the *Universal Foot Inventory* given in (3) below, to account for stress patterns in a wide range of languages.

(3) Universal Foot Inventory (Hayes 1995:71, 101-5)



The inventory in (3) consists of two trochaic foot types and one iamb. As one would expect under the ITL, trochaic feet are either insensitive to syllable quantity or quantitatively even, while the canonical iambic foot is quantitatively uneven. Systems which require even iambs are very rare, although Hayes (1995:266-7) lists Southern Paiute, Araucanian, Onandaga, and Dakota as examples of such systems.

The precise linguistic mechanism by means of which the ITL is manifested has received much attention in recent years. Prince (1992) expresses the ITL in terms of a foot well-formedness hierarchy, where quantitatively even (<u>L</u>L) trochees are preferred over quantitatively uneven (<u>H</u>L) ones. Conversely, quantitatively uneven (L<u>H</u>) iambs are favoured over quantitatively even (L<u>L</u>) ones, as shown in (4) below.

(4) Bisyllabic foot types under the Iambic/Trochaic Law (Prince 1992:360)

a. Trochaic: (<u>L</u>L) >> (<u>H</u>L)

b. Iambic: (L<u>H</u>) >> (L<u>L</u>)

In Optimality Theory (OT: Prince & Smolensky 1993; McCarthy & Prince 1995), a framework which evaluates competing outputs against a set of ranked violable constraints, the effects of the ITL are achieved through the satisfaction of various constraints.

Examples of constraints disfavouring uneven (<u>H</u>L) trochees and even (L<u>L</u>) iambs are given in (5) and (6) below, respectively.

(5) RHYTHMIC HARMONY (RHHRM: Prince & Smolensky 1993:59)
*($\underline{H}$L)

(6) UNEVEN-IAMB (Kager 1999:151)
(L$\underline{H}$) > (L$\underline{L}$), ($\underline{H}$)

A similar approach is taken by Alber (1997), who collapses ITL effects in iambic and trochaic systems into a single constraint, given in (7) below.

(7) IAMBIC/TROCHAIC LAW (Alber 1997:6)
a. The components of a trochaic foot must be quantitatively equal.
b. The components of an iambic foot must contrast in quantity.

Examples (5) and (7)a militate against quantitatively uneven trochees while (6) and (7)b militates against quantitatively even iambs. Canonical even ($\underline{L}$L) trochees and uneven (L$\underline{H}$) iambs, however, trigger no violation. While such approaches generate what are arguably the observed patterns, they are vulnerable to the criticism that they lack independent theoretical motivation and thus are essentially descriptive rather than explanatory in nature. The present work takes a different approach; following the spirit of Kager (1993), Van de Vijver (1998) and others, it *derives* the effects of the ITL (to the extent that these effects are indeed empirically well-motivated, see below) from independent principles, and develops a theory of foot structure which can account for a range of quantitative processes straightforwardly.

In addition to its consequences on the basic foot inventory, the ITL has also — in one form or another — been invoked to account for various quantitative processes which derive even trochees and uneven iambs (to be discussed in detail in the following section). At the same time, however, there is abundant cross-linguistic evidence that the ITL does not apply. An obvious problem is the existence of so-called "quantity insensitive" trochaic systems which parse syllables into binary trochaic feet without regard to syllable weight.[1] Labelling these systems as "quantity-insensitive" amounts to diacritically marking a set of exceptions to what is purportedly a universal principle. Moreover, Kager (1992) has called the very existence of true quantity insensitivity into question by demonstrating that the stress systems of better-described languages which have phonemic quantity invariably exploit quantity distinctions in some way, often in the location of secondary stresses; at the same time, a compelling case for quantity insensitivity is conspicuously absent. A similar line in taken by Fitzgerald (to appear), who demonstrates that quantity-insensitive stress can be accompanied by quantitative processes and other effects demonstrating sensitivity to quantity in the realm of prosodic morphology. Particularly problematic are quantitative processes which *introduce* quantity distinctions within trochaic feet, in direct contravention of the view expressed in (7).

The remainder of this chapter is organised as follows: §2.2 reviews a number of quantitative processes, including those predicted by the ITL (§2.2.1), as well as those which are problematic for an ITL-based account of quantitative adjustment (§2.2.2). The section concludes by developing an alternative analysis for quantitative adjustment in these cases. §2.3 identifies typological asymmetries in the cross-linguistic distribution of various quantitative processes and develops a theory of foot structure to account for them. §2.4 extends the analysis to so-called 'unbounded' stress languages, demonstrating that no special provision is needed to account for such systems. Finally, a summary is

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[1] See §5 for discussion and analysis of quantity relations in iambic systems.

provided in §2.5.

2.2 The ITL and Quantitative Processes

2.2.1 Predicted Quantity Shifts

In some languages, metrical feet are brought into conformity with the structural requirements of the ITL through quantitative adjustment. Kager (1993, 1995, 1999) accomplishes this by appealing to the mora-rhythmic properties of different foot shapes, following Prince's (1983) assumption that within a heavy syllable it is the first mora which is prominent and bears stress.[2] Mora-rhythmic profiles for various foot shapes are given in (8) below.

(8) Mora-rhythmic Profiles of Quantitative Feet (after Kager 1993, 1995:441)

	Well-formed			*Ill-formed*			
Trochees	$(\underline{\mathrm{L}}\mathrm{L})$	=	(* .)	$*(\underline{\mathrm{H}}\mathrm{L})$	=	(* . .)	**Lapse**
	$(\underline{\mathrm{H}})$	=	(* .)	$*(\underline{\mathrm{L}})$	=	(*)	**Final beat**
				$*(\underline{\mathrm{L}}\mathrm{H})$	=	(* . .)	**Lapse**
				$*(\underline{\mathrm{H}}\mathrm{H})$	=	(* . . .)	**2 Lapses**
Iambs	$(\mathrm{L}\underline{\mathrm{H}})$	=	(. * .)	$*(\mathrm{L}\underline{\mathrm{L}})$	=	(. *)	**Final beat**
	$(\underline{\mathrm{H}})$	=	(* .)	$*(\underline{\mathrm{L}})$	=	(*)	**Final beat**
				$*(\mathrm{H}\underline{\mathrm{L}})$	=	(. . *)	**Lapse, Final beat**
				$*(\mathrm{H}\underline{\mathrm{H}})$	=	(. . * .)	**Lapse**

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[2] The persistent trochaicity of heavy syllables at the moraic level follows from a general rhythmic preference for prominence-initial groupings in binary domains (see §4.2.3 starting on page 126 and §5.3.1 starting on page 149 for formal statements of this generalisation and discussion; cf. iambic heavy syllables in Chugach in §6.3.2 (starting on page 186) and Slovak in §4.3.1 (starting on page 133)). Note that the head mora of a heavy syllable located in the dependent position of a foot does not project grid prominence.

Ill-formed foot types in (8) are easily distinguishable on structural grounds from their well-formed counterparts: notice that ill-formed foot types are characterised by either a *final beat* (stress on the final mora) or a *foot-internal lapse* (a sequence of two unstressed moras). By contrast, all well-formed feet in table (8) share a common structural property — they all end in a strong-weak contour (a stressed mora followed by an unstressed one), suggesting that the relevant constraint is as in (9) below.

(9) RH-CONTOUR (Kager 1995, 1999:174; cf. Kager 1993)
A foot must end in a strong-weak contour at the moraic level.

While functionally virtually equivalent to Alber's formulation of the ITL in (7) above, the constraint in (9) identifies a single structural property which unifies putatively well-formed feet in both system types, thereby avoiding having to express the ITL in separate statements for iambic and trochaic systems.

In OT grammars, quantitative adjustment in satisfaction of the ITL occurs in systems where RH-CONTOUR outranks IDENTWEIGHT, the constraint which demands like syllable weight in inputs and outputs, given in (10) below.[3]

(10) IDENTWEIGHT (cf. WT-IDENT-IO: McCarthy 1995; Rosenthall & Van der Hulst 1999; MORAFAITH: Broselow et al. 1997)
The number of moras in the input is equal to the number of moras in the output.

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[3] IDENTWEIGHT is used here for expository purposes to illustrate how prosodic well-formedness, which takes precedence over quantitative faithfulness. In many systems, the formal analysis of quantitative adjustment requires separate constraints for mora insertion and deletion, respectively (see §3.2.3.2, starting on page 78).

IDENTWEIGHT demands a one-to-one correspondence between moras in input and output forms, and is violated by outputs which contain additional moras (mora insertion) as well as by outputs which lack underlying moras (mora deletion). The ranking of IDENTWEIGHT and RH-CONTOUR responsible for quantitative adjustment is given in (11) below.

(11) Quantitative Adjustment (QA) under the Iambic/Trochaic Law

RH-CONTOUR >> IDENTWEIGHT

Since the ITL has differing requirements in iambic and trochaic systems, the manifestation of QA under the constraint ranking in (11) will differ in the two system types. The two predicted patterns are given in (12) below.

(12) Quantitative Adjustment predicted under the Iambic/Trochaic Law[4]

Iambic systems:

IAMBIC LENGTHENING: /LL/ → (L$\underline{\mathrm{H}}$)

Trochaic systems:

TROCHAIC LEVELLING: /HL/ → ($\underline{\mathrm{L}}$L), /LH/ → ($\underline{\mathrm{L}}$L)

Both Iambic Lengthening and Trochaic Levelling are attested, and are introduced in the following sections.

2.2.1.1 Iambic Lengthening: /LL/ → (L$\underline{\mathrm{H}}$)

Iambic Lengthening occurs in many iambic languages. Representative examples include

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[4] Strictly speaking, the ITL (as formulated generally, e.g. in (2) on page 13 and (7) on page 15) also predicts the following quantitative processes as well: /HL/ → ($\underline{\mathrm{H}}$H), /LH/ → ($\underline{\mathrm{H}}$H), /HH/ → (L$\underline{\mathrm{H}}$). Such processes are apparently unattested, however.

Carib, a Cariban language spoken in Surinam, and Choctaw, a Muskogean language, data from which are provided in (13) and (14) below, respectively. (Carib data from Van de Vijver 1998:66, attributed to Hoff 1968; Choctaw data from Hayes 1995:210, attributed to Munro & Ulrich 1984 and Ulrich 1986).

(13) /LL/ → (LH) in Carib[5]

a.	/turupo/	(tu.ru:) po	*(tu.ru) po	‘heart’
	/L L L/	(LH) L	*(LL) L	
b.	/maʔmatakara/	(maʔ.ma:)(ta.ka:) ra	*(maʔ.ma)(ta.ka) ra	‘species of fish’
	/L L L L L/	(LH) (LH) L	*(LL) (LL) L	

(14) /LL/ → (LH) in Choctaw

a.	/sa-litiha-tok/	(sa.li:)(ti.ha:)(tok)	*(sa.li)(ti.ha)(tok)	‘I was dirty’
	/L L L L H/	(LH) (LH) (H)	*(LL) (LL) (H)	M&U:192
b.	/oktʃa -li-li-h/	(ok)(tʃa.li:)(lih)	*(ok)(tʃa.li)(lih)	‘I woke him up’
	/H L L H/	(H) (LH) (H)	*(H) (LL) (H)	U:54

In both systems exemplified in (13) and (14), underlyingly short vowels undergo lengthening in the final syllables of iambic feet. The tableaux for iambic lengthening is given in (15) below.[6]

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[5] Van de Vijver (1998) assumes vowel length to be independent of syllable weight in Carib (cf. Hoff 1968). Since the present analysis assumes a weight contrast, coda consonants must be assumed not to contribute to syllable weight.

[6] For purposes of the present discussion we assume exhaustive parsing of syllables into feet. This provision is formalized in OT through the PARSE–σ constraint (example (83) on page 65).

(15) Iambic Lengthening: /LL/ → (LH̲)

Input: /LL/	RH-CONTOUR	IDENTWEIGHT
a. ☞ (LH̲)		*
b. (LL̲)	*!	

Candidate (15)b fatally violates RH-CONTOUR since the even (LL̲) iamb does not end in a strong-weak moraic contour (recall from the mora-rhythmic representations in (8) that (LL̲) = (. *)). Candidate (15)a is thus optimal, despite a violation of lower-ranked IDENTWEIGHT due to the discrepancy in output syllable weight with that of the input. Iambic Lengthening is extremely common in iambic systems; see Buckley (1998) for a recent survey.

2.2.1.2 Trochaic Levelling: /HL/, /LH/ → (L̲L)

In trochaic systems, quantitative adjustment takes the form of Trochaic Levelling. Examples of /HL/ → (L̲L) levelling from Fijian are given in (16) below. (Data from Hayes 1995:145, attributed to Schütz 1985 and Dixon 1988.)

(16) /HL/ → (L̲L) in Fijian

a.	/ᵐbu:-ᵑgu/	(ᵐb̲ú̲.ᵑgu)	*(ᵐb̲ú̲:̲.ᵑgu)	‘my grandmother’
	/HL/	(L̲L)	*(H̲L)	S:528
b.	/si:ßí/	(s̲í̲.ßi)	*(s̲í̲:̲.ßi)	‘exceed’
	/HL/	(L̲L)	*(H̲L)	D:26-7

In (16), underlyingly long vowels undergo shortening in the initial syllable of trochaic feet forming an even (L̲L) trochee. The tableau for this process follows the same constraint ranking as iambic lengthening, and is given in (17) below.[7]

(17) Trochaic Levelling: /HL/ → (LL)

Input: /HL/	**RH-CONTOUR**	**IDENTWEIGHT**
a. ☞ (LL)		*
b. (HL)	*!	

Candidate (17)b fatally violates RH-CONTOUR since the uneven (HL) trochee does not end in a strong-weak contour (recall from (8) that (HL) = (* . .)). Candidate (17)a is thus optimal, despite a violation of IDENTWEIGHT.

A second pattern of Trochaic Levelling is exemplified in Pre-Classical Latin in a process known as *Brevis Brevians* (Allen 1973; Kager 1989; Prince 1992; Prince & Smolensky 1993; Mester 1994). As illustrated in (18) below, the second syllable of an underlying /LH/ sequence optionally undergoes truncation, yielding a canonical even (LL) trochee.[8] (Data from Mester 1994:11-12.)

(18) /LH/ → (LL) in Pre-Classical Latin

a.	/puta:/	(pu.ta)	'believe'
	/LH/	(LL)	2.sg. imp.
b.	/homo:/	(ho.mo)	'human being'
	/LH/	(LL)	nom. sg.

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[7] The analysis of longer words in Fijian requires a constraint demanding the head-foot be aligned with the right edge of the prosodic word (e.g. that in example (39) on page 36 below). See Kager (1999) for a complete analysis of these facts in OT.

[8] This process is also known as *Iambic Shortening*. A similar phenomenon, *Cretic Shortening* shortens /HLH/ to (H)(LL) (Mester 1994). See also Allen (1973) for discussion.

Traditionally analysed in terms of adherence to canonical foot shape and a language-specific dispreference for final stress, this pattern can be accounted for by appealing to exactly the same constraint ranking, as shown in (19) below.

(19) Trochaic Levelling: /LH/ → (LL)

Input: /LH/	**RH-CONTOUR**	**IDENTWEIGHT**
a. ☞ (LL)		*
b. (LH)	*!	

Candidate (19)b fatally violates RH-CONTOUR since the reverse (LH) trochee does not end in a strong-weak contour (recall from (8) that (LH) = (* . .)). Candidate (19)a is thus optimal, despite a violation of IDENTWEIGHT. Trochaic Levelling also occurs in Hawaiian (Elbert & Pukui 1979), Tongan (Churchward 1953; Feldman 1978), Middle English (Lass 1992), and Abruzzese Italian (Fong 1979).

In this section we have seen how the Iambic/Trochaic Law provides a straightforward account for quantitative processes of Iambic Lengthening as well as Trochaic Levelling if RH-CONTOUR is assumed to outrank IDENTWEIGHT. The following section will examine data from other quantitative processes which are problematic for the present interpretation of the Iambic/Trochaic Law. Such processes constitute a crucial piece of empirical motivation for a re-examination of the forces which drive quantitative processes and the basic foot inventory, to be taken up in §2.3.

2.2.2 Against an ITL-driven Model of Quantitative Adjustment

There are at least three reasons why we may *not* want to assume that trochaic /HL/ → (LL) and iambic /LL/ → (LH) are driven by the same mechanism. Firstly, such an assumption might lead us to expect the two processes to manifest themselves in a similar manner and to a similar extent. The data do not support such a view, however. Iambic

/LL/ → (LH) is far better attested than trochaic /HL/ → (LL); Hayes (1995:83, 148) lists 19 languages undergoing the former process, compared to 5 undergoing the latter, and this despite the fact that trochaic systems far outnumber iambic ones across the world's languages. Secondly, iambic /LL/ → (LH) normally applies in every foot within the word, while trochaic /HL/ → (LL) is generally restricted to the rightmost (main) stress foot only.[9] Such evidence weakens the case for both processes resulting from a single principle or constraint. Thirdly, there are a number of quantitative processes which directly contravene the ITL by producing non-canonical feet. Such processes are restricted to trochaic systems and will be discussed presently.

2.2.2.1 Trochaic Lengthening: /LL/ → (HL)

While trochaic systems like Fijian and Pre-Classical Latin undergo Trochaic Levelling creating even (LL) trochees, other trochaic languages exploit quantitative adjustments to different ends. These systems create uneven (HL) trochees by lengthening the first vowel of an underlying /LL/ sequence as illustrated in the examples in (20) from Selayarese, a Makassar language of South Sulawesi, Indonesia (Mithun & Basri 1986; Goldsmith 1990; Broselow 1999; Piggott 2001; data Mithun & Basri 1986.)

(20) /LL/ → (HL) in Selayarese

a.	/golo/	(gó:.lo)	*(gó.lo)	'ball'
	/LL/	(HL)	*(LL)	
b.	/golo-ku/	go.(ló:.ku)	*go.(ló.ku)	'my ball'
	/LL-L/	L (HL)	* L (LL)	

Trochaic Lengthening cannot follow from the ranking in (11), as illustrated by the tableau

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[9] See §5.5.2 for further discussion and a proposal on this asymmetry.

in (21) below where the ungrammatical even (L̲L) trochee is incorrectly selected (indicated by the filled-in hand) as the optimal candidate.[10]

(21) Trochaic Lengthening is not driven by RH-CONTOUR: /LL/ → (H̲L)

Input: /LL/	**RH-CONTOUR**	**IDENTWEIGHT**
a. ☛ (L̲L)		
b. (H̲L)	*!	*

Trochaic Lengthening induces violations of *both* RH-CONTOUR *and* IDENTWEIGHT, as illustrated by the grammatical candidate in (21)b. This fact means that the analysis cannot be rescued merely by adjusting the ranking of these constraints, and suggests that the process is driven by a different mechanism.

2.2.2.2 Trochaic Shortening: /HH/ → (H̲L)

In other trochaic systems, uneven (H̲L) trochees are created through shortening of the second heavy syllable in an underlying /HH/ sequence (Bethin 1998, Mellander 2001a). This is illustrated by the Central Slovak examples in (22) below (§3.2; data from Kenstowicz & Rubach 1987 and Oravec & Laca 1975).

(22) /HH/ → (H̲L) in Central Slovak

a. /stra:ʒ-ɲi:k/	(s̲t̲r̲á̲:̲ʒ̲.ɲik)	*(s̲t̲r̲á̲:̲ʒ̲.ɲi:k)	'guard' (n.)	
/HH/	(H̲L)	*(H̲H)		K&R:468
b. /da:v-a:ʃ/	(d̲á̲:̲.vaʃ)	*(d̲á̲:̲.va:ʃ)	'give' 2.p.sg.	
/HH/	(H̲L)	*(H̲H)		O&L:26

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[10] Evidence for the phonological status of Trochaic Lengthening in Selayarese will be presented in §2.2.3.3 below (starting on page 39).

Trochaic Shortening is also problematic for the present ranking as illustrated in tableau (23) below.

(23) Trochaic Shortening is not driven by RH-CONTOUR: /HH/ → (HL)

Input: /HH/	**RH-CONTOUR**	**IDENTWEIGHT**
a. ☛ (HH)	*	
b. (HL)	*	*!

As in the previous tableau, the uneven (HL) trochee violates both RH-CONTOUR and IDENTWEIGHT, as shown in (23)b, and is thus incorrectly ruled out. Also parallel to (21) above, a reversed ranking of these constraints would still select the ungrammatical output, implying that both Trochaic Lengthening and Trochaic Shortening result from a different formal mechanism.

2.2.3 The Phonological Basis of (HL)-Creating Processes

Trochaic Lengthening and Trochaic Shortening occur in a range of languages. In addition to Selayarese (§2.2.3.3), Trochaic Lengthening occurs in Mohawk (Michelson 1988; Piggott 1995, 1998; see §2.2.3.2), Icelandic (Kiparsky 1984; Hayes 1995), Chimalapa Zoque (Knudsen 1975; Hayes 1995), Chamorro (Chung 1983; Prince 1992), Gilbertese (Blevins & Harrison 1999; see §6.3.3) and certain Italian dialects (Bolognesi 1998; Molinu 2001; see below and §6.3.4). In addition to Central Slovak (§3.2), Trochaic Shortening occurs in Gidabal (Geytenbeek & Geytenbeek 1971; Kenstowicz & Kisseberth 1979; Zoll 1992; see §3.4) and Oromo (Gragg 1976, 1982; Zoll 1992; see §3.5). These (HL)-creating processes are deeply problematic for the ITL. Not only does the latter fail to account for such processes, but the fact that a quantitative shift ensues to produce a putatively marked foot type from a putatively unmarked one (note that both (LL) and (HL) are quantitatively even trochees) runs counter to the very spirit of the ITL.

This problem is particularly salient in the case of Trochaic Lengthening, where an ostensibly ill-formed (<u>H</u>L) trochee is derived from an underlying sequence which could have been parsed into an ostensibly canonical even (<u>L</u>L) trochee with no faithfulness violation. To get around this argument, Hayes (1995) contends that such processes are generally phonetic in character, and do not represent a shift in true *phonological* quantity. In Swedish and Wargamay, for example, lengthening introduces only a minute durational contrast, as one might expect on a phonetic analysis (1995:84). Other systems, however, display effects which are incompatible with such a view.

In Selayarese (§2.2.3.3), stressed open syllables undergo three distinct augmentation processes according to context as shown in (24) below.

(24) Three Augmentation Processes in Selayarese

OPERATION	**CONTEXT**
Trochaic Lengthening	underlying vowels
Gemination	voiceless obstruents after epenthetic vowels
Glottal Stop Insertion	before other consonants after epenthetic vowels

If lengthening in Selayarese were a phonetic process, the occurrence of gemination and glottal stop insertion in exactly the same context would have to be viewed as coincidental. By contrast, a *phonological* requirement that stressed syllables be heavy accounts for all three processes simultaneously.

In Mohawk (§2.2.3.2), underlying /e/ is stressed and lengthened in open penults while epenthetic /e/ is not, suggesting that lengthening is sensitive to phonological representations. A phonetic analysis would have difficulty accounting for the differential behaviour of epenthetic and underlying vowels with respect to lengthening.

In Sardinian (§6.3.4), Trochaic Lengthening of stressed syllables is restricted to penults; stressed antepenults do not undergo augmentation. In certain Sardinian dialects, Trochaic Lengthening is accompanied by deletion of a post-tonic coronal nasal /n/ and nasalization of the lengthened vowel. An analysis based on phonetic augmentation would have difficulty accounting for the differential behaviour of stressed penults vs. stressed antepenults, as well as the nasalization effect. Finally, in Neapolitan (Mary Caputo, p.c.), onset consonants following stressed penults undergo gemination just in case the penult is open: *au.to.bús.sə* 'bus' but *spór.tə* 'sport' **spórt.tə*, indicating that augmentation in this dialect is sensitive to syllable structure.

The phonological nature of Trochaic Shortening is demonstrated by the fact that in Central Slovak, unstressed long vowels undergo shortening following heavy syllables, as shown in (25) below.

(25) Post-tonic long vowels shorten *only* after heavy syllables

a.	/ba:s-ɲi:k/	(bá:s.ɲik)	*(bá:s.ɲi:k)	'poet'
	/HH/	(HL)	*(HH)	
b.	/les-ɲi:k/	(lés.ɲi:k)	*(lés.ɲik)	'forester'
	/LH/	(LH)	*(LL)	

It is striking that while faithfulness to the underlying form is violated through shortening to produce an uneven (HL) trochee as in (25)a, such a violation is unacceptable in (25)b, where the result would be the putatively unmarked even (LL) trochee. Moreover, long vowels shorten in the dependent position of a foot even if the foot-head is unstressed, as shown in (26) below (see §3.2 starting on page 72 for analysis of foot structure in Central Slovak).

(26) Long vowels shorten.in the dependent position of a foot *even if non-post-tonic*

a.	/briga:d-ɲi:k/	(brí)(ga:d.ɲik)	*(brí)(gà:d.ɲik)	'brigade leader'
	/LHH/	(L)(HL)		
b.	/pis-a:r-sk-i:/	(pí)(sa:r.ski)	*(pí)(sà:r.ski)	'writer' adj.
	/LHH/	(L)(HL)		

Such evidence suggests that a reexamination of the ITL and the relative markedness of various foot types is in order. We begin in the following section by introducing the formal analysis for (HL)-creating processes.

2.2.3.1 Analysis under Head Prominence

As demonstrated in the previous section, (HL)-creating processes are problematic for the ITL, since the latter assumes the even (LL) trochee to be the optimal realisation of a trochaic foot while the uneven (HL) trochee is comparatively ill-formed. The present analysis takes issue with this claim, assuming the following constraint on syllable well-formedness, which favours (HL) to other trochaic foot types.

(27) Head Prominence(Foot) (Hd-Prom: cf. example (3) on page 4)

The head of a foot is intrinsically prominent.

Hd-Prom requires the head of a prosodic category to have greater relative prominence than dependent positions. In feet, *intrinsic* prominence is measured in terms of the relative moraicity of the constituent syllables, and is not affected by *derived* prominence resulting from the assignment of stress. Hd-Prom is violated in feet where a dependent syllable is quantitatively equal to or greater than the head syllable; the quantitatively even

(LL) and (HH) trochees violates HD-PROM, while the uneven (HL) trochee does not.[11]

In systems where HD-PROM outranks faithfulness constraints, head syllables are enhanced through the adjustment of syllable quantity to produce an uneven (HL) trochee.[12] As we have seen, an uneven (HL) trochee can be generated in two different ways — either through augmentation of a head syllable (e.g. Selayarese data in (20) above) or through truncation of a dependent syllable (e.g. the Central Slovak data in (22) above). These two patterns are given in (28) below.

(28) (HL)-creating Processes under HD-PROM

a. Trochaic Lengthening: /LL/ → (HL)

b. Trochaic Shortening: /HH/ → (HL)

As demonstrated in §2.2 above, quantitative adjustment in OT can be accounted for by ranking structural well-formedness constraints above IDENTWEIGHT. This ranking is given in (29) below.

(29) Constraint ranking for (HL)-creating processes

HD-PROM >> IDENTWEIGHT

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[11] Note that HD-PROM is distinct from STRESS-TO-WEIGHT (e.g. Riad 1992), which requires stressed syllables to be heavy without reference to relative prominence within the foot, i.e. it does not distinguish between (HH) and (HL).

[12] Hayes (1995:7 citing Carlson 1978) notes a quantitative process in Finnish emphatic stress whereby initial (LL) becomes (LH). Paul Kiparsky (p.c.) suggests that since main stress falls on the initial syllable in Finnish, this process may be driven by the desire to enhance the prominence of the head-foot of the prosodic word, by augmenting the mora count of this foot. This effect would follow straightforwardly from HD-PROM if enforced at the level of feet within the prosodic word, rather than syllables within feet (§2-3; §6) or moras within syllables (§4).

The ranking in (29) correctly predicts Trochaic Lengthening in systems like Selayarese, as shown in (30) below.

(30) Trochaic Lengthening

Input: /LL/	HD-PROM	IDENTWEIGHT
a. ☞ (HL)		*
b. (LL)	*!	

Candidate (30)b fatally violates HD-PROM because the head syllable of the foot is no more prominent than the dependent syllable. By contrast, the head syllable in (30)a is heavy and thus intrinsically more prominent than the (light) dependent syllable. Candidate (30)a is thus preferred, despite a violation of lower-ranked IDENTWEIGHT for nonidentity of syllable weight in input and output.

Since in the contexts described above HD-PROM is manifested in terms of *syllable weight,* the ranking HD-PROM >> IDENTWEIGHT demands only that the head syllable be bimoraic (cf. (30)), and not that it contain a long vowel *per se*. Indeed, bimoraicity can also be manifested as a closed syllable, a fact which grammars readily exploit in satisfaction of HD-PROM. Note that in cases where a stressed syllable is closed by a coda consonant, no augmentation takes place.

(31) No augmentation in closed syllables in Selayarese

a. (lám.pa)	*(láːm.pa)	'to go'
b. (bál.lo)	*(báːl.lo)	'beautiful'

Since coda consonants can bear a mora in Selayarese, augmentation in closed syllables is unnecessary. This is illustrated in the tableau in (32) below.

(32) No Trochaic Lengthening in closed syllables[13]

Input: /lampa/	**HD-PROM**	**IDENTWEIGHT**
a. ☞ (lám.pa)		
b. (lá:m.pa)		*!

Since the initial syllable of candidate (32)a is closed with a (moraic) coda consonant, it is heavy and thus satisfies HD-PROM. Since augmentation is unmotivated by HD-PROM, candidate (32)b fatally violates IDENTWEIGHT leaving (32)a as the optimal output.

Trochaic Shortening in systems like that of Central Slovak follows from exactly the same ranking, as shown in (33) below.

(33) Trochaic Shortening

Input: /HH/	**HD-PROM**	**IDENTWEIGHT**
a. ☞ (HL)		*
b. (HH)	*!	

Candidate (33)b fatally violates HD-PROM because both syllables are of equal prominence. Trochaic Shortening in candidate (33)a allows HD-PROM to be satisfied at the expense of lower-ranked IDENTWEIGHT.

Trochaic Shortening and Trochaic Lengthening thus differ only in how IDENTWEIGHT is violated: through deletion or insertion of a mora, respectively.

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[13] For purposes of the present discussion we abstract away from the origin of the mora associated with the coda consonant. An Optimality-Theoretic analysis of *Weight-by-Position* (Hayes 1989) is offered in §4.2.4 (starting on page 129).

2.2.3.2 Mohawk

Trochaic Lengthening generating the uneven (HL) trochee is exemplified in Mohawk, an Iroquoian language spoken in Quebec. The Mohawk data reproduced below are taken from Michelson (1988) and Piggott (1995).

Stress normally falls on the penultimate syllable in Mohawk. When the stressed penult is an open syllable, it is augmented through vowel lengthening. Examples are given in (34) below.

(34) Penultimate stress in Mohawk

a.	/wak-haratat-u/	wakharatá:tu	'I am holding it up'
b.	/wak-haratat-u-hatye-Ø/	wakharatatuhátye	'I go along lifting up'
c.	/k-atirut-ha/	katirútha	'I pull'
d.	/ʌ-k-atirut-ʌʔ/	ʌkatirú:tʌʔ	'I will pull'

The canonical pattern of penultimate stress in (34) can be captured straightforwardly in the Hayesian framework by assuming a syllabic trochee aligned with the right word-edge. The fact that stressed penults must either contain a long vowel or be closed by a coda consonant, however, is suggestive of an additional requirement, namely, that the head syllable of the foot be heavy. If word-final consonants are assumed not to contribute to syllable weight, the foot can be analysed in terms of the uneven (HL) trochee (Piggott 1998).

Additional evidence for the (HL) trochee in Mohawk comes from word-minimality requirements in this language. Inflected verb forms in Mohawk must contain at lease two syllables. Forms which contain only one underlying vowel are augmented by the insertion of prothetic /i/, as shown in (35) below (inserted material given in *italics*).

(35) Prothetic /i/ and the minimal word in Mohawk

a.	/k-kʌ-s/	(_í_k.kʌs)	'I see'
b.	/w-e-ʔs/	(_í:_.weʔs)	'She, it is walking around'

The resulting disyllabic forms receive normal penultimate stress, and if the stressed syllable is open the prothetic vowel surfaces as long. The fact that the augmentation of subminimal words is obligatorily accompanied by Trochaic Lengthening constitutes strong evidence that the canonical foot in Mohawk is the uneven (HL) trochee.

A possible objection to this analysis would be to claim that Trochaic Lengthening in Mohawk is a phonetic manifestation of stress. Such a view would predict that all stressed vowels in open syllables should undergo lengthening, but this is not the case. When an open penultimate syllable contains epenthetic /e/, stress is shifted to the antepenult and lengthening does not occur, as shown in (36) below.[14]

(36) Mohawk antepenultimate stress without Trochaic Lengthening

a.	/ʌ-k-r-ʌʔ/	ʌ́k_e_rʌʔ	'I will put it into a container'
b.	/te-k-rik-s/	ték_e_riks	'I put them next to each other'
cf. c.	/wak-ashet-u/	wakashé:tu	'I have counted it'

Examples (36)a and (36)b provide us with two pieces of evidence in support of a phonological account of Trochaic Lengthening: first, the failure of stressed open antepenults to undergo lengthening before epenthetic /e/, e.g. *_ʌ́:kerʌʔ_, *_té:keriks_, and second, the failure of epenthetic /e/ to receive stress, e.g. *_ʌké:rʌʔ_, *_teké:riks_. If

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[14] Note that an analysis of epenthetic /e/ as a (non-syllabic) transitional articulatory event is not tenable, since closed syllables containing epenthetic /e/ can bear stress, e.g. _wakényaks_ < _/wak-nyak-s/_ 'I get married', _sérhos_ < _/s-rho-s/_ 'you coat it with something'. See Piggott (1995) for discussion.

lengthening were analysed as a phonetic process, there would be no way to account for these two asymmetries. Both the differential behaviour of underlying vs. epenthetic vowels and the differential behaviour of penults vs. ante-penults require reference to phonological representations.

Trochaic Lengthening of underlying vowels in stressed open penults in Mohawk can be accounted for in terms of mora insertion with the ranking in (29), as demonstrated in (37) below.

(37) Trochaic Lengthening in Mohawk

Input:	/ʌ-k-atirut-ʌʔ/	**HD-PROM**	**IDENTWEIGHT**
a. ☞	ʌkati (rúː.tʌʔ)		*
b.	ʌkati (rú.tʌʔ)	*!	

Candidate (37)b fatally violates HD-PROM due the even (<u>L</u>L) trochaic foot in which the head syllable is no more prominent than the dependent syllable. This violation is avoided in candidate (37)a through mora insertion in the stressed syllable, creating an uneven (<u>H</u>L) trochee at the expense of lower-ranking IDENTWEIGHT.

In the case of penultimate epenthetic /e/, antepenultimate stress as well as the absence of lengthening on stressed open antepenults find straightforward explanation under HD-PROM. Noting that epenthetic /e/ in Mohawk is phonologically "weightless" (Michelson 1988, Piggott 1995), or nonmoraic, Piggott (1998) proposes the prosodic representation in (38)a for Mohawk words with penultimate epenthetic /e/ such as *(<u>té</u>.ke) riks* ((36)b) rather than that in (38)b, as one might expect. (A slashed zero represents a nonmoraic syllable.)

(38) Prosodic representation of open syllables with epenthetic /e/ (e.g. (36))

a. (LØ) L

b. *(LL) L

While both representations in (38) contain binary trochaic feet, the dependent syllable in (38)a is phonologically weightless or nonmoraic, while that in (38)b is monomoraic. This distinction has far-reaching implications both for stress placement and Trochaic Lengthening in Mohawk.

In connection with these phenomena, we assume the following constraint, demanding that the main stress foot be aligned with the edge of the prosodic word.

(39) Align-Head-Left / Align-Head-Right (Align-L/R: cf. McCarthy & Prince 1993)

The head foot of the prosodic word is aligned with the leftmost / rightmost edge of the prosodic word.

In Mohawk, Align-R is ranked below IdentWeight, as shown in (40) below.

(40) Mohawk Constraint Ranking (provisional)

Hd-Prom >> IdentWeight >> Align-R

Consider now the foot structure of words like (36)a and (36)b above, where the penult is weightless epenthetic /e/, as illustrated in (41) below.[15]

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[15] I assume epenthesis to entail the insertion of a single moraless vocalic melody in response to the interaction of syllable well-formedness constraints, the details of which are abstracted away from for purposes of the present discussion. The use of the small '*v*' to mark epenthesis sites in inputs here and in the following section is expository in nature and is not intended to suggest that epenthesis sites are

(41) Mohawk antepenultimate stress with penultimate epenthetic /e/

Input:	/L*v*L/	HD-PROM	IDENTWEIGHT	ALIGN-R
a.	L (ØL)	*!		
b.	L (*H*L)		*!*	
c. ☞	(LØ) L			*
d.	(HØ) L		*!	*

A penultimate epenthetic /e/ cannot be stressed in Mohawk, as demonstrated by the illicit representation in (41)a. This is because the (ØL) trochee violates HD-PROM, since the intrinsic prominence of the nonmoraic epenthetic vowel in head position is less than that of the monomoraic vowel in the dependent position. This problem can be resolved through augmentation of the penult as in (41)b, but this candidate is eliminated by IDENTWEIGHT due to mora insertion. Another way of avoiding a violation of HD-PROM is to shift stress to the antepenult, as in the optimal candidate (41)c, where only low-ranking ALIGN-R is violated. Recall, finally, that Trochaic Lengthening does not occur in antepenultimate stressed syllables preceding epenthetic /e/. This result follows straightforwardly from the ranking of IDENTWEIGHT above ALIGN-R, where mora insertion is tolerated iff such action improves well-formedness with respect to HD-PROM. This is not the case in (41)d, however; given a weightless dependent syllable, HD-PROM is satisfied without augmentation (cf. (41)c), and the violation of IDENTWEIGHT which augmentation incurs is fatal.

Another context for antepenultimate stress in Mohawk is where the final vowel is epenthetic /e/. Unlike cases of penultimate epenthetic /e/ discussed above, however, antepenultimate stress resulting from final epenthetic /e/ is accompanied by Trochaic

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underlyingly specified *per se*.

Lengthening. This is illustrated in examples (42)a and (42)b below.

(42) Mohawk antepenultimate stress with Trochaic Lengthening under final epenthesis

a.	/ʌ-wak-ok-ʔ/	ʌwá:kok*e*ʔ	'I will have a blister'
b.	/ka-hur-ʔ/	ká:hur*e*ʔ	'gun'
cf. c.	/yo-nake-ʔ/	oná:keʔ	'canoe'

Since Trochaic Lengthening in stressed open syllables is expected under HD-PROM when the following syllable is not weightless (see tableau (37) above), the question posed by the examples in (42) is not why lengthening occurs but why stress falls on the antepenult rather than the penult. The culprit is clearly epenthetic /e/ in the final syllable; notice that when underlying /e/ occurs in this position ((42)c), stress falls on the penult. The invisibility of final epenthetic /e/ to foot-parsing is formalized by means of the following constraint.

(43) HEAD-DEPENDENCE (HEAD-DEP: Broselow 1999; cf. Alderete 1999)
The head foot of a word may not contain an epenthetic vowel.

HEAD-DEP militates against epenthetic vocalic material within the head foot of a prosodic word. In Mohawk, HEAD-DEP is highly ranked, as shown in (44) below, and accounts for antepenultimate stress in the case of final epenthetic /e/, as shown in (45).[16]

(44) Mohawk Constraint Ranking (final)
HEAD-DEP, HD-PROM >> IDENTWEIGHT >> ALIGN-R

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[16] HEAD-DEP cannot capture cases of pre-antepenultimate stress in Mohawk, however. See Piggott (1998) and Mellander (in press b) for alternative accounts in terms of prosodic licensing.

(45) Mohawk antepenultimate stress with final epenthetic /e/

Input: /LL*v*/	HEAD-DEP	HD-PROM	IDENTWT	ALIGN-R
a. L (L*Ø*)	*!			
b. (LL) *Ø*		*!		*
c. L (H*L*)	*!		**	
d. ☞ (HL) *Ø*			*	*

Candidates (45)a and (45)c incur fatal violations of HEAD-DEP for the parsing of epenthetic segmental material into a foot, candidate (45)b is ruled out by HD-PROM, since the intrinsic prominence of the head syllable in an even (LL) trochee is no greater than that of the dependent syllable. This leaves candidate (45)d as the optimal output, despite violations of IDENTWEIGHT and ALIGN-R.

2.2.3.3 Selayarese

Another language which exemplifies phonological Trochaic Lengthening is Selayarese, introduced above. Selayarese data in this section are taken from Mithun & Basri (1986) and from Broselow (1999), who does not mark vowel length.

As in Mohawk, the minimal word in Selayarese is disyllabic and quantitatively uneven. Subminimal forms from Bahasa Indonesia, the source language for most Selayarese borrowings, are augmented through epenthesis and Trochaic Lengthening in loanword adaptation in order to satisfy this requirement, as illustrated in (46) below.

(46) Adaptation of subminimal loanwords through augmentation in Selayarese

	Bahasa Indonesia	*Selayarese*	
a.	gol	(gó:.l*o*)	'ball'
b.	per	(pé:.r*e*)	'metal spring'

This evidence suggests that the canonical foot is the uneven (HL) trochee in Selayarese as well.

As mentioned in §2.2.3 above, augmentation in Selayarese is manifested in three different ways according to context (Mithun & Basri 1986; Piggott 2001). Representative examples are given in (47) below, where suffixation is applied to two different roots.

(47) Three manifestations of (HL) in Selayarese

a. /sahala-ku/	sa.ha (lá:.ku)	'my sea cucumber'
b. /sahal-ku/	sa.ha (*lák*.ku)	'my benefit'
c. /sahal-mu/	sa.ha (*lá?*.mu)	'your (fam.) benefit'

The stressed vowel in (47)a is an underlying vowel and undergoes lengthening. This is not the case in (47)b and (47)c, however, where the stressed vowel is epenthetic. In the latter cases a contextually-determined coda consonant is inserted. When a stressed epenthetic vowel precedes an obstruent, the syllable is closed through gemination of the obstruent as in (47)b. Elsewhere, a glottal stop is inserted as in (47)c.

A unified account of these three processes is only possible under a phonological analysis of Trochaic Lengthening. On such a view, the stressed syllable is made heavy in all three cases through mora insertion resulting in an uneven (HL) trochee. This result is precisely what we would expect under HD-PROM, where feet with even prominence are dispreferred. By contrast, if lengthening in Selayarese were a phonetic process, the occurrence of gemination and glottal stop insertion in exactly the same context as lengthening would have to be viewed as accidental.

The unified analysis of (HL)-creating augmentation in Selayarese follows the same basic ranking as in Mohawk, i.e. HD-PROM >> IDENTWEIGHT, where faithfulness to underlying quantity is subordinated to the requirement that a head syllable have greater intrinsic prominence than its dependent syllable. Selayarese differs from Mohawk in a number of ways, however. Recall from (36) above that in Mohawk, penultimate epenthesis yields antepenultimate stress without augmentation. In Selayarese, however, penultimate epenthesis is accompanied by penultimate stress and augmentation, as shown in (47)b and (47)c. This distinction is explained straightforwardly by the fact that Align-R outranks IdentWeight in Selayarese, as shown in (48) below. Penultimate stress in Selayarese is illustrated in (49).

(48) Selayarese Constraint Ranking (cf. Mohawk in (44) above)

Head-Dep, Hd-Prom >> Align-R >> IdentWeight

(49) Selayarese penultimate epenthesis and stress

Input:	/L*v*L/	**Head-Dep**	**Hd-Prom**	**Align-R**	**IdentWt**
a.	L (ØL)	*	*!		
b. ☞	L (*H*L)	*			**
c.	(LØ) L	*		*!	

All three candidates in (49) incur one violation of Head-Dep since in every case the foot contains exactly one epenthetic vowel. Candidate (49)a incurs a fatal violation of Hd-Prom since the weightless head syllable does not have greater intrinsic prominence than the monomoraic dependent syllable, while candidate (49)c is eliminated by Align-R, for non-alignment of the foot with the right word edge. This leaves candidate (49)b as optimal despite two violations of IdentWeight.

Consider now the examples in (50) below, illustrating final epenthetic ((50)a and (50)b) and underlying ((50)c and (50)d) vowels in Selayarese.

(50) Selayarese epenthetic versus lexical final vowels under allomorphy

a.	/lamber/	(lám.be) *re*	'long'
	/lamber-aŋ/	lam (bé:.raŋ)	'longer'
b.	/hallas/	(hál.la) *sa*	'suffer'
	/hallas-i/	hal (lá:.si)	'make suffer'
c.	/lohe/	(ló:.he)	'many'
	/lohe-aŋ/	lo (hé:.aŋ)	'more'
d.	/ruppa/	(rúp.pa)	'face'
	/ruppa-i/	rup (pá:.i)	'confront'

Epenthetic final vowels disappear when a vowel-initial suffix morpheme is present, as illustrated in (50)a and (50)b while a final underlying vowel does not, as shown in (50)c and (50)d. As in Mohawk (cf. (42)), final epenthesis in Selayarese is also accompanied by antepenultimate stress. Except for words with clitics, antepenultimate stress in Selayarese obtains uniquely in the case of final epenthesis and is always accompanied by Trochaic Lengthening. Consider the minimal pair in (51) below where the same segmental string is prosodified differently according to whether the final vowel is epenthetic (as in (51)a) or lexical (as in (51)b), cf. suffixed forms of these roots in (47) above.

(51) Selayarese minimal pair: epenthetic versus lexical final vowels

a.	/sahal/	(sá:.ha) *la*	'benefit'
b.	/sahala/	sa (há:.la)	'sea cucumber'

The prosodification of Selayarese words with final epenthetic vowels can be accounted for with the same constraint ranking, i.e. that in (48). This is illustrated in (52) below.

(52) Selayarese antepenultimate stress with Trochaic Lengthening

Input:	/LL*v*/	**HEAD-DEP**	**HD-PROM**	**ALIGN-R**	**IDENTWT**
a.	L (LØ)	*!			
b.	(LL) Ø		*!	*	
c.	L (H*L*)	*!			**
d. ☞	(HL) Ø			*	*

Since the final syllable in (52) is epenthetic, candidates (52)a and (52)c are eliminated by HEAD-DEP since they foot the syllable. Candidate (52)b incurs a fatal violation of HD-PROM for even intrinsic prominence within the foot, leaving candidate (52)d as the optimal output. Notice that this is the same result as in Mohawk (cf. (45)); the fact that in both systems all alternative candidates are ruled out by high-ranking HEAD-DEP or HD-PROM means that the differential ranking of ALIGN-R and IDENTWEIGHT in the two systems has no effect on the outcome in this case.

Finally, an analysis of the augmentation processes in (24) requires an explanation for why inserted vowels do not undergo lengthening. Piggott (2001) attributes this to the fact that the epenthetic vowel in Selayarese is (normally) a copy of the preceding vowel. As such, the inserted vowel stands in a head-dependent relation with the vowel from which it was copied, and is thus subject to the following structural well-formedness constraint.

(53) HEAD-DEPENDENT ASYMMETRY (HDA: Dresher and Van der Hulst 1995)
A dependent cannot be more complex than a head.

In the case of vowel copy, the epenthetic copy is clearly the dependent element. Under HDA then, if the underlying vowel is monomoraic, the copy can be maximally monomoraic. This restriction prevents stressed epenthetic vowels from undergoing

Trochaic Lengthening in Selayarese, forcing the satisfaction of HD-PROM by other means.

The choice of which other means is governed by phonotactic restrictions in Selayarese. For example, coda consonants in Selayarese are restricted to glottal stop and the first half of a geminate or homorganic nasal-stop sequence, a restriction which we formalize here as the constraint in (54) below.

(54) SELAYARESE CODA CONDITION (CODACOND)

Only glottal stop or the first half of a geminate or homorganic nasal-stop sequence may occupy the syllable-coda.

Another restriction is a ban on sequences of glottal stop + voiceless obstruent (hereafter ʔC°). Not only are ʔC° sequences absent from surface forms in Selayarese, but underlying ʔC° sequences are invariably realised as voiceless geminates on the surface (e.g. */taʔ-tuda/* > *tattuda*, 'to bump against'). In the present analysis this restriction is formalized in terms of the following constraint (cf. Goldsmith 1990; see Piggott 2001 for an analysis of this restriction in terms of inter-constituent licensing).

(55) *ʔC°

Sequences of glottal stop + a voiceless consonant are illicit.

A final constraint bans geminates, and is given in (56) below.

(56) *CC

Geminate consonants are illicit.

These constraints are ranked in Selayarese as in (57) below. This ranking accounts for the three-way contrast between Trochaic Lengthening, gemination, and glottal stop insertion in (24), as illustrated in (58) below.

(57) Selayarese constraint ranking for the implementation of (HL) augmentation

CodaCond, HDA, *ʔC° >> *CC

(58) The implementation of Selayarese (HL) augmentation

		CodaCond	HDA	*ʔC°	*CC
/sahala-ku/	a. ☞ sa.ha (lá:.ku)				
	b. sa.ha (lá*k*.ku)				*!
	c. sa.ha (lá*ʔ*.ku)			*!	
/sahal-ku/	d. sa (hal.ku)	*!			
	e. sa.ha (l*á:*.ku)		*!		
	f. ☞ sa.ha (l*ák*.ku)				*
	g. sa.ha (l*áʔ*.ku)			*!	
/sahal-mu/	h. sa (hal.mu)	*!			
	i. sa.ha (l*á:*.mu)		*!		
	j. sa.ha (l*ám*.mu)				*!
	k. ☞ sa.ha (l*áʔ*.mu)				

Epenthesis ensues in order to rescue an consonant which cannot be parsed into the syllable-coda due to CodaCond, as in (58)d and (58)h where the lateral /l/ occupies coda position. In candidates (58)e and (58)i, Trochaic Lengthening of an inserted vowel is blocked by HDA, since an epenthetic copy vowel may not be more complex than the underlying vowel from which it is copied. The result is that Trochaic Lengthening is selected as an augmentation strategy only when the penultimate vowel is underlying, as in (58)a. In cases where the consonant following the inserted vowel is a voiceless obstruent, glottal stop insertion is not available due to *ʔC°, as demonstrated in (58)c and

(58)g. Consequently, this strategy is only employed when an epenthetic vowel is followed by a voiced consonant as in (58)k. Finally, geminate consonants are disfavoured, but do surface when there is no better alternative, i.e. when a penultimate epenthetic vowel is followed by a voiceless obstruent as in (58)f.

2.2.3.4 Selayarese Loanwords

A putative exception to the processes outlined in (24) is the behaviour of certain loanwords. Examples are given in (59) below.

(59) Selayarese loanwords adapted from Bahasa Indonesia

	Bahasa Indonesia	*Selayarese*	
a.	súrga	su (rú:.ga)	'heaven'
b.	rámli	ra (má:.li)	'proper name'

The medial vowels in the Selayarese forms were clearly inserted at the time of adaptation in order to syllabify the string, yet glottal stop insertion does not apply as predicted in stressed epenthetic syllables ((24)c).[17] The absence of systematic glottal stop insertion / gemination in Selayarese adapted loanwords is interpreted by Broselow (p.c.) to mean that such processes are idiosyncratic properties of the pronominal suffix morphemes rather than a general property of the language as described by Mithun & Basri (1986:239-40).[18]

This argument relies crucially on the assumption that the inserted vowels are

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[17] Broselow (p.c.) notes that there is a high degree of variability in adaptation patterns, with gemination / glottal stop insertion occasionally occurring alongside lengthening.

[18] On this view, vowel lengthening in open syllables is analysed as a phonetic manifestation of stress. Broselow (p.c.) notes that the added length of lengthened vowels is quite subtle and variable as one might expect with phonetic length, although the generalisation of penultimate heaviness in (24) is lost on such an

analysed as epenthetic in the synchronic grammar, but this is not entirely clear. The adaptation of loanwords involves the modification of source language surface forms in such a way that phonotactic constraints of the borrowing language are satisfied. Faithfulness to source language forms is clearly a consideration as well, however, and it is reasonable to assume that underlying representations constructed during the adaptation process will yield outputs that are maximally faithful to source language surface forms with respect to segmental content. In the language of Correspondence Theory, such a requirement would evaluate correspondence between segmental strings in source and adapted surface forms, as in (60) below.

(60) DEP-SEG-SA (cf. DEP-SEG-IO, BR: McCarthy & Prince 1995)
Every segment in an adapted form has a correspondent in the source form.

The constraint in (60) demands that the segmental content surface forms of adapted loanwords be harmonic to that of source forms. Accordingly, the selection of underlying representations in loanword adaptation can be understood to proceed as in (61) below.

(61) Selection of URs in Selayarese loanword adaptation

Source:	surga			**DEP-SEG-SA**
a.	/surga/	>	su (*rúʔ*.ga)	**!
b. ☞	/suruga/	>	su (rúː.ga)	*

In the case of the words in (59) above, the positing of the underlying representations */surga/* and */ramli/* would trigger synchronic epenthesis with glottal stop insertion,

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analysis.

yielding [su.*rúʔ*.ga] and [ra.*máʔ*.li], respectively. This choice, represented in (61)a results in two violations of DEP-SEG-SA — one for the vowel and one for the glottal stop. By contrast, the positing of the underlying representations */suruga/* and */ramali/* would yield surface forms with lengthened penults [su.*rúː*.ga] and [ra.*máː*.li], respectively, as in (59). This option is represented in (61)b, which crucially incurs only one violation of DEP-SEG-SA for the vowel and is thus preferred. This reasoning suggests that the penultimate vowels in (59) are underlying rather than epenthetic.

An additional argument in support of this view is one of learnability. Since not all speakers of Selayarese are bilingual, the analysis of synchronic epenthesis in words like those in (59) must be learnable on the basis of Selayarese native vocabulary and *adapted* loans, but crucially not on the basis of the original *unadapted* forms in the source language (Paradis and LaCharité 1997 and references therein). This assumption is problematic for an epenthetic analysis of the forms in (59), however, as there appears to be no evidence which would lead a learner of Selayarese to opt for an epenthetic analysis in these cases. In the Selayarese native vocabulary as well as in Mohawk, vowels are inserted at morpheme boundaries where their epenthetic status is easily recoverable through allomorphy. Stress (and in Mohawk length) can also be used to identify epenthetic vowels in certain positions, but neither of these types of evidence are present in the adapted loanwords in (59). Not only is stress penultimate as one would expect if all vowels were underlying, but the fact that the putative epenthetic vowel occurs morpheme-internally means that its epenthetic status can never be confirmed through allomorphy.[19] Nor can epenthesis be deduced from the presence of an identical vowel in

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[19] There are some cases where the existence of a morpheme-internal epenthetic vowel can be established through stress alone, e.g. *solodére* 'weld', where the final vowel is clearly epenthetic as evidenced by allomorphy, but where the antepenultimate vowel is also epenthetic, as evidenced by unexpected penultimate stress and not the antepenultimate stress which normally accompanies word-final epenthesis,

the previous syllable, as words containing identical underlying vowels in adjacent syllables occur as well, e.g. (51). Absent implicit knowledge of a loanword's original form in the source language, there is no way for a learner to distinguish between native vocabulary such as *sa(há:.la)* ((51)b) and loanword vocabulary such as *ra(má:.li)* ((59)b), and consequently no foundation for assuming that the learner would not construct parallel lexical representations — */sahala/* and */ramali/* — for these items in the synchronic grammar.

Additional support for the learnability argument comes from the adaptation of French loanwords in Kinyarwanda, a Bantu language spoken in Rwanda (Rose 1995, 1999). Kinyarwanda enforces an even more restrictive set of constraints on syllable structure than Selayarese, disallowing all coda consonants as well as branching onsets. Loanwords from source languages such as French which tolerate consonant clusters are adapted with epenthesis, as shown in (62) below. (Data from Rose 1995.)

(62) Kinyarwanda loanwords adapted from French

	French	*Kinyarwanda*	
a.	*drapeau*	darapo	'flag'
b.	*micro*	mikʷoro	'microphone'

The monomorphemic forms in (62) are used even by preschoolers, who have no knowledge of the source language (Rose p.c.). This means that lexical representations are constructed on the basis of these *adapted* forms directly from the ambient language as *native* vocabulary. Speakers may learn the origin of loanwords later, but this subsequent *explicit* learning has no bearing whatsoever on their lexical representations.

The implications of this argumentation are far-reaching. If the distinction

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cf. (51)a. See Broselow (1999:314-6) and Mellander (in press b) for analyses of such forms.

between epenthetic and underlying vowels is not learnable in certain adapted forms, then underlying vowels must be assumed for these forms in the synchronic grammar, regardless of their status at the time of adaptation.

A third argument comes from the principle of Lexicon Optimization (Prince & Smolensky 1993; Itô, Mester & Padgett 1995), according to which lexical representations are constructed in order that target outputs may be derived with minimal constraint violations. Since outputs with inserted material violate segmental faithfulness, Lexical Optimization will force the learner to build inputs from which the correct outputs can be derived without.insertion, where possible. Thus, underlying vowels are assumed in all contexts where epenthetic ones are not required to account for alternations or other phenomena. Consequently, we expect no difference between native words and adapted loanwords in the behaviour of such vowels. This prediction is borne out in the Selayarese loanword facts. The absence of glottal stop insertion in the putative epenthetic syllables in (59) is not a counterexample to the process described in (24)c where glottal stop insertion accompanies epenthesis, but rather a further exemplar of the process described in (24)a, where underlying vowels undergo Trochaic Lengthening under stress.

2.2.4 Attested Patterns in (<u>H</u>L)-Creating Processes

A final argument put forth against a phonological analysis of (<u>H</u>L)-creating processes comes from Hayes (1995) and others who have pointed out that such processes normally occur only in the main stress foot of a word. While Chimalapa Zoque, Central Slovak, and Gidabal are clear counterexamples, and the absence of secondary stress renders this distinction opaque in Mohawk and Selayarese, there are a number of systems where quantity shift is restricted to the main stress foot (e.g. Chamorro, Icelandic). Such patterns find explanation in the constraint in (63) below, which for any prosodic category (PCat) *n*, enforces HD-PROM in head position of the next higher prosodic category *n+1* (strong position), cf. the more general constraint enforcing HD-PROM in all instantiations of prosodic category *n* (HD-PROM, repeated in (64)).

(63) HEAD PROMINENCE(Head-PCat$_n$(PCat$_{n+1}$)) (HD-PROM(HD))

In strong position, the head of a prosodic category is intrinsically prominent.

(64) HEAD PROMINENCE(PCat$_n$) (HD-PROM: repeated from example (3) on page 4)

The head of a prosodic category is intrinsically prominent.

These constraints are organised according to the universal harmonic ordering in (65) below (cf. Prince & Smolensky 1993), where HD-PROM(HD) is universally ranked above HD-PROM.[20]

(65) Universal Harmonic Ordering of HD-PROM Constraints

HD-PROM(HD) >> HD-PROM

In other words, the head-foot of a PWd is understood as a special case occurrence of a foot, the head syllable of a foot as a special case occurrence of a syllable, etc. The specific formulations of (65) at the Foot and Syllable levels are given in (66) below.

(66) Universal Ranking of HD-PROM Constraints at the Foot and Syllable Levels[21]

a. HD-PROM(HD-Foot(PWd)) >> HD-PROM(Foot)

b. HD-PROM(HD-Syll(Foot)) >> HD-PROM(Syll)

In (66)a, enforcement of HD-PROM in the head foot of a prosodic word is more crucial

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[20] This ranking is derivable from absolute enforcement of Pāṇini's Theorem, where a specific constraint must precede a more general one. See Piggott (2002) on Pāṇini's Theorem and constraint rankings.

[21] A downward extension of this ranking to the moraic level is not possible since moras, as the lowest level of prosodic structure, do not have constituent elements.

than enforcement of HD-PROM in feet generally. When IDENTWEIGHT is ranked between the two constraints in (66)a, Trochaic Lengthening is predicted to occur in the head-foot of the prosodic word only, while lengthening in every foot follows from a ranking where IDENTWEIGHT is dominated by both constraints in (66)a. These results are summarized in (67) below.

(67) A Typology of (<u>H</u>L)-creating Quantitative Adjustments

	Ranking	*Domain of QA*
a.	HD-PROM(HD) >> HD-PROM >> IDENTWT	QA in every foot
b.	HD-PROM(HD) >> IDENTWT >> HD-PROM	QA in head-foot only
c.	IDENTWT >> HD-PROM(HD) >> HD-PROM	No QA

The three rankings in (67) generate the three attested patterns: QA in every foot (e.g. Central Slovak), QA in the head foot only (e.g. Icelandic), and no quantity shift. The analysis correctly rules out the existence of systems where QA is restricted to non-head feet.[22]

As we have seen, the ITL can only account for a subset of the attested quantitative processes discussed in the preceding sections. The ITL (or RH-CONTOUR) and HD-PROM make opposite predictions with regard to the type of quantity shift should occur in trochaic systems. Since both Trochaic Levelling and Trochaic Lengthening / Shortening are attested, however, an adequate analysis of quantity shift should be able to account for both processes within a single unified theory of prosody. The first step is to tease apart

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[22] Analogously, (66)b expresses a preference for enforcement of HD-PROM in the head syllable of a foot over enforcement of HD-PROM in syllables generally. Such a ranking is necessary to account for certain patterns of long-vowel diphthongization in Quebec French and Malmö Swedish (§4.5 starting on page 141), constituting independent motivation for the ranking in (65).

the specific contexts for the various processes. To accomplish this, we will now turn to an examination of quantitative processes from the perspective of language typology.

2.3 Quantitative Processes and Foot Typology

2.3.1 A Typology of Trochaic Quantitative Processes

If (HL)-creating processes are to be viewed as phonological in nature, this must be reconciled with the ITL and the existence of (LL)-creating processes in languages like Fijian. An examination of trochaic languages reveals a striking distributional asymmetry concerning the type of quantitative process which may obtain in a given language. As it turns out, (LL)-creating processes are restricted to moraic trochee systems, i.e. to those systems where feet consist of exactly two moras, as evidenced by quantitative equivalence between (LL) and (H) in the placement of stresses; (LL)-creating processes do not occur in syllabic trochee systems, where feet are left-headed but generally disyllabic, even when they contain heavy syllables.[23] Conversely, (HL)-creating processes occur only in syllabic trochee systems, as illustrated in (68) below.[24]

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[23] As pointed out by a reviewer, the fact that Trochaic Lengthening in Chamorro and historically in Italian occurs in penultimate but never antepenultimate syllables has been analysed in terms of a moraic trochee with final extrametricality (Prince 1992). This account runs into difficulty, however in words with final stress which never undergo lengthening as one would expect on a moraic trochee analysis. Moreover, the moraic trochee analysis is not corroborated by secondary stress, which is quantity-insensitive in both Chamorro (Chung 1983) and Italian (Sluyters 1990). Finally, since the location of primary stress in both systems must be lexically specified, it is conceivable that such marking is phonological rather than diacritic in character; based on the stress/length facts of the language, learners might posit weightless syllables in underlying representations, e.g. Chamorro *hígadu* /LØL/, *lugát* /LLØ/, in which case the absence of lengthening in (LØ) feet would follow straightforwardly from HD-PROM. In any event, the claim being made here is that there appear to be no unambiguous cases of moraic trochee systems (e.g. Fijian, Latin) where an (HL)-creating process is attested.

[24] /LL/ → (HL) also occurs in Gilbertese, a mora-based language (Blevins and Harrison 1999), although

(68) Trochaic Quantitative Processes by System Type

	(H̲L)-creating	**(L̲L)-creating**
Syllabic Trochee Systems	a. Mohawk Icelandic Chimalapa Zoque Selayarese Chamorro Gidabal Oromo Central Slovak	b.
Moraic Trochee Systems	c.	d. Fijian Hawaiian Tongan Middle English Abruzzese Italian Pre-Classical Latin

The breakdown in (68) suggests that the type of quantitative process a language manifests is predictable on the basis of system type. Both gaps in (68) come as a surprise and require explanation. Under the ITL, it is not immediately clear why the putative well-formedness of the even (L̲L) trochee should be enforced through quantitative processes in mora-based but not syllable-based systems. Hayes (1995) attributes the gap in (68)b to "quantity insensitivity" in syllabic trochee systems, effectively exempting such systems

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the exceptionality of this system with respect to (68) can be attributed to ternarity (see §6.3.3 starting on page 194).

from the ITL. There are problems with such an approach, however, as mentioned in §2.1.1 above. It appears then, that the crucial factor determining what type of quantitative process a trochaic language may manifest is not quantity sensitivity *per se*, but rather the level of prosodic structure — syllabic or moraic — at which maximal binarity is enforced. If this is correct, it is worth investigating the possibility that both phenomena are determined by the same set of underlying principles. This idea will be pursued in the following sections, where an account for these gaps will be developed.

2.3.2 Accounting for Typological Gaps

The restriction of (L̲L)-creating processes to moraic trochee systems is no accident, however; these systems are subject to a requirement of strict binarity at the moraic level. Mester (1994) defines such systems as those which enforce both a bimoraic minimum as well as a bimoraic maximum on foot shape, as shown in (69) below.

(69) Moraic Trochee Theory (Mester 1994:6-7)

a. Metrical feet contain a minimum of two moras.
b. Metrical feet contain a maximum of two moras.

Closely related to the familiar Foot Binarity constraint (Ft-Bin: see example (82) on page 65 below), which requires metrical feet to be binary at either the syllabic or moraic level, (69) refers to moraic analysis only. Of specific interest for our purposes is (69)b. Notice that a bimoraic maximum in moraic trochee systems provides an explanation for the existence of (L̲L)-creating processes ((68)d): a bimoraic foot maximum comes into conflict with the trimoraic status of both /HL/ and /LH/ sequences. This conflict is resolved through shortening, creating bimoraic (L̲L) trochees.

The bimoraic maximum similarly provides an explanation for the absence of (H̲L)-creating processes in moraic trochee systems ((68)c). Since uneven (H̲L) trochees are trimoraic, such feet are ill-formed in these systems and quantitative processes creating uneven trochees are consequently blocked — HD-PROM notwithstanding.

Finally, if (L̲L)-creating processes are seen to follow from a bimoraic maximum on feet, one would predict their occurrence only in systems where this constraint is enforced. This prediction is borne out: the absence of (L̲L)-creating processes in syllabic trochee systems ((68)b) follows from the absence of a bimoraic maximum on foot shape in these systems.

While the bimoraic maximum in moraic trochee systems is of central importance in understanding quantitative processes in trochaic systems generally, the analysis developed here does not conceive of this restriction as a constraint in its own right. Contra Mester's (1994) analysis where the enforcement of strict bimoraicity defines a moraic trochee system, this thesis views the bimoraic maximum in such systems as an artefact of the formal mechanism which generates the basic foot inventory. This mechanism will be developed in the following section.

2.3.3 The Basic Foot Inventory and Head Government

In the spirit of Kager (1993, 1995), the present analysis appeals to a two parametric choices: headedness (trochaic / iambic) and rhythmic unit type (syllable / mora), to generate foot types. In OT, these system types can be generated by the relative ranking of constraints on headedness and rhythmic unit type, as shown in (70) and (71), respectively.

(70) RHTYPE=T/I (cf. Prince and Smolensky 1993)

The head of a foot is associated with the leftmost / rightmost syllable.

(71) RHUNIT=μ/σ

The metrical constituents of feet are moras / syllables.

Trochaic systems are generated by ranking RHTYPE=T above RHTYPE=I, while iambic systems arise from the reverse ranking. Likewise, mora-based and syllable-based systems are generated by the relative ranking of RHUNIT=μ and RHUNIT=σ. RHUNIT=μ/σ require the metrical constituents of a foot (i.e. those which project prominence onto the metrical grid) to be moras or syllables, respectively.[25]

The maximal expansion of feet is constrained by the foot-internal governing relation in (72) below, which defines a particular structural relationship between head and dependent elements (rhythmic units, as determined by (71)).

(72) HEAD GOVERNMENT (HD-GOV: repeated from example (4) on page 5)

Dependent elements within a foot must be governed by the foot-head, which is:

a. strictly adjacent to governed positions, and

b. associated with an edge-adjacent syllable.

HD-GOV demands that dependent elements of feet be strictly adjacent to the foot-head (condition (72)a, cf. Halle & Vergnaud 1987), and that the foot-head be associated with (i.e. containing or contained within) a syllable that is adjacent to a foot-edge (condition (72)b).[26] Together these conditions ensure maximal binarity at the syllabic level, regardless of rhythmic unit type.[27]

In principle, HD-GOV applies bidirectionally, since the requirement of strict adjacency is not conditioned by directionality. In practice, however, bidirectional

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[25] In moraic systems, the free parsing of strings of moras into binary feet is restricted by *Syllable Integrity* (Prince 1976, 1980; Kager 1993), a requirement that prevents the two moras of a heavy syllable from being parsed into separate metrical feet (see also footnote on page 194).

[26] Kager (1993:394) achieves these effects through the *Anti-Lapse Filter* which bans adjacent unstressed elements within the foot (cf. §2.2.1), and the assumption of binarity in foot parsing, respectively. The latter assumption is unnecessary here.

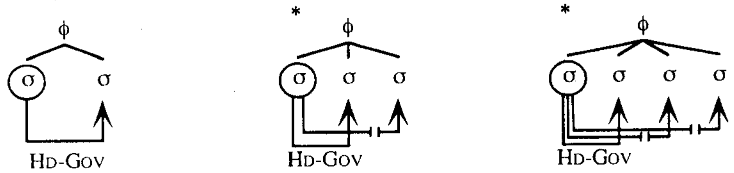
[27] See §0 (starting on page 165) on the role of HD-GOV in ternary systems.

government is only available in iambic systems (see §2.3.5, starting on page 62 below), since in trochaic systems the head element is always leftmost in the foot. This is demonstrated in the following section.

2.3.3.1 Syllabic Trochees

In syllabic trochee systems (i.e. where RhUnit=σ >> RhUnit=μ, and RhType=T >> RhType=I), Hd-Gov enforces maximal binarity at the syllabic level, as illustrated in (73) below. (The foot-head is circled and the governing relation is indicated by an arrow.)

(73) Maximal Binarity in Syllabic Trochee Systems

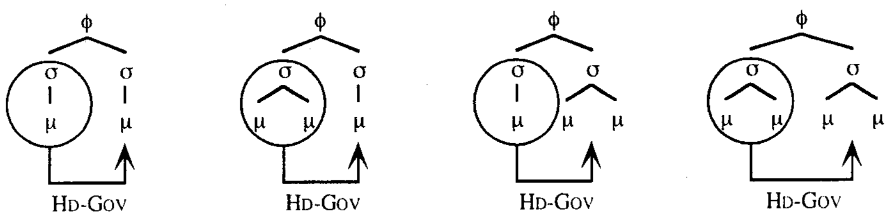


a. ($\underline{\sigma}\sigma$) b. *($\underline{\sigma}\sigma\sigma$) c. *($\underline{\sigma}\sigma\sigma\sigma$)

Since the head syllable of a trochaic foot must be situated at the left edge of the foot (a consequence of high-ranking RhType=T), only one dependent syllable can be governed. This is because only one syllable is adjacent to the head, as in (73)a; cf. the ungovernable syllables in (73)b and (73)c.

Quantity has no bearing on Hd-Gov at the syllabic level, and thus any two syllables can form a syllabic trochee irrespective of quantity. This is shown in (74) below.

(74) Binary Feet in Syllabic Trochee Systems

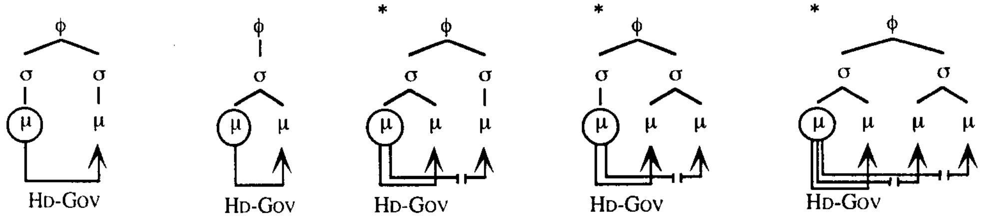

a. (L̲L) b. (H̲L) c. (L̲H) d. (H̲H)

Syllables can be grouped into a foot regardless of syllable weight, provided the adjacency requirement on governed syllables is respected. So-called 'quantity-insensitive' parsing in syllabic trochee systems follows from the fact that government holds between adjacent *syllables* rather than adjacent moras.

2.3.3.2 Moraic Trochees

In moraic trochee systems (i.e. where RhUnit=μ >> RhUnit=σ, and RhType=T >> RhType=I) the fact that government holds between adjacent moras restricts significantly the inventory of licit binary feet in such systems. It is in fact precisely this adjacency requirement which produces the effects of a bimoraic maximum, as shown in (75) below.

(75) Binary feet in a moraic trochee system


a. (L̲L) b. (H̲) c. *(H̲L) d. *(L̲H) e. *(H̲H)

Since in moraic trochee systems government holds between moras rather than syllables, strict adjacency is manifested at the moraic level. Consequently, bisyllabic feet which exceed two moras are ill-formed in such systems. Notice that only the even (L̲L) trochee

((75)a) and the single heavy syllable ((75)b) satisfy the requirement that all dependent moras be adjacent to the head.

The bimoraic maximum in moraic trochee systems is thus a consequence of HD-GOV under strict adjacency at the moraic level, and as such is exactly parallel to the bisyllabic maximum in syllabic trochee systems, which results from the enforcement of strict adjacency at the syllabic level. Consequently, there is no need for a separate constraint explicitly limiting the maximum expansion of feet, e.g. FOOTMAX (Hewitt 1994; Crowhurst 1996; Mellander 2000a, b; cf. Mester 1994).[28]

2.3.4 Trochaic Quantitative Processes and Constraint Interaction

Since HD-GOV is not violated, we place it at the top of the constraint hierarchy. HD-PROM, by contrast, is violated with every occurrence of an even (L̲L) trochee and is thus ranked below HD-GOV. Finally, as discussed in §2.2 above, the effect of quantitative adjustment is obtained through the low ranking of IDENTWEIGHT.

In syllabic trochee systems, the uneven (H̲L) trochee is well-formed under HD-GOV. Trochaic Lengthening of /LL/ → (H̲L) is predicted, provided that HD-PROM outranks IDENTWEIGHT. This is illustrated in (76) below.

(76) /LL/ → (H̲L) in Syllabic Trochee Systems (cf. (68)a)

Input: /LL/	**HD-GOV**	**HD-PROM**	**IDENTWT**
a. ☞ (H̲L)			*
b. (L̲L)		*!	

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[28] While HD-GOV ensures that feet are *maximally* binary at the syllabic or moraic level, an additional constraint is required to ensure that feet are *minimally* binary (e.g. FOOTMIN: Hewitt 1994; Crowhurst 1996; Mester 1994; cf. FT-BIN: example (82) on page 65).

Candidate (76)b fatally violates Hd-Prom because the head syllable of the foot is no more prominent than the dependent syllable. By contrast, the head syllable in (76)a is heavy and thus intrinsically more prominent than the (light) dependent syllable. Candidate (76)a is thus preferred, despite a violation of lower-ranked IdentWeight for non-identity of syllable weight in the input and output.

In moraic trochee systems, by contrast, no lengthening is possible, even when Hd-Prom outranks IdentWeight. This is illustrated in (77) below.

(77) No /LL/ → (HL) in Moraic Trochee Systems (cf. (68)c)

Input: /LL/	**Hd-Gov**	**Hd-Prom**	**IdentWt**
a. (HL)	*!		*
b. ☞ (LL)		*	

Lengthening is blocked in candidate (77)a by Hd-Gov because the third mora in an uneven (HL) trochee is not governable in a moraic trochee system (cf. (75)c). Candidate (77)b is thus optimal despite a violation of Hd-Prom.

Exactly the same mechanism accounts for /HL/ → (LL) Trochaic Levelling in moraic trochee systems, as shown in (78) below.

(78) /HL/ → (LL) in Moraic Trochee Systems (cf. (68)d)

Input: /HL/	**Hd-Gov**	**Hd-Prom**	**IdentWt**
a. (HL)	*!		
b. ☞ (LL)		*	*

Candidate (78)a fatally violates Hd-Gov, because the uneven (HL) trochee is ill-formed in a moraic trochee system This leaves candidate (78)b as optimal despite violations of Hd-Prom and IdentWeight.

Finally, (LL)-creating processes do not occur in syllabic trochee systems, as shown in (79) below.

(79) No /HL/ → (LL) in Syllabic Trochee Systems (cf. (68)b)

Input: /HL/	HD-GOV	HD-PROM	IDENTWT
a. ☞ (HL)			
b. (LL)		*!	*

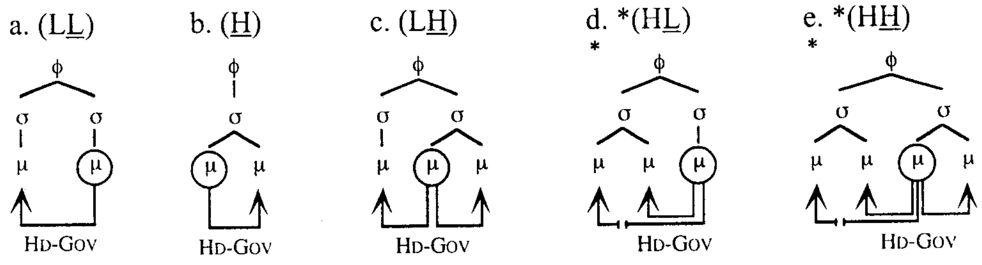
Trochaic Levelling is completely unmotivated in these systems, since the uneven (HL) trochee does not violate HD-GOV. Candidate (79)b incurs violations of both HD-PROM and IDENTWEIGHT, and is thus dispreferred to the optimal candidate, (79)a.

A formal account of the distribution of various quantitative processes in trochaic systems thus follows straightforwardly from the maximal satisfaction of HD-PROM while respecting HD-GOV. Iambic quantitative processes can also be accounted for under HD-GOV, although the formal mechanism differs somewhat from the one responsible for quantity shifts in trochaic systems. This issue will be taken up in the following section.

2.3.5 Bidirectional Government in Iambic Systems

While iambic languages conform to maximal binarity at the syllabic level, the enforcement of maximal bimoraicity in iambic systems is extremely rare, and /LH/ → (LL) quantity shifts are completely unattested. If the bimoraic maximum were a constraint in its own right, we would predict such processes in moraic iamb systems as the iambic correlate of Trochaic Levelling in moraic trochee systems. The nonoccurrence of *Iambic Levelling*, i.e. /LH/ → (LL) processes would thus have to be considered an accidental gap. On the present analysis, however, this gap follows straightforwardly from HD-GOV in conjunction with the prominence-initial mora-rhythmic profile of heavy syllables mentioned in §2.2.1 above. Taking the prominent mora as the head of a moraic iamb, this means that in final heavy syllables, the head mora of the foot is not the rightmost mora but rather the penultimate one; the iamb is thus amphibrachic at the moraic level (Kager 1993: see example (8) on page 17 above). Such feet are well-formed under Hd-Gov, since the foot-head is still syllable-adjacent to the (right) foot edge. This is illustrated in (80) below, cf. the moraic trochee feet in (75) above where the head mora is always leftmost in the foot.

(80) Bidirectional Hd-Gov in iambic systems: no bimoraic maximum



The implications of the head mora not being rightmost in the foot are significant. Recall that binarity in (moraic) trochee systems results from 1) the requirement under Hd-Gov that dependent elements be strictly adjacent to the head, and 2) the fact that head elements are always leftmost in the foot. Since there is no directionality requirement on adjacency under Hd-Gov (cf. Halle & Vergnaud 1987), a penultimate head mora can govern adjacent moras on both sides — the antepenultimate mora as well as the final mora, as shown in (80)c above, cf. (75)c. Enforcement of Hd-Gov thus leads to asymmetric predictions with regard to the maximal expansions of mora-based feet in iambic and trochaic systems.[29] It is precisely this asymmetry which accounts for the fact that while Iambic Lengthening can occur unproblematically in iambic systems, *Iambic*

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[29] Since under Hd-Gov foot-heads must be associated with an edge-adjacent syllable, bidirectional government can only occur in *moraic* and not *syllabic* iambic systems.

Levelling (i.e. the iambic analogue of Trochaic Levelling) is completely unattested.[30]

2.4 Unbounded Stress Systems

A central aspect of OT grammars is the assumption that all constraints are in principle violable. With respect to HD-GOV, this view predicts the existence of stress systems which cannot be analysed in terms of the standard inventory of foot types, and that instead require the use of other metrical constituents which fail to satisfy the requirements of HD-GOV. Reasonable candidates for such systems are represented by the so-called *unbounded* stress languages, where the placement of stress is determined solely by the location of heavy syllables rather than alternating at regular intervals (Kiparsky 1973; Prince 1976, 1983; Halle & Vergnaud 1978, 1987; Hayes 1981, 1995; Hammond 1986; Halle & Idsardi 1995; Hewitt & Crowhurst 1996; Zoll 1997 and many others).

Adapting Hayes' (1995:296-299) analysis of unbounded systems, Mellander (2002b) has shown that such systems can be analysed in terms of a violable HD-PROM constraint. What has not been established, however, is whether the facts of these systems *require* violations of HD-GOV. We will devote the remainder of this chapter to investigating this issue.

In unbounded systems, main stress follows the general pattern of 'leftmost / rightmost heavy syllable, otherwise the leftmost / rightmost syllable'. The four logical possibilities can be reduced to two formal patterns according to whether main stress in the default (light syllable) case is aligned with the same or opposite domain-edge as in the canonical (heavy syllable) case. These patterns will be analysed in turn.

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[30] Also unattested is a "quantity insensitive" iambic system, i.e. a system corresponding to the ranking RHTYPE=I >> RHTYPE=T and RHUNIT=σ >> RHUNIT=μ with phonemic quantity. While iambic languages with even (LL̲) feet do occur, as mentioned on page 14 above, such systems invariably lack heavy syllables. The present analysis cannot account for this gap, but see §5 for further discussion.

2.4.1 Default to Same

The 'default to same' pattern is exemplified by Khalkha Mongolian, where main stress falls on the leftmost heavy syllable, or on the leftmost syllable in words without heavy syllables. Representative examples are provided in (81) below. (Data from Hammond 1986:196, attributed to Street 1963.)

(81) Khalkha Mongolian main stress

a.	bariáːd	LL 'H	'after holding'
b.	xǿtəlbərə	'LLLL	'leadership
c.	xoyərdugáːr	LLL 'H	'second'
d.	garáːsaː	L 'H H	'from one's own hand'

These patterns can be captured straightforwardly under constraint interaction. In addition to HD-PROM, the core analysis requires the following two constraints.

(82) FOOT BINARITY (FT-BIN: McCarthy & Prince 1986; Prince & Smolensky 1993:47)

A foot must be binary.at some level (syllable / mora).

(83) PARSE SYLLABLE (PARSE–σ: Hayes 1981; Halle & Vergnaud 1987; Prince & Smolensky 1993:58)

Syllables must be parsed by feet.

FT-BIN requires that feet be binary at either the syllabic or moraic level and is violated by feet containing only a single mora or syllable. PARSE–σ requires syllables to be organised into feet, and is violated by unfooted syllables. The data in (81) can be accounted for by assuming that FT-BIN and HD-PROM outrank PARSE–σ. This ranking ensures that all foot-heads will be heavy (cf. the *Obligatory Branching Parameter*: Halle

& Vergnaud 1978, Hayes 1981, Hammond 1986), as illustrated in (84) below.

(84) Khalkha Mongolian foot structure: heavy foot-heads[31]

Input:	/LLLH/	**Ft-Bin**	**Hd-Prom**	**Parse–σ**
a. ☞	LLL (H)			***
b.	(L)(L)(L)(H)	*!**		
c.	(LL) L (H)		*!	*

Candidate (84)b is eliminated from consideration by Ft-Bin for sub-minimal feet, while candidate (84)c incurs a fatal violation of Hd-Prom for a foot where the head is no more prominent than the dependent syllable. This leaves candidate (84)a as the optimal output. The requirement that foot-heads be heavy is enforced through the simultaneous satisfaction of Ft-Bin and Hd-Prom.

The only exception to this requirement is in cases where there are no heavy syllables available. In such cases, violations of Hd-Prom are minimized by constructing only a single foot. The location of this foot is determined by the relative ranking of the AllFeet constraints, given in (85) below.

(85) AllFeetLeft / AllFeetRight (AllFt-L/R: McCarthy & Prince 1993a)

The left / right edge of every foot is aligned with the left / right edge of the prosodic word.

The AllFeet constraints demand that all feet within a PWd be aligned with the left / right PWd-edge, and are violated by output candidates with feet that are not aligned with

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[31] Tableau (84) assumes trochaic footing (RhType=T >> RhType=I), but this is not crucial to the analysis.

the relevant PWd-edge. By convention, violations of AllFeet are assessed incrementally, per misaligned foot and per number of syllables of misalignment. In unbounded systems, the relative ranking of AllFt-L and AllFt-R determines which PWd-edge the foot will be aligned with in words which lack heavy syllables. This is illustrated in (86) below.

(86) Khalkha Mongolian foot structure: default to leftmost syllable

Input:	/LLLL/	**Ft-Bin**	**Hd-Prom**	**Parse-σ**	**AllFt-L**	**AllFt-R**
a.	(L̲) LLL	*		***!		***
b.	LLL (L̲)	*		***!	***	
c. ☞	(L̲L) LL		*	**		**
d.	LL (L̲L)		*	**	*!*	
e.	(L̲L)(L̲L)		**!		**	**

Candidates (86)a and (86)b incur fatal third violations of Parse–σ for unfooted material. Candidate (86)e is eliminated by a second violation of Hd-Prom due to a second foot with even prominence. Candidate (86)d is ruled out by AllFt-L for non-alignment with the left PWd-edge (by two syllables), leaving candidate (86)c as optimal.

The placement of main stress in words with more than one heavy syllable is determined by Align-L >> Align-R, demanding alignment of the PWd-head with the left / right edge of the prosodic word. This is illustrated in (87) below

(87) Khalkha Mongolian main stress on the leftmost heavy syllable

Input: /LHH/	FT-BIN	HD-PROM	PARSE-σ	ALLFT-L	ALLFT-R	ALIGN-L	ALIGN-R
a. ☞ L ('H) (H)			*	***	*	*	*
b. L (H) ('H)			*	***	*	**!	

As shown in (84) above, foot structure is determined by maximal satisfaction of FT-BIN, HD-PROM, and PARSE–σ. Since the choice of which foot will receive main stress has no bearing on the position of feet, the ALLFEET constraints cannot play a decisive role here either; in (87), both candidates incur equal violations of ALLFT-L and ALLFEETRIGHT, for incremental non-alignment of the two syllables with the left / right PWd-edge, respectively. The placement of main stress is thus determined by low-ranking ALIGN-L, which selects candidate (87)a as optimal over (87)b since the main stress foot in the former candidate is closer to the left PWd-edge.

Default to same cases which refer to the right edge are the mirror image of Khalkha Mongolian, exploiting ALLFT-R >> ALLFT-L and ALIGN-R >> ALIGN-L. The formal explanation for why such systems are 'default to same' lies in the fact that the values of the relatively more highly ranked ALIGN and ALLFEET constraints match, i.e. they both require alignment to the same PWd-edge.

2.4.2 Default to Opposite

The 'default to opposite' pattern is exemplified by Amele, a Gum language of Papua New Guinea spoken by roughly 5500 according to an official 1977 estimate (Roberts 1987). In monomorphemic words, Amele main stress falls on the rightmost heavy syllable, or on the leftmost syllable in words without heavy syllables.[32] Data (from Roberts 1987:358) are provided in (88) below.

(88) Amele main stress

a.	gæ.dɔ.lɔ́h	LL 'H	'edge'
b.	nɪ́.fu.lə	'LLL	'species of beetle'
c.	ɟæ.wǽl.ti	L 'HL	'wind from north'
d.	seɪ.bʊ́l	H 'H	'war club'

As demonstrated in (86) above, the effect of left-edge default stress follows from ALLFT-L >> ALLFT-R. Main stress on the rightmost heavy syllable follows straightforwardly from ALIGN-R >> ALIGN-L, as illustrated in (89) below.

(89) Amele main stress on the rightmost heavy syllable (cf. (87))

Input: /HH/	FT-BIN	HD-PROM	PARSE-σ	ALLFT-L	ALLFT-R	ALIGN-R	ALIGN-L
a. ('H) (H)				*	*	*!	
b. ☞ (H) ('H)				*	*		*

---

[32] Roberts (1987:357-8) analyses Amele main stress as falling on the leftmost heavy syllable, but the data he provides do not support this conclusion. Crucially, there are no words listed which contain more than one heavy syllable which would corroborate this claim. Moreover, Roberts' analysis relies crucially on the assumption that the offglide in a vowel-glide sequence contributes to syllable weight word-finally, but not elsewhere. This is a rather unconventional assumption, given that cross-linguistically, postvocalic melodies which show positional asymmetries in syllable weight are generally *light word-finally* and heavy elsewhere (see e.g. Piggott 1999), but see McCarthy's & Prince's (1993c) discussion of the FINAL-C requirement for a different view.

Candidate (89)a fatally violates ALIGN-R for non-alignment of the main stress foot with the right PWd-edge, leaving candidate (89)b as optimal. 'Default to opposite' thus arise when the values of the relatively more highly ranked ALIGN and ALLFEET constraints do not match, i.e. they require alignment to different PWd-edges.

2.4.3 Discussion

Summarizing, canonical and default main stress in 'unbounded' systems are determined by the relative ranking of ALIGN-L and ALIGN-R, and of ALLFT-L and ALLFT-R, respectively, which can be reranked independently of one another to generate the four unbounded system types. The effects of *Obligatory Branching* can be achieved through constraint interaction without appeal to separate metrical constituents.

The implications of this finding are far-reaching. The fact that even unbounded stress systems can be accounted for in terms of the standard foot inventory constrained by HD-GOV means that there appear to be no stress systems which *require* HD-GOV to be violated.[33] If correct, this result poses a challenge for Optimality Theory, as it removes the evidence that HD-GOV is indeed a violable constraint rather than a universal principle of human language. HD-GOV thus becomes a counterexample to the basic tenet of the theory which holds that all constraints are in principle violable.[34]

2.5 Summary

The foregoing chapter has attempted to provide an overview of a broad range of stress

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[33] A possible exception is Pulaar, an unbounded system where patterns of vowel shortening in certain unstressed syllables appears to require unbounded feet (Prunet & Tellier 1985).

[34] The assumption of universally inviolable constraints in the absence of counterevidence follows other work in OT which appeals to *ranking markedness* to account for "apparently robustly undominated constraints across languages" (Itô, Mester & Padgett 1995:585; Prince & Smolensky 1993; McCarthy & Prince 1993b).

systems, with special emphasis on quantitative processes. The unified analysis provided here offers better empirical coverage than standard analyses, as well as a principled account of asymmetries between the manifestation of quantitative processes in trochaic and iambic systems. A cornerstone of the analysis is the principle of HD-GOV, which accounts for the basic foot inventory and the maximal expansion of various foot types. Additionally, the analysis explains the restriction of Trochaic Levelling to moraic trochee systems and the non-attestation of parallel Iambic Levelling in iambic systems. Finally, contrary to other recent proposals (Hayes 1995, Alber 1997, Kager 1993, 1995, 1999), the uneven (HL) trochee is assumed to be a well-formed phonological structure, and quantitative processes creating such feet are seen as *phonological* rather than phonetic in nature. Specifically, (HL)-creating processes occur under constraint interaction where the demands of HD-GOV and HD-PROM can be satisfied simultaneously through a quantity shift.

In the following chapter we will take a closer look at Trochaic Shortening processes, which have been argued to be linear in nature (driven by string adjacency) rather than prosodic (driven by metrical constituency), as assumed here. The chapter reviews the data from three languages in which Trochaic Shortening has been observed, including an detailed investigation of the stress system of Central Slovak.

3. TROCHAIC SHORTENING IN SLOVAK AND OTHER LANGUAGES

3.1 Introduction

One type of quantitative adjustment which has received comparatively little attention in the phonological literature is Trochaic Shortening, of which the best-described exemplar is Slovak. The *Slovak Rhythmic Law* (e.g. Dvonč 1955) is a ban on long vowels in consecutive syllables which is resolved through the shortening of the second syllable. Similar processes are observable in Gidabal (Geytenbeek & Geytenbeek 1971; Kenstowicz & Kisseberth 1979; Zoll 1992) and Oromo (Gragg 1976, 1982; Zoll 1992). In the spirit of Bethin (1998) and Mellander (2001a), this chapter takes the view that Trochaic Shortening in all three systems is a prosodically-driven phenomenon, following from HD-PROM (§2.2.3.1) — the same principle which drives Trochaic Lengthening in languages such as Mohawk (§2.2.3.2) and Selayarese (§2.2.3.3).

The chapter begins with an overview of the Slovak shortening facts in the next section, followed by a sketch of the analysis in terms of HD-PROM. We then move to a detailed examination of Slovak stress, and develop an analysis of foot parsing in Central Slovak — the dialect region where Trochaic Shortening is a synchronic phenomenon. Quantity sensitivity in foot parsing ensures that the prosodic account of Trochaic Shortening is tenable in all environments where the process is manifested. Finally, in §3.4 and §3.5 the analysis is extended to Gidabal and Oromo, respectively.

3.2 Trochaic Shortening in Slovak

Slovak is a West Slavic language spoken by some five million people in the Slovak Republic, and is described by Stanislav (1967) and Rubach (1993), among others.

Standard Slovak has six short vowels as shown in (1) below.[1]

(1)	a. Short Vowels		b. Long Vowels	
	i	u	i:	u:
	e	o	ie (e:)	(o:) uo
	ä	a	ia	a:

Long vowels in Slovak are durationally about twice as long as their short counterparts (Hála 1929). The long vowel system consists of five monophthongs and three diphthongs, although /e:/ is restricted to only a small number of morphemes and /o:/ occurs exclusively in loanwords.[2] Slovak exhibits a number of synchronic lengthening and shortening processes, where each short vowel in (1)a alternates with a corresponding long monophthong or diphthong in (1)b. Examples are provided in the following section.

3.2.1 The Rhythmic Law

Slovak's *Rhythmic Law* (hereafter RL) is a characteristic property of many Central Slovak dialects as well as the standard literary language. The RL bans the occurrence of long vowels in consecutive syllables, and is resolved through the shortening of the vowel in the second syllable of the sequence.[3] Examples are given below. (Data from Oravec & Laca 1975 and Kenstowicz & Rubach 1987.)

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[1] In addition to vocalic segments, syllable peaks in Slovak can be formed by the short syllabic liquids /r/, /l/ and their long counterparts /r:/, /l:/.

[2] Some scholars also include the diphthong /iu/ in the inventory of long vowels (Ďurovič 1973; Birnbaum 1981), although this claim is disputed in the literature (cf. Kenstowicz & Rubach 1987; Rubach 1993).

[3] There are a number of exceptions to rhythmic shortening. See Bethin (1998:219) for a summary and discussion in English. Dvonč (1955) provides a more extensive discussion of these exceptions.

(2) Underlying length preserved

a.	/vod-aːx/	vodaːx	'water' loc. pl.	O&L:25
b.	/mest-aːm/	mestaːm	'town' dat. pl.	
c.	/rol'-ɲiːk/	rol'ɲiːk	'farmer'	K&R:468
d.	/dobr-iː/	dobriː	'good'	K&R:467

(3) Underlying length shortened

a.	/vlaːd-aːx/	vlaːdax	'government' loc. pl.	O&L:25
b.	/bluːz-aːm/	bluːzam	'blouse' dat. pl.	
c.	/straːʒ-ɲiːk/	straːʒɲik	'guard'	K&R:468
d.	/muːdr-iː/	muːdri	'wise'	K&R:468

In (2), underlying long vowels surface as long when the vowel in the preceding syllable is short. Underlying length is lost, however, when the preceding vowel is long, as shown in (3).

Sequences of heavy syllables in Central Slovak demonstrate that Trochaic Shortening applies in a domain of exactly two syllables, as illustrated in (4) below.[4]

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[4] Kenstowicz & Kisseberth (1979:319-20) and Browne (1971:255) analyse rhythmic shortening in Slovak as 'iterative', i.e. applying cyclically from right to left across the word. The account is based on habituative verb forms with a long stem vowel; such forms invariably contain short vowels in the two following syllables, e.g. *tʃiitavam* < */tʃiit-aav-aa-m/* 'I read' pres. habit., cf. *volaavam* < */vol-aav-aa-m/* 'I call' habit. (For additional examples see Oravec & Laca 1975:27). These forms can be reanalysed, however. Instead of */-aav/*, Dvonč (1955:147-155; cf. Kenstowicz & Rubach 1987) analyses the habituative morpheme as */-va/*, which triggers lengthening in the preceding vowel (we might call this vowel a verb classifier morpheme), yielding *-aa* < */-a/*, *-ie* < */-e/*, *or -uu* < */-u/*. On this analysis */tʃiit-a-va-m/* > */tʃiit-aa-va-m/* by habituative lengthening > */tʃiit-a-va-m/* by rhythmic shortening, cf. */vol-a-va-m/* > */vol-aa-va-m/* with no rhythmic shortening. Significantly, habituative forms undergo rhythmic shortening in the penultimate syllable only, and crucially not in the final syllable which is short underlyingly. With respect

(4) Trochaic Shortening in a two-syllable window[5]

a.	/ba:s-ɲi:k-i:/	ba:sɲitski:	'poetic' adj.
	/H-H-H/	HLH	
cf. b.	/les-ɲi:k-i:/	lesɲi:tski	'forester' adj.
	/L-H-H/	LHL	
c.	/briga:d-ɲi:k-i:/	briga:dɲitski:	'brigade leader' adj.
	/LH-H-H/	LHLH	
cf. d.	/su:ken-ɲi:k-i:/	su:kenɲi:tski	'draper' adj.
	/HL-H-H/	HLHL	
e.	/u:st-uotʃk-a:/	u:stotʃka:	'mouth' dim. pl.
	/H-H-H/	HLH	
cf. f.	/ohɲ-iv-uotʃk-a:/	ohɲivuotʃka	'chain link' dim. pl.
	/L-L-H-H/	LLHL	
g.	/ɟievtʃ-a:t-iek-Ø/	ɟievtʃatiek[6]	'girl' dim. gen. pl.
	/H-H-H/	HLH	
cf. h.	/jehɲ-a:t-iek-Ø/	jehɲiatok	'lamb' dim. gen. pl.
	/L-H-H/	LHL	

---

to Slovak morphology, the latter analysis avoids the need to posit parallel habituative morphemes */-uuv/* and */-iev/* to account for habituative forms like *zahriakuvac* and *hovorievam*. Conversely, it provides an explanation for the coincidence that the vowel following the putative */-aav/* morpheme is always */a/*, a fact that Kenstowicz & Kisseberth capture by stipulation (pp. 319-320).

[5] Carlton (1991:242) notes a pattern of alternating length in a different morphological context, citing *hi:baɲi:* 'movement', cf. Czech *hi:ba:ɲi:*.

[6] Length in the final diphthong of (4)g is triggered by the gen. pl. null suffix morpheme (/-Ø/). Pauliny et al. (1955:70) identify dialectal variants which do not undergo lengthening in this context, e.g. *ɟievtʃatok* 'girl' dim., *za:hradok* 'garden' dim. The quality of the final vowels in (4)g and (4)h may be explicable in terms of a [back] harmony with a preceding stem vowel (see Mellander 1999), which by hypothesis only applies to monomoraic syllables.

Another important observation which can be made on the basis of the data in (4) is that shortening can occur in *any* non-initial syllable. This fact will become crucial in the prosodically-based analysis introduced in §3.2.3.3 below, because it requires foot parsing to be sensitive to syllable quantity.

3.2.2 Trochaic Shortening in L2 Czech

The view that Trochaic Shortening is a synchronically active process is supported by evidence from Central Slovak speakers of Czech, a closely related language where rhythmic shortening does not occur. Jakobson (1931/1962:226 footnote) notes that such speakers have difficulty recognizing Czech length contrasts in syllables following long vowels.

This neutralisation effect extends to production as well, as evidenced in (5) below. A native of Central Slovakia, Peciar (1946:146) reports difficulty producing consecutive long vowels in Czech words when inattentive or fatigued.

(5) Rhythmic shortening in L2 Czech (Peciar 1946:146)

	Standard Czech		*Peciar's Czech*		
a.	da:.va:.me	HHL	da:.va.me	HLL	'give' 1. pl. imperf.
b.	spi:.va:.ɲi:	HHH	spi:.va.ɲi:	HLH	'singing' n.
c.	ja:.sa:.ɲi:	HHH	ja:.sa.ɲi:	HLH	'rejoicing' n.
d.	zi:s.ka:.va:.ɲi:	HHHH	zi:s.ka.va:.ɲi	HLHL	'gaining' n.

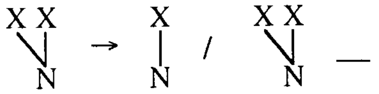
Under such conditions, Peciar displays a tendency to shorten alternating long vowels in Czech words with consecutive length, in accordance with the Slovak Rhythmic Law — this despite having lived in a Czech-speaking environment for nine years, and having otherwise mastered the language.

3.2.3 Analysis of Trochaic Shortening in Slovak

3.2.3.1 Previous Analyses

Recent treatments of Slovak have formalized the RL in terms of skeletal positions, where a rule of shortening removes an X-slot from the target vowel (Kenstowicz & Rubach 1987; Rubach 1993). In (6) below, a bipositional nucleus is shortened following another bipositional nucleus.

(6) Rhythmic shortening in skeletal theory (Kenstowicz & Rubach 1987:481)



The rule in (6) is assumed to apply from left to right across the word and refers to a specific tier of syllable structure — the nuclear tier. Intervening consonants in onset or coda position are thus unaffected by the rule. Since consonants do not contribute to syllable weight in Slovak, however, a more general statement of rhythmic shortening can be made by appealing to moraic theory.[7] Since syllables with long vowels constitute the only heavy (bimoraic) syllables in Slovak, the RL can be expressed as a ban on adjacent heavy syllables (Peciar 1946; Birnbaum 1981).[8] The rule of rhythmic shortening can thus be formulated as in (7) below

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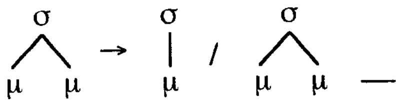
[7] The are two pieces of evidence for weightless coda consonants in Slovak: firstly, CVC syllables behave as short in quantitative processes in Slovak (Rubach 1993:636) and, secondly, CVC syllables do not possess the stress-attracting power of CVV syllables (see §3.3.1).

[8] Birnbaum (1981) argues that the two melodies of Slovak rising diphthongs do not form a single (nuclear) constituent, but rather, are split between onset and nucleus. Such data is potentially problematic for the rule in (6) which would assume the pre-peak onglide of a rising diphthong to be a nuclear constituent. The facts of Slovak diphthongs are discussed in greater detail in §4.3.1 (starting on page 133).

(7) Rhythmic shortening in moraic theory



The structural description for both formulations of rhythmic shortening is a two-syllable window, a fact which has prompted some theorists to take the position that the domain for rhythmic shortening is the metrical foot (Pauliny et al. 1955, 1968; Bethin 1998; Mellander 2001a, 2002b).[9] We will pursue this line of investigation in the following section. In §3.3.2 (starting on page 90) it will be demonstrated that the metrical structure required to analyse Trochaic Shortening is independently-needed to account for the distribution of stresses.

3.2.3.2 Trochaic Shortening and the WSP

Pauliny et al. (1955, 1968) propose that shortening occurs in response to a ban on feet *(taktá)* of the shape (H̲H). This idea is elaborated on by Kenstowicz & Rubach (1987:481 footnote) who — while ultimately rejecting a metrical analysis — note that:

> "... Slovak rhythmic shortening could be interpreted as a side effect of the construction of left-headed binary feet. Since the recessive position in a foot may not branch, the second of two long syllables will shorten."

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[9] In a detailed examination of patterns of quantity distribution in Slovak as well as Czech, Scheer (to appear) posits a morphological condition on the two-syllable domain of rhythmic shortening: the RL is argued to hold between the morphological head of a structure and an affix, subject to parametric directionality to account for the lack of shortening in Czech suffixes. Such an approach is intriguing, as it accounts for a broader range of facts than those traditionally understood to be governed by the RL. With regard to the Central Slovak facts under discussion here, the present *prosodic* account of rhythmic shortening requires no morphological conditioning or parametrization.

This proposal can be understood in terms of the following constraint on prosodic well-formedness:

(8) WEIGHT-TO-STRESS PRINCIPLE (WSP: Prince 1992)
Heavy syllables bear stress.

On this view, Trochaic Shortening forestalls violations of the WSP by removing heavy syllables from unstressed positions. This is formalized by ranking the WSP above the relevant faithfulness constraint. Consider the constraints in (9) and (10) below.

(9) MAX-μ (McCarthy & Prince 1995)
Every mora in the input has a correspondent in the output.

(10) DEP-μ (McCarthy & Prince 1995)
Every mora in the output has a correspondent in the input.

A violation of MAX-μ is incurred when an underlying mora is not realised in the output (mora deletion), while a violation of DEP-μ is incurred when an output contains an inserted mora (cf. IDENTWEIGHT, example (10) on page 18).

In (11) below, the constraint ranking WSP >> MAX-μ is applied on an input containing two heavy syllables (e.g. the forms in (3)).[10]

---

[10] Since the RL does not *lengthen* alternate syllables in Slovak, we assume DEP-μ to be highly ranked (see §3.2.3.3, starting on page 81 below). We further assume RHTYPE=T and to be highly ranked as well (see §3.3.2.2 starting on page 94).

(11) Trochaic Shortening on a WSP analysis

Input: /HH/	**WSP**	**MAX-μ**
a. ☞ (HL)		*
b. (HH)	*!	

Candidate (11)b fatally violates the WSP since it contains an unstressed heavy syllable. In candidate (11)a, however, this violation is avoided as the unstressed syllable has been made light, triggering a violation of MAX-μ. Since the WSP outranks MAX-μ, candidate (11)a emerges as optimal.

A WSP-driven analysis is not tenable, however, as evidenced by the fact that unstressed heavy syllables do surface; shortening occurs *only* after heavy syllables. This is illustrated in (12) below, repeated from example (25) (page 28) in the previous chapter but with stress marked.

(12) Post-tonic long vowels shorten *only* after heavy syllables

a. /baːs-ɲiːk/	(báːs.ɲik)	*(báːs.ɲiːk)	'poet'
/HH/	(HL)	*(HH)	
b. /les-ɲiːk/	(lés.ɲiːk)	*(lés.ɲik)	'forester'
/LH/	(LH)	*(LL)	

Observe that in (12)a above, shortening applies normally following a heavy syllable. This contrasts sharply with (12)b, where shortening fails to occur. If the WSP were responsible for rhythmic shortening within the foot, we would expect shortening to occur in (12)b as well, yielding an even *(LL) trochee, an ungrammatical result here. This is illustrated in tableau (13) below.

(13) Shortening incorrectly predicted after light syllables

Input: /LH/	WSP	MAX-μ
a. ☞ (L̲L)		*
b. (L̲H)	*!	

Since the WSP does not refer to prosodic structure, it is violated by unstressed heavy syllables regardless of their environment. Tableau (13) thus functions exactly parallel to tableau (11) above, except that it generates an ungrammatical output.[11]

The fact that rhythmic shortening creates *uneven* trochees as in (12)a but fails to create *even* ones as shown in (12)b is problematic for the standard (e.g. Hayes 1995) view that even (L̲L) trochees are *less marked* than uneven (H̲L) ones.[12] This fact finds straightforward explanation on the HD-PROM analysis advanced in this thesis, where the relative markedness between these two feet is dependent on system type. On such a view the rhythmic preference for even (L̲L) trochees holds in mora-based systems only (§2.3.4; see also §5).

3.2.3.3 Trochaic Shortening in Prosodic Terms

Bethin (1998) understands Trochaic Shortening in Slovak as a syllable enhancement strategy. By creating uneven (H̲L) trochees, shortening introduces a quantity opposition between metrically strong and weak syllables, as shown in (14) below.

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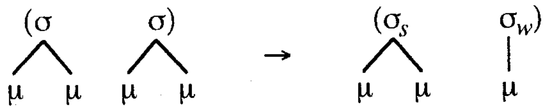
[11] Note that while the heavy syllable in (12)b and (13)b is footed, it does not bear stress.

[12] Stanislav (1958:629) identifies an interesting process in West Gemer dialects of Central Slovak where quantity transfer occurs changing /LH/ to ("H̲L), e.g. *smu:tni* (cf. Std. Sk. *smutni:* 'sad' masc. anim. pl.), *z wo:tʃi* (cf. Std. Sk. *z otʃi:* 'from the eyes'). Krajčovič (1988:267) identifies the same process in the Ipel' dialect: *powne* (cf. Std. Sk. *plni:* 'full'), *no:ʒik* (cf. Std. Sk. *noʒi:k* 'knife' dim.). Unfortunately, data for longer words, e.g. the behaviour of /LHLH/ is not reported. Nevertheless, a process which changes /LH/ to ("L̲L), e.g. **smutni, *z otʃi, *poni, *noʒik* is unattested in Slovak.

(14) Slovak Trochaic Shortening as syllable enhancement (Bethin 1998:151)



This opposition enhances the relative prominence of the head syllables of feet, thereby reinforcing trochaic metrical structure.[13] This process can be accounted for straightforwardly in terms of HD-PROM, repeated below.

(15) HEAD PROMINENCE(Foot) (HD-PROM: repeated from example (27) on page 29)

The head of a foot is intrinsically prominent.

Recall from §2.2.3.1 in the previous chapter that by requiring the head of a foot to have greater intrinsic prominence than dependent positions, HD-PROM favours quantitatively uneven feet such as the (HL) trochee to quantitatively even ones such as the (LL) trochee. As in Mohawk (§2.2.3.2) and Selayarese (§2.2.3.3), a ranking of HD-PROM above faithfulness constraints accounts for Trochaic Shortening creating an uneven (HL) trochee in Slovak, as illustrated in (16) below, cf. example (33) in the previous chapter (page 32).

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[13] Bethin (1998:151) notes " ... I think that the Rhythmic Law is not quantity-based as much as it is intensity-based, though the intensity is realized by syllable length [...] if quantity were the basis for metrical rhythm in Slovak, then one might expect the first of two long syllables to shorten, thereby producing an iambic (quantity-based) rhythm."

(16) Trochaic Shortening after a heavy syllable

Input: /HH/	**HD-PROM**	**MAX-μ**
a. ☞ (HL)		*
b. (HH)	*!	

Candidate (16)b fatally violates HD-PROM because both syllables in the foot have equal intrinsic prominence, leaving candidate (16)a as the optimal output despite a violation of MAX-μ for mora loss.

In contrast to MAX-μ, DEP-μ is highly ranked in Slovak, and cannot be violated to satisfy HD-PROM. Consequently, Slovak tolerates feet of the shape (LL) despite the fact that such feet violate HD-PROM, e.g. *kniha* 'book' **kniːha*. This result is illustrated in (17) below.

(17) No Trochaic Lengthening in Central Slovak

Input: /LL/	**DEP-μ**	**HD-PROM**	**MAX-μ**
a. (HL)	*!		
b. ☞ (LL)		*	

Candidate (17)a fatally violates DEP-μ due to mora insertion and is thus ruled out in favour of candidate (17)b, despite a violation of HD-PROM.

When a heavy syllable follows a light syllable, however, shortening is correctly predicted not to apply, as shown in (18) below.

(18) No Trochaic Shortening after a light syllable[14]

Input: /LH/	**DEP-μ**	**HD-PROM**	**MAX-μ**
a. (LL)		*	*!
b. ☞ (LH)		*	

Trochaic Shortening applies *only* when the faithfulness violation entailed by mora deletion would improve well-formedness with respect to HD-PROM. Since both candidates in (18) violate HD-PROM, the added violation of MAX-μ in candidate (18)a is unmotivated, leaving (18)b as the optimal output.[15]

The HD-PROM analysis developed so far accounts for the effects of Trochaic Shortening within trochaic feet in the appropriate contexts. For the argument to go through, however, it must be demonstrated that *all* syllables which undergo shortening under the RL are indeed in the dependent position of a foot. The facts of Slovak stress are of utmost importance in determining the position of feet, and will be introduced presently.

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[14] Another potential candidate is (HL), where a mora is simply transferred from the second to the first syllable. This candidate would satisfy HD-PROM without incurring a fatal violation of DEP-μ, since the inserted mora in the first syllable of the output would correspond to the deleted mora in the second syllable of the input, as shown below.

Such a pattern is actually attested dialectically (see footnote on page 81), and is assumed to be blocked here by a constraint on quantity transfer.

[15] One could argue, however, that (LL) is *less ill-formed* than (LH) with respect to the HD-PROM, since the head is not *less prominent* than the dependent, cf. HDA (example (53) on page 43). I am unaware of any data which compel a gradient interpretation of HD-PROM, and thus the issue is not explored here.

3.3 The Slovak Stress System

3.3.1 Stress and Quantity Sensitivity in Slovak

In Standard Slovak, as in Czech, primary stress is fixed on the first syllable. The facts of Slovak secondary stress are less clear, however. Most prescriptive grammars place secondary stress on alternating syllables after primary stress. Kochik (1971:15 attributed to Stanislav 1967:692-6) provides the following examples:

(19) Alternating secondary stress

a.	"kɲiha	'book'	"LL
b.	"hovo 'ric	'speak' inf.	"LL 'L
c.	"spolu 'hla:ska	'consonant'	"LL 'HL
d.	"tʃesko 'sloven 'sko	'Czechoslovakia'	"LL 'LL 'L
e.	"bespod 'mieɲetʃ 'ne:ho	'unconditional' gen. sg. nonfem.	"LL 'HL 'HL

Pauliny et al. (1955:72) differ from Kochik in that they do not mark secondary stress on word-final syllables, leaving trisyllabic words without secondary stress as shown in (20)a and (20)b below. 5-syllable words are marked with penultimate stress as shown in (20)c and (20)d below.

(20) Slovak stress (Pauliny et al. 1955:72)

a.	"jeseɲe	'autumn' gen. sg.	"LLL
b.	"koɲi: tʃka	'hobby' dim.	"LHL
c.	"demokra 'citski:	'democratic'	"LLL 'LH
d.	"univer 'zita	'university'	"LLL 'LL

No mention is made of quantity, which is assumed to play no role in the stress system of literary Slovak. This is demonstrated by Pauliny (1997:31) with the example in (21) below, where a heavy syllable is flanked by two stressed light syllables.

(21) Slovak stress (Pauliny 1997:31)

a.	"briga:d 'ɲitsi	‘brigade leader’ nom. pl.	"LH 'LL

Still another pattern is provided by Král’ (1988:164), who marks antepenultimate secondary stress in 5-syllable words while penults and final syllables receive no secondary stress, as shown in (22) below.

(22) Slovak stress (Král’ 1988:164)

a.	"predpo 'kladaju:	‘assume’ 3. pl.	"LL 'LLH
b.	"para 'zititski:	‘parasitic’	"LL 'LLH

Rather than offering a strict set of parameters for the location of secondary stress in Slovak, Král’ (1988:164) gives a rather general definition of secondary stress, suggesting that while there are broad tendencies regarding its occurrence, these are not hard and fast:

> “Secondary stress is understood as a smaller accentuation of the third syllable of four-syllable words, the third or penultimate syllable of longer words, or generally any raising and strengthening of the voice in that particular measure.”[16]

The passage suggests that while there are recoverable acoustic correlates of secondary stress, its location is not *predictable.*

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[16] “Za vedl’ajší prízvuk sa pokladá menšie zvýraznenie tretej slabiky štvorslabičných slov, tretej alebo predposlednej slabiky dlších slov, alebo vôbec ďalšie zvýšenie a zosilnenie hlasu v tom istom takte.”

There are two factors which contribute to the uncertainty about the location of secondary stress: dialectal variation and interference from prescriptive grammars. Stanislav (1958:619) identifies alternating stress as the correct stress pattern for the standard *literary* language. However, this pattern is not representative of all Slovak dialects, and in particular it is not representative of Central Slovak, where rhythmic shortening occurs synchronically.

> "In reality, [the pattern of alternating stress] obtains only in the West Slovak dialect, consistent with the [stress pattern of] Czech."[17]

This poses a problem for our investigation of the RL. Recall that while the RL is part of the standard literary language, in synchronic grammars it is enforced in Central Slovak dialects only. Standard literary Slovak thus combines a quantitative process (the RL) from one dialect area (Central Slovak) with the stress system from another (West Slovak). Significantly, Krajčovič (1988) in an extensive study of Slovak dialectology does not list a single West Slovak dialect where effects of the RL are attested. It is likely that this gap is not an accidental one, given the strong relationship between quantity and stress cross-linguistically (cf. the WSP). In other words, the absence of a West Slovak dialect where Trochaic Shortening is attested suggests a potential incompatibility between these two.[18] In light of this, we shift the focus now to the stress system of Central Slovak.

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[17] "V skutočnosti tento stav je u nás len v západoslovenskom nárečí, a tu je zhodný s českým jazykom."

[18] Uhlár (1941/1942) makes a similar claim, citing the contradiction between phonologically heavy diphthongs and the prescriptive rule that they be pronounced 'short' (e.g. Bělič et al. 1964:12, 26). This view is supported by acoustic data from Hála (1929), whose measurements indicate that the diphthong /uo/ is durationally equivalent to long monophthongs.

In contrast to the quantity-insensitive West Slovak stress system described above, there is evidence that quantity does play a role in the stress system of Central Slovak. Stanislav (1958:619) notes that while the precise relationship between stress and quantity in Central Slovak is not entirely clear, he identifies a general (but not exceptionless) tendency for heavy syllables to attract stress. Liška (1942/1943, 1944, cited in Dvonč 1955:224-5) observes that heavy syllables attract stress in certain dialects of northeastern Zemplín, and argues that historically the disassociation of quantity and stress never reached the same degree in Central and Eastern Slovak as in Czech or Western Slovak.

In his discussion of Central Slovak quantity, Novák (1933-1934:157) notes a contrast between long and short vowels in stressed penultimate syllables. Under emphasis, main stress can be optionally shifted from the initial syllable to the penult, where it can be strengthened to receive a phrasal accent. Under such conditions, penults containing long vowels receive a perceptibly stronger phrasal accent than those containing short vowels.

Finally, the role of quantity in Central Slovak stress is supported by empirical evidence collected from a 20-year-old native of Banská Bystrica, given in (23) and (24) below.[19]

(23) Stress in all odd-numbered syllables

a.	"kɲiha	'book'	"LL
b.	"ekspe 'rimen 'tuje	'he/she experiments'	"LL 'LL 'LL
c.	"stra:ʒɲik	'guard'	"HL
d.	"para 'zitits 'ki:	'parasitic'	"LL 'LL 'H

---

[19] Data from two interviews conducted by the author in January and March 2000. The informant was given a list of words and asked to tap out rhythms for each word. Thanks to Colleen Fitzgerald for suggesting this methodology, which is discussed in detail in Fitzgerald (1997).

e.	"u:rad 'ɲi:ka	'bureaucrat' gen. sg.	"HL 'HL
f.	"les ɲi:k	'forester'	"LH

The informant identified a pattern of alternating stress on odd-numbered syllables in words with no heavy syllables ((23)a and (23)b) in words where heavy syllables occur in odd-numbered syllables ((23)c, (23)d, and (23)e), and in disyllabic words of the /LH/ shape ((23)f). This pattern is interrupted, however, where heavy syllables appear in even-numbered non-final positions, as shown in (24).[20]

(24) No stress following a heavy peninitial syllable

a.	"pretxa:dza 'ju:tsej	'preceding' gen. sg. fem.	"LHL 'HL
b.	"briga:dɲi 'ka	'brigade leader' gen. sg.	"LHL 'L
c.	"aku:tɲi	'acute'	"LHL
d.	"opu:ʃca 'ju:	'abandon' 3. pl. perf.	"LHL 'H

Third syllables are consistently unstressed when preceded by a heavy syllable in (24) (cf. the literary Slovak pattern in (21)). This contrasts with the data in (23), however, where stress falls on all odd-numbered syllables. The difference between the two patterns can only be attributed to quantity-sensitivity in the stress system of Central Slovak; an alternating pattern obtains only as long as quantity occurs in odd-numbered syllables.[21] Such data support Bethin's (1998) view that quantity reinforces rhythmic organisation in

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[20] The informant was uncertain as to whether the second syllable is stressed in the words in (24). This contrasts with judgements of secondary stress on other syllables in the same words (e.g. (24)a), however, and thus I do not mark stress here.

[21] Štefan Beňuš (p.c.), a native speaker born in Banská Bystrica, reports rhythmic shortening with quantity-insensitive stress in his dialect. Clearly, more extensive fieldwork needs to be done in order to gain a more complete picture of the range of variability in the stress systems of Central Slovak dialects.

Slovak.

The implications of quantity-sensitivity for an analysis of Trochaic Shortening in Slovak are far-reaching. The fact that syllable quantity affects the location of secondary stresses in Central Slovak entails that quantity plays a role in the mechanism by which strings of syllables are parsed into feet. Given that adjacent heavy syllables do not occur in Central Slovak, it is reasonable to assume under quantity-sensitive parsing that every non-final heavy syllable heads a disyllabic foot. Consequently, every post-heavy syllable is in the dependent position of a trochaic foot and subject to Trochaic Shortening under HD-PROM. Since the secondary stress facts of Central Slovak independently require some kind of parsing algorithm, and since HD-PROM is independently motivated in other languages, the present analysis accounts for the effects of the RL without having to posit synchronic rule of shortening based on string adjacency, such as those in (6) and (7) above. The formal mechanism for foot parsing in Central Slovak will be developed in the following section.

3.3.2 Analysis of Trochaic Shortening and Stress in Central Slovak

3.3.2.1 Stress Clash and Stressless Feet

A preliminary descriptive analysis of the data in (23) and (24) is instructive. It appears that the canonical pattern of footing involves an iterative parse of syllables into trochaic feet starting from the left word edge. This yields a pattern of alternating stress, which is interrupted when the peninitial syllable is heavy. In such cases, the stress resumes on the fourth syllable. The ten stress patterns in (23) and (24) are given in (25) below, along with the foot structure which generates them.

(25) Central Slovak foot structure

a.	"kɲiha	"LL	("L̲L)
b.	"stra:ʒɲik	"HL	("H̲L)

c.	"ekspe 'rimen 'tuje	"LL 'LL 'LL	("L̲L) ('L̲L) ('L̲L)
d.	"para 'zitits 'ki:	"LL 'LL 'H	("L̲L) ('L̲L) ('H̲)
e.	"u:rad ’ɲi:ka	"HL 'HL	("H̲L) ('H̲L)
f.	"les ɲi:k	"LH	("L̲H)
g.	"pretxa:dza 'ju:tsej	"L HL 'HL	("L̲) (H̲L) ('H̲L)
h.	"briga:dɲi 'ka	"L HL 'L	("L̲) (H̲L) ('L̲)
i.	"aku:tɲi	"L HL	("L̲) (H̲L)
j.	"opu:ʃca 'ju:	"L HL 'H	("L̲) (H̲L) ('H̲)

A question remains as to why the second syllable is unstressed in examples (25)g through (25)j, despite appearing in the head position of a foot. The answer is that Slovak does not tolerate stress clash. Despite quantity-sensitivity, adjacent stresses within a word never occur in Slovak. In fact, Slovak's intolerance of clash is so strict that it even applies across word boundaries. Stanislav (1958:618) points out that secondary stress on a final syllable when uttered in isolation is removed in connected speech in contexts where a stressed syllable follows, as illustrated in (26) below.

(26) De-stressing in clash (Stanislav 1958:618)

a.	"utʃi 'tel’	‘teacher’	"LL 'L
b.	"utʃitel’ "kazal ...	‘The teacher ordered ...’	"LLL "LL
cf. c.	*"utʃi 'tel’ "kazal ...		*"LL 'L "LL

The prohibition on stress clash follows from the following constraint, which is highly-ranked in Slovak.

(27) *CLASH (Pater 1995; Alber 1997; cf. Prince 1983)

Adjacent syllables must not bear stress.

*CLASH has the effect of removing a grid mark from the weaker of two stresses in clash contexts. The removal of a grid mark, however, does not necessarily imply de-footing. Indeed, the decoupling of constituency and grid prominence in foot structure has been exploited by a number of theorists in recent years to account for metrical phenomena which require the presence of feet but where stress is not observable (Halle & Vergnaud 1987; Hewitt 1991, 1992; Crowhurst 1991, 1996; Crowhurst & Hewitt 1995; Van de Vijver 1998; Mellander 2001a). On this view, the acoustic correlates of stress are a sufficient, but not a necessary condition for establishing the presence of a foot. In Slovak, *CLASH prevents the placement of a grid mark (i.e. stress) on the head syllable of a foot in clash contexts, as illustrated in (28) below.

(28) Clash Resolution: constituency without grid prominence

(grid theoretic representation of example (25)h)

```
                   ✗a.  *                    ✓b.  *
                        *    *       *            *              *
                       ------------------        ------------------
/L H  -  H - L/        ("L) ('H  L) ('L)         ("L) (H  L) ('L)
/briga:d-ni:k-a/        bri  ga:d ni  ka          bri  ga:d ni  ka
```

The representation in (28)a is ill-formed because it contains adjacent stressed syllables. The grid mark projected over the second syllable must therefore be removed, as shown in (28)b. Even without overt stress, however, the second and third syllables in (28)b are grouped into a foot. Notice that the third syllable is (28)b is unstressed. This contrasts with the canonical alternating pattern, exemplified in (29) below, where the third syllable bears stress:

(29) Canonical alternating stress

(grid theoretic representation of example (25)d)

```
                       *
                       *       *      *
                      -------------------
/L L L -  L - H/      ("L  L) ('L  L) ('H)
/parasit-ick-i:/        pa  ra  zi tic  ki:
```

The contrasting stress patterns between (28)b and (29) indicate a difference in the prosodic organisation of the two words.

Finally, the third syllable in (28)b undergoes shortening. If one assumes the presence of a foot this effect follows straightforwardly as Trochaic Shortening under HD-PROM. If, on the other hand, one rejects the presence of a foot because of the absence of stress, the observed shortening requires additional explanation.

The occurrence of headless feet is restricted by the following constraints.

(30) PARSE-HEAD (PARSE-HD: Van de Vijver 1998:45; cf. FOOT-TO-HEAD: Crowhurst 1996:417)[22]

The head of a foot must be realised on the metrical grid.

PARSE-HD demands that foot-heads project a grid mark onto the metrical grid, and is violated by output candidates containing unstressed feet. In the analysis of Central Slovak that follows, we will assume PARSE-HD to be ranked low in the constraint hierarchy.

A second constraint bearing on headless feet is that in (31) below.

(31) HEAD VISIBILITY (HD-VIS: cf. HD-PROM: example (27) on page 29)

The head of a foot is overtly prominent.

Similar to HD-PROM, HD-VIS requires feet to be *overtly* prominent rather than *intrinsically* prominent. Overt prominence differs from intrinsic prominence in that it

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[22] Given PARSE-HD and the special relationship between foot-heads and heavy syllables with regard to HD-PROM, it is not inconceivable that the WSP (example (8) on page 79) could be done away with entirely. This idea is not pursued here.

looks beyond the internal structure of the foot and considers prominence on the grid as well. HD-VIS is thus satisfied by all feet whose heads project grid prominence. Since prominence is a relative notion, however, HD-VIS is additionally satisfied by stressless feet in which the head syllable is prominent with respect to a dependent syllable of lesser intrinsic prominence, e.g. a stressless (<u>H</u>L) trochee. In grammars where PARSE-HD is ranked low and HD-VIS is ranked high, stressless feet must be quantitatively uneven. This is precisely the situation in Central Slovak.[23]

The specific constraints and constraint ranking which constitute the parsing mechanism in Central Slovak will be developed in the following section.

3.3.2.2 Additional Constraints

The following constraint, when highly ranked, ensures the exhaustive parsing of syllables into feet, and is given in (32) below.

(32) PARSE SYLLABLE (PARSE–σ: repeated from example (83) on page 65)
Syllables must be parsed by feet.

PARSE–σ is violated by every syllable in the output which is not grouped into a metrical foot.

Additionally, the fact that stress iterates in sequences of light syllables creating feet which violate HD-PROM, there must be a high-ranking constraint which limits foot size to a maximum of two syllables. This constraint is HD-GOV, repeated below.

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[23] Similar facts obtain in Choctaw, an iambic system with stressless feet, but where (L<u>L</u>) does not occur (Lombardi & McCarthy 1991; see also §2.2.1.1 on page 20).

(33) Head Government (Hd-Gov: repeated from example (4) on page 5)

Dependent elements within a foot must be governed by the foot-head, which is:

a. strictly adjacent to governed positions, and

b. associated with an edge-adjacent syllable.

When Hd-Gov and Parse–σ outrank Hd-Prom, the result is iterative footing, even if feet fail to satisfy Hd-Prom.

Another important constraint is Ft-Bin, repeated in (34) below.

(34) Foot Binarity (Ft-Bin: repeated from example (82) on page on page 65)

A foot must be binary.at some level (syllable / mora).

Ft-Bin is ranked low in Central Slovak, as it is systematically violated in polysyllabic words with initial LH, which are parsed into separate feet, e.g. (25)g through (25)j above. Finally, since metrical feet in Central Slovak are trochaic, we assume RhType=T >> RhType=I (see §2.3.3 starting on page 56).

The proposed constraint ranking for rhythmic shortening and stress in Central Slovak is given in (35) below.

(35) Constraint Ranking for Central Slovak

Hd-Gov, Parse–σ, Hd-Vis, *Clash, Dep-μ   RhType=T
| |
Hd-Prom   RhType=I
|
Max-μ, Parse-Hd, Ft-Bin

For expository purposes, Hd-Gov, Parse–σ, Ft-Bin, RhType=T and RhType=I will be omitted from tableaus in the following section.

3.3.2.3 Constraint Interaction

The basic alternating pattern in (23) follows from high-ranked *CLASH, as illustrated in (36) below.

(36) Canonical Alternating Stress (e.g. (23)b)

Input: /LLLLLL/	HD-VIS	*CLASH	DEP-μ	HD-PROM	MAX-μ	PARSE-HD
a. ☞ ("LL)('LL)('LL)				***		
b. ("HL)('HL)('HL)			*!**			
c. ("L)('LL)('LL)('L)		*!		**		
d. ("L)(LL)('LL)('L)	*!			**		*

Candidate (36)b satisfies HD-PROM through multiple application of Trochaic Lengthening, but at the insurmountable cost of multiple DEP-μ violations. Candidates (36)c is ruled out by *CLASH for adjacent stressed syllables while candidate (36)d, is eliminated by HD-VIS for an unstressed (LL) foot.[24] This leaves candidate (36)a as optimal, despite three violations of HD-PROM for three even (LL) trochees, where the head syllable is no more prominent than the dependent syllable. Observe that monosyllabic feet satisfy HD-PROM vacuously, as there is no dependent syllable of equal or greater intrinsic prominence.

In disyllabic words, Trochaic Shortening occurs in sequences of heavy syllables, as illustrated by the tableau in (37) below.

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[24] In (36)c and (36)d the construction of degenerate feet is blocked by *CLASH and HD-VIS, respectively, a function normally attributed to FT-BIN, a low-ranking constraint in Central Slovak (see (35)).

(37) Trochaic Shortening in disyllabic words (e.g. (23)c)

Input: /H-H/	Hd-Vis	*Clash	Dep-μ	Hd-Prom	Max-μ	Parse-Hd
a. ("HH)				*!		
b. ☞ ("HL)					*	
c. ("H)('H)		*!				
d. ("H)(H)	*!					*

Candidate (37)a fatally violates Hd-Prom, because the head syllable of the foot is intrinsically no more prominent than the dependent syllable. Candidates (37)c and (37)d — where the string is broken up into separate feet — incur fatal violations of *Clash due to adjacent stressed syllables, and Hd-Vis for an unstressed foot, respectively. This leaves candidate (37)b as optimal, despite a violation of Max-μ due to shortening.

The absence of shortening after light syllables follows from the same ranking, as illustrated in (38) below.

(38) No Shortening after a light syllable (e.g. (23)f)

Input: /L-H/	Hd-Vis	*Clash	Dep-μ	Hd-Prom	Max-μ	Parse-Hd
a. ☞ ("LH)				*		
b. ("LL)				*	*!	
c. ("HL)			*!		*	
d. ("L)('H)		*!				
e. ("L)(H)	*!					*

Candidates (38)c and (38)d are ruled out by DEP-μ and *CLASH respectively, while candidate (38)e fatally violates HD-VIS due to an unstressed foot. Candidates (38)a and (38)b both violate HD-PROM, since in neither the reverse (LH) or even (LL) trochee is the head syllable more prominent than the dependent syllable, but candidate (38)b additionally violates MAX-μ for shortening in the final syllable, leaving candidate (38)a as the optimal output.

Tableau (39) below illustrates a special case of Trochaic Shortening, where it applies in the third syllable of a word.

(39) Trochaic Shortening in a non-initial sequence (e.g. (24)b)

Input: /LH-H-L/	HD-VIS	*CLASH	DEP-μ	HD-PROM	MAX-μ	PARSE-HD
a. ("LH)('HL)				*!		
b. ("LL)('HL)				*!	*	
c. ("HL)('HL)			*!		*	
d. ("L)('HL)('L)		*!			*	
e. ☞ ("L)(HL)('L)					*	*

Candidates (39)a and (39)b both fatally violate HD-PROM, since one or more feet have a dependent syllable of equal or greater intrinsic prominence than that of the head syllable. Candidate (39)c is ruled out by DEP-μ due to mora insertion, and candidate (39)d fatally violates *CLASH due to adjacent stressed syllables. This leaves candidate (39)e as optimal, despite a violation of MAX-μ for mora loss, and PARSE-HD, for an unstressed foot-head. Notice that candidate (39)e does not violate HD-VIS, however, since the intrinsic prominence of the head of an uneven (HL) trochee satisfies HD-VIS even when prominence is not projected to the metrical grid.

The ranking in (35) thus accounts for the Central Slovak data in (23) and (24) with respect to the placement of stress and Trochaic Shortening with a single formal apparatus. This account of Trochaic Shortening is thus superior to the approaches based on strict linear adjacency outlined in §3.2.3.1 above (starting on page 77; see especially examples (6) and (7)), since it does not require separate mechanisms for shortening and stress assignment, i.e. the fact that Trochaic Shortening always occurs in the dependent position of a trochaic foot must no longer be viewed as accidental. Finally, the analysis allows us to view Trochaic Shortening from a cross-linguistic perspective by linking it to other Trochaic Lengthening processes in other languages. There are, however, other systems which evidence Trochaic Shortening. Two of these will be discussed in the following section.

3.4 Gidabal

Gidabal (Geytenbeek & Geytenbeek 1971; Kenstowicz & Kisseberth 1979; Zoll 1992) is one of several dialects of Bandjalang, an endangered aboriginal language spoken in New South Wales, Australia. The number of fluent speakers of Bandjalang is estimated by Geytenbeek & Geytenbeek at around 200, only a small subset of whom speak the Gidabal dialect. The Gidabal vowel system, like that of Central Slovak, consists of short/long pairs of vowel phonemes, as illustrated in (40) below (cf. the Slovak vowel system in (1) on page 73 above).

(40) a. Short Vowels b. Long Vowels

i u i: u:
e e:
a a:

3.4.1 Trochaic Shortening in Gidabal

Trochaic Shortening in Gidabal follows exactly the same pattern as in Slovak, applying in the second of two consecutive heavy syllables. As in Central Slovak, closed syllables do not count as heavy, so the structural description for Trochaic Shortening in both languages is two long vowels in adjacent syllables. In (41) below this process is exemplified with the mild intensifier /-be:/ and the present tense marker /-la:/, both of which are suffix morphemes. (Data from Geytenbeek & Geytenbeek 1971:15.)

(41) Trochaic Shortening in Gidabal[25]

	a.	/buru:r-be:/	buru:rbe	'only two'
		/LH-H/	LHL	
cf.	b.	/bugal-be:/	bugalbe:	'very good'
		/LL-H/	LLH	
	c.	/jaga:-la:/	jaga:la	'fixes'
		/LH-H/	LHL	
cf.	d.	/ga:da-la:/	ga:dala:/	'chases'
		/HL-H/	HLH	

Also parallel to Slovak, shortening in Gidabal applies in a two-syllable window, as shown in (42) below. (Data from Geytenbeek & Geytenbeek 1971:5.)

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[25] I follow Geytenbeek's & Geytenbeek's transcription system roughly here: /d, n, l, r/ are dental (/r/ is "vibrant") while /dj, nj/ represent the alveo-palatal stop and nasal, respectively.

(42) Gidabal Trochaic Shortening in a two-syllable window

a. /djalum-ba:-da:ŋ-be:/ djalumba:daŋbe: 'is certainly right on the fish'
/LL-H-H-H/ LLHLH

b. /gunu:m-ba:-da:ŋ-be:/ gunu:mbada:ŋbe 'is certainly right on the stump'
/LH-H-H-H/ LHLHL

These patterns find straightforward explanation in terms of the model developed above, where footing is sensitive to syllable quantity and feet are subject to shortening in satisfaction of HD-PROM. Such an analysis requires (minimally) the foot structure in (43) below.

(43) Gidabal Trochaic Shortening under HD-PROM

a. buru:rbe L ($\underline{H}$L)

b. jaga:la L ($\underline{H}$L)

c. djalumba:daŋbe: LL ($\underline{H}$L) H

d. gunu:mbada:ŋbe L ($\underline{H}$L) ($\underline{H}$L)

As in Central Slovak, this effect can be achieved through the ranking DEP-μ >> HD-PROM >> MAX-μ (see §3.2.3.3, starting on page 81).

In the following section we will see that, like those of Central Slovak, the stress facts of Gidabal also support such an analysis.

3.4.2 Stress in Gidabal

Although Geytenbeek & Geytenbeek do not mark stress in most of their data, they identify Gidabal stress as *non-phonemic*, and predictable according to the following rules. (Data from Geytenbeek & Geytenbeek 1971:2 with prosodic representations added.)

(44) Gidabal Stress

a. In disyllabic words of the shape LH, stress varies freely:

djulu:n	'L H *or* L 'H	'Common grass skink'

b. In longer words beginning with LH, stress falls on the heavy syllable:

jaga:la	L 'HL	'fixes'

c. Otherwise, stress falls on initial and heavy syllables:

gawaŋ	'LL	'mother's brother'
diliŋgir	'LLL	'sparks'
mandara:m	'LL 'H	'wild raspberry'
ga:ŋale:n	'HL 'H	'was bringing'
gawariwa:la	'LLL 'HL	'is definitely running'

According to this description, the Gidabal stress system is very similar to that of Central Slovak, and only differs in a number of minor respects. Previewing, Parse–σ occupies a lower position in the Gidabal constraint ranking relative to that of Central Slovak (see example (35) on page 95 above), while Ft-Bin occupies a higher position. This is illustrated in (45) below.

(45) Constraint Ranking for Gidabal

Hd-Gov, Hd-Vis, *Clash, Dep-μ,

Parse-Hd, Ft-Bin RhType=T

| |

Hd-Prom RhType=I

|

Parse–σ, Max-μ

3.4.2.1 Treatment of LHL

Notice the asymmetric parsing of surface LHL sequences, which are realised as L 'HL in

Gidabal (cf. (44)b) but as 'L HL in Central Slovak (cf. (24)c), as evidenced by the contrastive placement of stress. This distinction is linked to the observation that, while both systems avoid stress clash, in Gidabal all foot-heads are stressed whereas in Central Slovak all syllables are parsed. This finds formal expression in the differential ranking of PARSE–σ and PARSE-HD. Recall that in Central Slovak, PARSE–σ is never violated, while the PARSE-HD, as shown in (46) below.

(46) Parsing of surface LHL in Central Slovak

Input:	/LHH/	**PARSE–σ**	**HD-VIS**	***CLASH**	**PARSE-HD**
a.	('L)('HL)			*!	
b. ☞	('L)(HL)				*
c.	(L)('HL)		*!		*
d.	L ('HL)	*!			

Abstracting away from the shortening effect, the candidates in (46) represent three possible parses for a surface LHL sequence. Candidate (46)a is eliminated by *CLASH since the first and second syllables are both stressed. Candidate (46)c fatally violate HD-VIS due to an unstressed (L) foot, and candidate (46)d is ruled out by PARSE–σ due to an unfooted syllable, leaving candidate (46)b as optimal despite a violation of PARSE-HD, for an unstressed foot-head.

In Gidabal, the relative ranking of PARSE–σ and PARSE-HD is reversed, accounting for the differential outcomes in the two systems. This is illustrated in (47) below.

(47) Parsing of surface LHL in Gidabal

Input:	/LHH/	HD-VIS	*CLASH	PARSE-HD	PARSE-σ
a.	('L)('HL)		*!		
b.	('L)(HL)			*!	
c.	(L)('HL)	*!		*	
d. ☞	L ('HL)				*

While candidate (47)a and (47)c are ruled out by *CLASH and HD-VIS, respectively, in exactly the same manner as their counterparts in (46) above, candidate (47)b is eliminated by PARSE-HD since unstressed foot-heads are strongly dispreferred in this system. This leaves candidate (47)d as optimal, despite a violation of lower-ranking PARSE–σ.

3.4.2.2 Free Variation in LH

The free variation in Gidabal words with an LH profile between initial and final stress contrasts with the situation in Central Slovak, where such sequences invariably receive initial stress.

Recall that in Central Slovak, PARSE-σ outranks HD-PROM. Given the need to avoid adjacent stresses, this ranking results in a reverse (LH) trochee output for words with an LH profile, as illustrated in (48) below.

(48) Parsing of LH in Central Slovak (cf. tableau (38) above)

Input:	/LH/	**PARSE–σ**	**HD-VIS**	***CLASH**	**HD-PROM**
a.	('L) H	*!			
b.	L ('H)	*!			
c.	('L)(H)		*!		
d.	(L)('H)		*!		
e.	('L)('H)			*!	
f. ☞	('LH)				*

While candidates (48)a and (48)b are ruled out by PARSE–σ and candidates (48)c and (48)d are eliminated by HD-VIS, candidate (48)e incurs a fatal violation of *CLASH for adjacent stresses, leaving candidate (48)f as optimal, despite a violation of HD-PROM.

Now consider the ranking in Gidabal, where HD-PROM outranks PARSE–σ as illustrated in (49) below.

(49) Parsing of LH in Gidabal

Input:	/LH/	**HD-VIS**	***CLASH**	**HD-PROM**	**PARSE–σ**
a. ☞	('L) H				*
b. ☞	L ('H)				*
c.	('L)(H)	*!			
d.	(L)('H)	*!			
e.	('L)('H)		*!		
f.	('LH)			*!	

Candidates (49)c and (49)d are ruled out by HD-VIS. At the same time, candidate (49)e is eliminated by *CLASH and candidate (49)f fatally violates HD-PROM. Since both remaining candidates incur offsetting violations of PARSE–σ, the grammar cannot select a single optimal output based on these constraints, and the two optimal candidates (49)a and (49)b correspond to the two stress patterns for words of this shape given in (44)a.

Since OT grammars assume other constraints, however, a satisfactory account of free variation between (49)a and (49)b would force us to demonstrate that these candidates cannot be distinguished with respect to violations of *any* constraint in the grammar. This is clearly not the case, however. Observe that (49)a fares better than (49)b with respect to ALIGN-L (see example (39) on page 36), while (49)b fares better with respect to FT-BIN (see example (82) on page 65). To account for free variation in OT grammars, Prince & Smolensky (1993) and Kager (1999) appeal to so-called *free ranking*. On such a view, ALIGN-L and FT-BIN would be assumed to outrank one another in separate sub-rankings, both of which are 'co-subphonologies' within the grammar.[26]

3.4.2.3 Non-iteration in Sequences of Light Syllables

Another important difference between Central Slovak and Gidabal is the absence in the latter system of alternating stresses in strings of light syllables.

Recall that in Central Slovak PARSE–σ is never violated, while HD-PROM is, an effect which yields iterative footing in strings of light syllables, accompanied by alternating stress. This is illustrated in (50) below.

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[26] While this approach has the advantage of obviating the effects of lowly-ranked constraints in such cases, it abandons the fundamental OT tenet of fixed constraint rankings.

(50) Iterative footing in Central Slovak

Input:	/LLLLLL/	PARSE–σ	HD-VIS	*CLASH	HD-PROM
a. ☞	('LL)('LL)('LL)				***
b.	('LL)('LL) LL	*!*			**
c.	('LL) LLLL	*!***			*

Candidates (50)b and (50)c are eliminated by PARSE–σ, as they each contain unfooted syllables. A complete parse of syllables into feet as in candidate (50)a is the only way to satisfy PARSE–σ, despite multiple violations of HD-PROM for even prominence within feet.

In Gidabal, however, the ranking of HD-PROM over PARSE–σ yields a different result. Under such a ranking, syllables are left unparsed unless they can be footed into feet which satisfy HD-PROM. This scenario is illustrated in (51) below.

(51) Unbounded footing in Gidabal

Input:	/LLLLLL	HD-VIS	*CLASH	HD-PROM	PARSE–σ
a.	('LL)('LL)('LL)			**!*	
b.	('LL) ('LL) LL			**!	**
c. ☞	('LL) LLLL			*	****

The results of tableau (51) are exactly the opposite of the Central Slovak tableau in (50). Since lengthening is assumed not to be an option due to high-ranking DEP-μ in both systems, candidates incur a violation of HD-PROM for every stress foot in a string of light syllables. Consequently, candidates which contain more than one foot — i.e. candidates (51)a and (51)b — are immediately ruled out by multiple violations of HD-PROM. Candidate (51)c emerges as optimal, incurring only a single violation of HD-PROM and multiple violations of lower-ranking PARSE–σ. The construction of at least one foot per lexical word follows from the requirement that every PWd constitutes a stress domain (cf. LX≈PK: Prince & Smolensky 1993:43). In this way, the absence of alternating stresses in strings of light syllables follows in Gidabal from the ranking HD-PROM >> PARSE–σ, independently motivated in the previous section.

3.4.2.4 Initial LL

A final unresolved issue in Gidabal is that fact that initial LL sequences are footed and stressed even in words which have heavy syllables, i.e. even in words where the requirement of at least one stress per word is already satisfied by feet which do not violate HD-PROM (e.g. the third and fifth data points in (44)c on page 102 above). This result follows straightforwardly if ALIGN-L is assumed to outrank HD-PROM, as illustrated in the tableau in (52) below.

(52) Initial stress in initial-LL words with heavy syllables

Input: /LLH/	ALIGN-L	HD-PROM	PARSE–σ
a. ☞ ('LL)('H)		*	
b. LL ('H)	*!		**

Candidate (52)b fatally violates ALIGN-L since there is no foot aligned with the left PWd-edge, leaving candidate (52)a as optimal despite a violation of HD-PROM. The relatively high ranking of ALIGN-L ensures that initial LL sequences are the only context where a foot will be constructed which does not satisfy HD-PROM.

Note however, that if ALIGN-L and FT-BIN can be minimally re-rankable under *free ranking* (see §3.4.2.2), then FT-BIN must dominate HD-PROM as well. This is consistent with the absence of degenerate (L) feet in polysyllabic words with initial LH in Gidabal (see tableau (47) on page 104, cf. Central Slovak in tableau (46) on page 103).

3.5 Oromo

Trochaic Shortening also occurs in Oromo (Gragg 1976, 1982; Zoll 1992), a Cushitic language spoken in Ethiopia, Kenya and Sudan by over ten million people.[27] The Oromo vowel system, like those of Central Slovak and Gidabal, consists of short/long pairs of vowel phonemes, as illustrated in (53) below (cf. the Slovak vowel system in (1) and the Gidabal vowel system in (40)).

(53)

a. Short Vowels			b. Long Vowels		
i		u	i:		u:
e		o	e:		o:
	a			a:	

3.5.1 Trochaic Shortening in Oromo

As in Central Slovak and Gidabal, closed syllables do not count as heavy in Oromo, so the basic structural description for Trochaic Shortening in all three languages is two long vowels in adjacent syllables. In (54) below, Trochaic Shortening is exemplified with two suffix morphemes: the masculine morpheme /-e:ssa/ and the plural morpheme /-o:ta/. (Oromo data from Zoll 1992:27, attributed to Gragg 1982.)

(54) Trochaic Shortening in Oromo

a.	/i:t-e:ssa/	i:tessa	'something that causes swelling'
	/H-HL/	HLL	
b.	/bo:s-e:ssa/	bo:sessa	'untidy' masc.
	/H-HL/	HLL	

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[27] Gragg's estimate is disputed by the volume editor, M. L. Bender, who places the number of speakers at closer to eight million.

cf. c.	/dargagg-e:ssa/	dargagge:ssa	‘young boy’
	/LL-HL/	LLHL	
d.	/dur-e:ss-o:ta/	dure:ssota	‘rich’ pl.
	/L-H-HL/	LHLL	
e.	/bine:ns-o:ta/	bine:nsota	‘wild animal’ pl.
	/LH-HL/	LHLL	
cf. f.	/dargagg-o:ta/	dargaggo:ta	‘young children’
	/LL-HL/	LLHL	

Trochaic Shortening is also visible in the feminine morpheme /-e:tti:/ as demonstrated in (55)a and (55)b below. Note, however, that final syllables never undergo shortening in Oromo, as illustrated in (55)c and (55)d below.

(55) No Trochaic Shortening in final syllables

a.	/ka:m-e:tti:/	ka:metti:	‘industrious woman’
	/H-HH/	HLH	
b.	/bo:s-e:tti:/	bo:setti:	‘untidy’ fem.
	/H-HH/	HLH	
cf. c.	/dargagg-e:tti:/	dargagge:tti:	‘young girl’
	/LL-HH/	LLHH	
cf. d.	/dur-e:tti:/	dure:tti:	‘rich’ fem.
	/L-HH/	LHH	

As will be demonstrated in the following sections, the Oromo facts can be analysed in terms of H HD-PROM given the following foot structure.

(56) Oromo Trochaic Shortening under HD-PROM

a.	i:tessa	($\underline{\mathrm{H}}$L) L
b.	bo:sessa	($\underline{\mathrm{H}}$L) L
c.	dure:ssota	L ($\underline{\mathrm{H}}$L) L
d.	bine:nsota	L ($\underline{\mathrm{H}}$L) L
e.	ka:metti:	($\underline{\mathrm{H}}$L) H
f.	bo:sctti:	($\underline{\mathrm{H}}$L) H

As in Central Slovak and Gidabal, this effect can be achieved through the ranking DEP-μ >> HD-PROM >> MAX-μ (see §3.2.3.3, starting on page 81).

In the following section we will see that the stress facts of Oromo support such an analysis, as in Central Slovak and Gidabal.

3.5.2 Stress in Oromo

Oromo places a pitch accent on the penultimate syllable of words in isolation. Secondary prominence falls on all heavy syllables preceding the penult. Assuming that the placement of the main pitch accent is independent of foot structure in Oromo, as in Choctaw and Chickasaw (Ulrich 1986; Hayes 1995),[28] Trochaic Shortening in penultimate syllables is unproblematic for a HD-PROM account. To account for secondary stresses, all heavy syllables preceding the penult must be correspond to foot heads.

The fact that final syllables never undergo shortening in Oromo is analysed by Zoll (1992) in terms of final-syllable extrametricality (ref to disc of Zoll below... mention intrinsic prominence and extrametricality). In OT, extrametricality is captured

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[28] Van der Hulst (1996) takes a stronger position, arguing that primary accent is universally independent of foot structure.

by assuming that PARSE–σ is dominated by NONFINALITY, which given in (57) below.

(57) NONFINALITY (Prince & Smolensky 1993:57)

No prosodic head of a prosodic word is final in the prosodic word.

NONFINALITY is violated whenever the final syllable of a word is contained within a foot. In grammars where NONFINALITY outranks PARSE–σ, word-final syllables remain unfooted.[29] The constraint ranking in Oromo differs minimally from that in Gidabal (example (45) on page 102), in that NONFINALITY is highly-ranked, as illustrated in (58) below.

(58) Constraint Ranking for Oromo

HD-GOV, HD-VIS, *CLASH, DEP-μ,
PARSE-HD, FT-BIN, NONFINALITY RHTYPE=T
| |
HD-PROM RHTYPE=I
|
PARSE–σ, MAX-μ

Trochaic Shortening and final extrametricality in Oromo is demonstrated in (59) below.

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[29] According to Prince & Smolensky (1993), separate violations of NONFINALITY are incurred for head-foot *and* the head-syllable of the prosodic word when in final position, but this is not critical here.

(59) Trochaic Shortening and final extrametricality in Oromo

Input: /HHH/	*CLASH	PARSE-HD	NONFINALITY	HD-PROM	PARSE-σ	MAX-μ
a. ('H)('H)('H)	*!*		*			
b. ('H)('H) H	*!				*	
c. ('H)(H)('H)		*!	*			
d. ('HH)('H)			*!	*		
e. ('H) H ('H)			*!		*	
f. ('HL)('H)			*!			*
g. ('HH) H				*!	*	
h. ☞ ('HL) H					*	*

Candidates (59)a and (59)b are eliminated by *CLASH for adjacent stressed syllables. Candidate (59)c is ruled out by PARSE-HD for an unstressed foot. Candidates (59)d, (59)e, and (59)f all incur fatal violations of NONFINALITY for footing the final syllable. Finally, candidate (59)g incurs a fatal violation of HD-PROM, leaving candidate (59)h as the optimal output, despite violations of lower-ranking PARSE-σ and MAX-μ.

A final consideration is the analysis of Oromo words beginning with LL. Recall from the beginning of this section that secondary stresses fall only on *heavy* syllables preceding the penult. This contrasts with Gidabal (cf. (44)c), where words beginning in LL receive initial stress. The explanation for this asymmetry lies in the fact that in Oromo ALIGN-R >> ALIGN-L, a ranking which is independently required in Oromo for the placement of the primary pitch accent, which is determined with reference to the right — and crucially not the left — word edge.[30]

As in Central Slovak and Gidabal, the stress and shortening facts of Oromo can be captured in a unified manner under HD-PROM.

3.6 Zoll's (1992) Account

Zoll (1992) analysis of shortening in Slovak, Gidabal and Oromo exploits a *moraic trochee* stress system, where heavy syllables necessarily form independent feet.[31] On this view, shortening is seen to be driven primarily by clash avoidance at the syllabic level, as illustrated in (60) below.

(60) Gidabal shortening on a moraic trochee analysis (cf. Zoll 1992)

Input: /LH-H/	*CLASH	MAX-μ
a. ☞ L ('H) L		*
b. L ('H)('H)	*!	

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[30] Since we assume placement of the primary pitch accent to be independent of foot structure in Oromo (see page 111), such an analysis requires adjustment of the ALIGN constraints (example (39) on page 36) so as not to refer to the *head-foot* of a PWd, but rather simply to the PWd-*head*.

[31] With respect to Gidabal, one piece of evidence marshalled by Zoll in favour of a moraic trochee analysis comes from a reduplicative prefix in Gidabal introducing tentative aspect, or a 'weakening of meaning'. According to Geytenbeek & Geytenbeek (1971:23), in words beginning with a light syllable, this prefix takes the form CVCV, while in words beginning with a heavy syllable the prefix surfaces as CV, i.e. prosodically, a stem of the shape /LL/ yields LL-'LL, while one of the shape /HL/ yields L-'HL. Zoll (1992:16-7) argues that the prefix is a moraic trochee, i.e. either LL- or H- according to the shape of the foot in the base. The H- is systematically realised as L- to avoid clash since it invariably precedes a (stressed) heavy syllable. Zoll appeals to a *Root Preservation Constraint* which militates against faithfulness violations within the root to explain why shortening occurs in the prefix rather than the root as one would expect under the shortening rule (Hermans 1999 proposes a similar constraint for Slovak).

Such an account cannot be extended straightforwardly to Central Slovak, however, because in the latter system shortening occurs in contexts where stress clash does not.[32] Recall from example (24)c that in Central Slovak underlying /LHH/ is realised as 'LHL, with no stress on the second syllable. To get around this difficulty, Zoll extends the domain of the ban on stress clash, which is assumed not to apply on the metrical grid, but rather at the level of *intrinsic syllable prominence*, where the adjacency of heavy syllables is a sufficient condition to trigger a violation of *CLASH regardless of stress (cf. HD-VIS, example (31) on page 93). Zoll does not take a clear position on whether this interpretation of *CLASH is intended as a mere extension of the domain of application to include both grid prominence and intrinsic syllable prominence or whether it is intended as a separate constraint which operates independently of grid prominence. The empirical facts of Central Slovak force the latter interpretation.

Consider Central Slovak words of the underlying shape /LH/, which invariably surface with initial stress and no shortening. If stress clash were conceived of as a ban on adjacent prominence peaks on either the metrical grid or intrinsic syllable prominence, a surface 'LH sequence would trigger a *CLASH violation, as illustrated in (61) below.

(61) Global enforcement of *CLASH

Input: /LH/	*CLASH	MAX-μ
a. ☞ 'LL		*
b. 'LH	*!	

---

[32] Another shortcoming of the moraic trochee analysis with respect to Central Slovak is the location of secondary stress in words with initial LH, e.g. example (25) on page 90. Assuming a ban on (metrical) stress clash, secondary stress in words of the shape LHLL would be expected to have penultimate secondary stress, i.e. *"LH'LL and not "LHL'L.

Candidate (61)b places a stressed syllable next to an intrinsically prominent heavy syllable, resulting in a fatal violation of *CLASH, when interpreted globally. This leaves candidate (61)a where no clash obtains as optimal, despite a violation of low-ranking MAX-μ for mora loss. This is the wrong result, however, since shortening applies *only* after heavy syllables. We must conclude, therefore, that Zoll's interpretation of *CLASH applies *uniquely* at the level of intrinsic syllable prominence.

This interpretation is problematic for the Oromo facts, however. Recall that final syllables are extrametrical in Oromo. If metrical prominence and intrinsic syllable prominence are assumed to be represented on separate tiers or grids as required to account for the facts of Central Slovak, then the fact that final heavy syllables are exceptional with respect to stress (metrical prominence) and shortening (intrinsic syllable prominence) must be viewed as accidental. If on the other hand, shortening is analysed as applying in the dependent position of a trochaic foot under Hd-Prom, both sets of facts can be captured in a single unified analysis.

3.7 Summary

The analysis presented in this chapter provides a prosodic account of Trochaic Shortening in three systems — Central Slovak, Gidabal, and Oromo — where shortening occurs in the dependent position of a trochaic foot (Bethin 1998; Mellander 2001a). The process is driven by HEAD-PROMINENCE — a constraint on prosodic well-formedness requiring the head syllable of a metrical foot to have greater intrinsic prominence than a dependent syllable (Piggott 1998, 2001; Mellander 2001a, c). The fact that shortening produces uneven (<u>H</u>L) trochees but never even (<u>L</u>L) ones suggests that the uneven (<u>H</u>L) trochee is a well-formed phonological structure (see §2), contrary to the standard view (cf. Prince 1992; Kager 1993; Hayes 1995).

In the following chapter, we turn to the subsyllabic level, examining the interaction of HD-PROM with rhythmic constraints in bimoraic syllables.

4. PROMINENCE AND RHYTHM AT THE MORAIC LEVEL

4.1 Introduction

If HD-PROM is taken to be a general principle of phonological theory, it is reasonable to expect that its effects should be observable not just in metrical feet, but in other prosodic domains as well. In this chapter we investigate prominence contours in heavy syllables, demonstrating that HD-PROM is instrumental in explaining a number of cross-linguistic generalisations which can be made regarding the subsyllabic prominence relations of bimoraic syllables. We begin in the following section with some cross-linguistic generalisations about diphthongal moraicity.

4.2 Sonority Contours and Diphthongal Moraicity

Cross-linguistically, diphthongs with a rising sonority profile from left to right (hereafter *rising diphthongs*,[1] e.g. that in French *bois* [bwa] 'wood') generally behave as phonologically light or monomoraic while those with a falling VG sonority profile (hereafter *falling diphthongs*, e.g. that in English *cow* [kaw]) behave as phonologically heavy or bimoraic, as represented in (1) below (cf. Kaye 1985; Hayes 1985; Hyman 1985; Schane 1987, 1995; Rosenthall 1994; Mellander 2001b).

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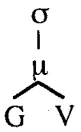
[1] The term *falling diphthong* has also been used to describe such structures, in reference to falling vowel height or falling syllabicity (Schane 1987, Booij 1989).

(1) Representations for diphthongs

a. Rising Diphthong (Light)



b. Falling Diphthong (Heavy)

Empirical motivation for the representations in (1) can be found in a number of languages. For example, Vata (Eastern Kru) allows rising diphthongs but not falling ones, as shown in (2) below. (Data from Kaye 1985:291 with tonal patterns omitted.)

(2) Monomoraic syllables in Vata

	Monomoraic			Bimoraic		
Monophthongs	a.	V		b.	*VV	
		di	'villages'		--	*diː
		vɛdɛ	'manioc'			*vɛːdɛː
		ɔ	'he/she'			*ɔː
Diphthongs	c.	GV		d.	*VG	
		cIa	'study'		--	*caɪ
		sɪɔ	'snail'			*sɔɪ
		yuʌ	'children'			*yʌu

Kaye analyses GV clusters in Vata as diphthongal constituents ((1)a) rather than onset-nucleus sequences on the basis of a ban on branching onsets in the language.[2] If Vata is

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[2] Tautosyllabic CLV sequences do occur in Vata, but Kaye analyses LV clusters as nuclear constituents analogous to rising diphthongs. This analysis is motivated by two pieces of evidence: firstly, putative CL onset clusters do not respect sonority sequencing, e.g. *wlɪ* 'fingers', *ylʊ* 'sun'; secondly, there are no

assumed to enforce a general ban on bimoraic syllables as we might infer from the absence of long vowels in (2)b, the presence of rising diphthongs in (2)c and the absence of falling diphthongs in (2)d follow straightforwardly from the representations in (1).

In Spanish, rising diphthongs can occur in word-medial closed syllables while falling diphthongs cannot, as illustrated in (3) below.[3] (Data from Rosenthall 1994:135-9.)

(3) Diphthongs by syllable type in Spanish

	Rising Diphthongs			Falling Diphthongs		
open syllables	a.	GV		b.	VG	
		dja.blo	'devil'		fraj	'friar'
		fwe.ro	'law'		aw.to	'car'
		kwo.ta	'quota'		pej.ne	'comb'
closed syllables	c.	GVC		d.	*VGC	
		mwer.te	'death'		--	*mewr.te
		sjes.ta	'siesta'			*sejs.ta
		pwer.ta	'door'			*pewr.ta

If the representations for diphthongs in (1) are assumed, this gap follows straightforwardly from a maximally bimoraic rime (cf. Rosenthall 1994; Selkirk 1984b). Given the monomoraic representation of a GV sequence in (1)a, the inclusion of a tautosyllabic moraic coda consonant is unproblematic with respect to a maximally binary

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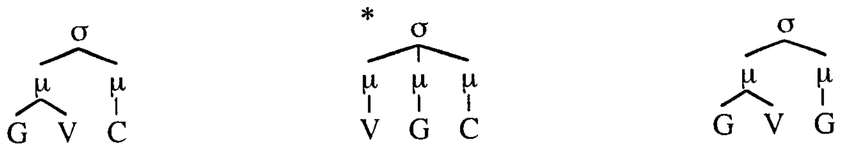
*CLGV sequences in Vata, as one would expect if both branching onsets and branching nuclei were allowed.

[3] Citing Harris (1983), Rosenthall (1994:139) notes three exceptions to this generalisation: *vein.te*, *trein.ta* and *aun.que*. José Alvarez (p.c.) notes two additional exceptions: *seis.cien.tos* and *pleis.to.ce.no*.

rime, as shown in (4)a below.

(4) Maximally binary rimes in Spanish


a. GVC b. *VGC c. GVG

The same does not hold, however, in the case of a (bimoraic) falling diphthong, as shown in (4)b.

Another logical possibility under a bimoraic maximum is the triphthongal representation in (4)c, which combines the branching structure of a light rising diphthong with the moraic offglide of a heavy falling diphthong. Triphthongs occur in the second person plural of first conjugation verbs in European Spanish, as shown in (5) below. (Data from José Alvarez, p.c.)

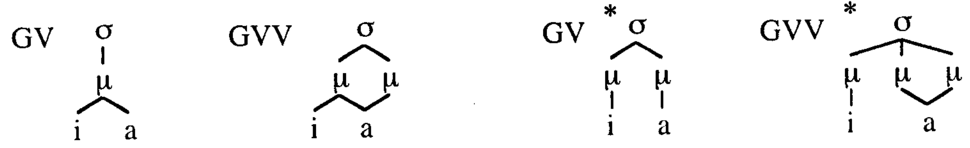
(5) Triphthongs in European Spanish

a.	/odi-a-is/	o.djajs	'you (pl.) hate'
b.	/kambi-a-is/	kam.bjajs	'you (pl.) change'

The monomoraic representation for rising diphthongs also provides an explanation for contrastive quantity in these structures, e.g. in Sanskrit *ia* versus *ia:*, *ua* versus *ua:*, etc. (Schane 1987:283). If a branching structure is assumed, this contrast can be represented as monomoraic versus bimoraic as in (6)a below, thereby respecting the requirement of a maximally bimoraic rime (cf. Schane 1987:285; Davis & Hammond 1995).

(6) Light and heavy rising diphthongs in Sanskrit

a. Monomoraic vs. Bimoraic b. Bimoraic vs. Trimoraic



The alternative is to represent the contrast as bimoraic versus trimoraic as in (6)b, in violation of the two-mora limit.

A final case which supports the representations of diphthongs in (1) above is that of Lenakel, where diphthongs and hiatus in (C)VVC words are in complementary distribution, according to the sonority profile of the two vocalic melodies, as shown in (7) below. (Data from Rosenthall 1994:117, 123.)

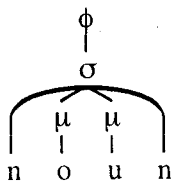
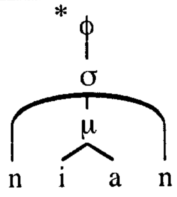
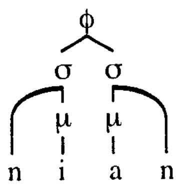
(7) Complementary distribution of diphthongs and hiatus in Lenakel

	Falling Sonority			Rising Sonority		
Diphthong	a.	(C)VGC		b.	*(C)GVC	
		nown	'fish poison'		--	*njan
		ewk	'to stamp'			*twɪn
Hiatus	c.	*(C)V.VC		d.	(C)V.VC	
		--	*no.un		ni.an	'day'
			*e.uk		tu.ɪn	'the top of it'

Where sonority falls across the two vocalic melodies, underlyingly (C)VVC words surface as monosyllabic with a falling diphthong, as in (7)a, and never as bisyllabic with hiatus, as in (7)c. When sonority rises across the two vocalic melodies, however, words which are underlyingly (C)VVC surface as bisyllabic with hiatus, as in (7)d, and never as monosyllabic with a rising diphthong, as in (7)b.

Rosenthall (1994:117, 123) explains this asymmetry in terms of word-minimality, where a well-formed prosodic word must minimally contain a well-formed foot, which in turn must contain at least two moras (FT-BIN: see example (82) on page 65 above). Assuming the representations in (1), a falling diphthong satisfies this requirement, as illustrated in (8)a below.

(8) Word minimality in Lenakel

Falling Diphthong	Rising Diphthong	Hiatus
a. 	b. 	c. 

By contrast, a rising diphthong does not satisfy the bimoraic minimum and is thus ill-formed, as shown in (8)b. The string can only be parsed into a bimoraic foot if the two melodies are parsed into separate syllables resulting in hiatus, as in (8)c.

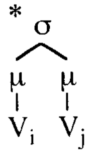
Our task in the present analysis is to complement the empirical motivation for the asymmetric representations of rising and falling diphthongs by providing a formal account of the link between the sonority contour and moraicity of diphthongal constituents. It will be demonstrated in the following sections that this link holds for long monophthongs and bimoraic closed syllables as well, and stems from the interaction of constraints on rhythm and prominence. We will begin with a brief look at Rosenthall's (1994) approach to this problem.

4.2.1 Rosenthall's (1994) Account

As demonstrated in the previous section, the structural distinction in (1) between the two types of diphthong is immensely useful in explaining a range of cross-linguistic facts. It is less clear, however, what principles underlie it. Two questions arise: firstly, why should a weight distinction hold between two types of what is ostensibly the same phonological entity — a vocalic nucleus containing two melodies? Secondly, why is it specifically *rising* diphthongs which are monomoraic and *falling* diphthongs which are bimoraic, and not vice versa? Rosenthall (1994) answers these questions by appealing to the constraints in (9) below, which correctly eliminate undesirable diphthong types in accordance with the observed distributional facts: (9)a rules out bimoraic diphthongs with rising sonority while (9)b rules out monomoraic diphthongs with falling sonority.

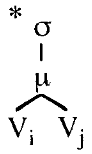
(9) Structural well-formedness constraints on vocalic nuclei

a. *HeavyRising (SonFall: Rosenthall 1994:19, Casali 1998:57)



$son_i < son_j$

b. *LightFalling (cf. SonRise: Rosenthall 1994:24)

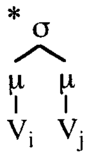


$son_i > son_j$

While such an approach provides the necessary mechanics to predict the right results, it does little to enhance our understanding of the relationship between sonority and moraicity in these structures. The problem with these constraints is that they are *ad hoc* — notice that there is no formal distinction between the proposed constraints in (9) and the logically possible but empirically unmotivated constraints in (10) below, respectively.

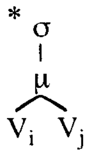
(10) Empirically unmotivated well-formedness constraints

a. *HeavyFalling



$son_i > son_j$

b. *LightRising



$son_i < son_j$

The solution to the problem lies in a conflict which arises uniquely in the context of rising diphthongs between the competing demands of phonological principles pertaining to two distinct domains: prominence and rhythm. These issues will be addressed in turn.

4.2.2 Moraic Sonority and Head Prominence

Syllables are subject to a number of restrictions, both combinatorial and absolute, on the types of segments which can occupy particular positions, and on which positions can be weight-bearing or moraic. One of these restrictions is HD-PROM, repeated as (11) below.

(11) HEAD PROMINENCE(PCat$_n$) (repeated from example (3) on page 4)
The head of a prosodic category is intrinsically prominent.

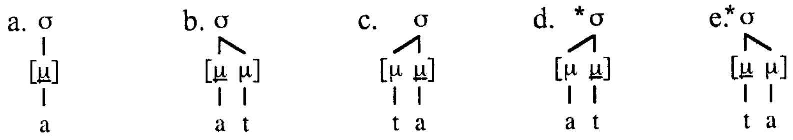
As demonstrated in previous chapters, quantity and quantity shift have proved to be indispensable devices in assessing and resolving prominence relations within feet. Here, however, we are concerned with prominence relations within syllables. The relevant formulation of HD-PROM is given in (12) below.

(12) Head Prominence(Syllable) (cf. Hd-Prom(Foot): example (27) on page 29)

The head of a syllable is intrinsically prominent

Quantity is not an appropriate metric to assess relative prominence within the moraic constituents of (heavy) syllables, as these constituents are themselves moras. Relative prominence in a bimoraic domain can be measured, however, in terms of the relative sonority of the melodies to which these moras are associated. At the subsyllabic level, Hd-Prom requires that the mora which forms the syllable-head be associated with the most sonorous melody in the syllable. To illustrate, consider the mora-rhythmic representations of the logically-possible syllable types given in (13) below. (Square brackets indicate metrically visible material within a syllable. Asterisks indicate structures which are illicit under Hd-Prom.)

(13) Mora-rhythmic representations of syllables under Hd-Prom[4]



Hd-Prom is satisfied vacuously in (13)a because the prominence domain contains only a single mora. The representations in (13)b and (13)c are also well-formed under Hd-Prom, since in both cases the head mora (<u>underlined</u>) is associated with the most sonorous melody in the domain — the vowel. The representations in (13)d and (13)e are

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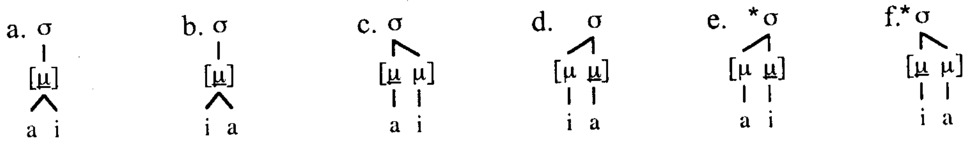
[4] Mellander (2001b) derives these contrasts by appealing to Peak Prominence (Prince & Smolensky 1993) rather than Hd-Prom. The present analysis is superior, however, achieving broader empirical coverage. This is a consequence of the fact that while Hd-Prom refers to the intrinsic prominence of syllable heads, Pk-Prom measures prominence on the metrical grid and thus is sensitive to syllable heads in stressed syllables only.

ill-formed under HD-PROM, however, since the head mora is associated with a consonant, which is necessarily less sonorous than the vowel.

Exactly the same logic can be extended to diphthongs, as shown in (14) below.

(14) Mora-rhythmic structure of diphthongs under HD-PROM



Both (14)a and (14)b satisfy HD-PROM trivially as there is only one mora in the prominence domain. HD-PROM is also satisfied in (14)c and (14)d, since in both cases the head mora of the syllable is constructed over the highly sonorous low vowel /a/. In (14)e and (14)f, however, HD-PROM is violated because the syllable-head is constructed over the relatively less sonorous high vowel /i/.

4.2.3 Mora Rhythm and Prominence Peaks

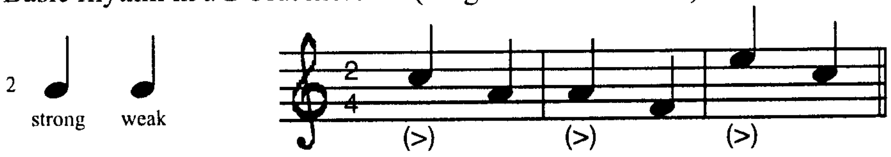
Kager (1993, 1995) develops a theory of prosodic organisation based on principles of rhythm, applied at either the syllabic or moraic level. As mentioned in §2.2.1 (starting on page 17), a central aspect of this theory is the assumption, due to Prince (1983), that in a tautosyllabic sequence of moras the prominence contour must fall. This restriction follows from the general rhythmic principle in (15) below.

(15) TROCHAIC DEFAULT (TROCHDEF: Mellander 2002a; cf. McCarthy & Prince 1986:7)[5]

Binary metrical groupings are prominence-initial.

TROCHDEF is understood as the elsewhere case for binary metrical groupings such as feet, the overwhelming majority of which manifest a trochaic rhythmic profile. Recall from §2 that systems with iambic rhythm are typically quantity-sensitive and quantitatively uneven (cf. the Iambic / Trochaic Law), and therefore *ternary* at the moraic level. Since syllables are maximally bimoraic in most languages, TROCHDEF predicts initial prominence at the subsyllabic level.[6]

Evidence for TROCHDEF can also be found in formal theories of rhythm in music. Ziegenrücker (1977) introduces the basic rhythmic form in (16) below, according to which beats are parsed into measures of two units with initial prominence.

(16) Basic rhythm in a 2-beat measure (Ziegenrücker 1977:38)

Ziegenrücker uses '>' to mark strong beats, although this appears in parentheses to indicate that such overt notation is unnecessary, as the location of a strong beat is

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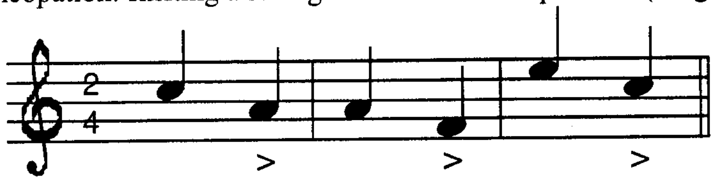
[5] In §5 we will show that a universal preference for trochaic rhythm in binary domains can be derived through constraint interaction from independently-motivated rhythmic constraints. For purposes of the present discussion, however, we will use TROCHDEF as a cover a constraint.

[6] Exceptions to initial prominence are rare, but include Chugach (§6.3.2), Slovak (§4.3.1) and Frisian (§4.3.2). Antony Green (p.c.) points out that heavy diphthongs of the Frisian type (i.e. schwa-final) also occur in Irish and certain non-rhotic dialects of English.

predictable on the first beat of each measure. Strong beats can appear elsewhere in a measure, but these *syncopated* beats must be overtly marked as such, as in (17) below, where the absence of parentheses indicates that the notation is not optional.

(17) Syncopation: shifting a strong beat onto a weak position (Ziegenrücker 1977:49)

Syncopated rhythms do not respect TROCHDEF, of course, but notice that such rhythm types are obligatorily *marked.* The notational distinction between basic and syncopated rhythms is in principle an arbitrary one, i.e. one could represent exactly the same information by marking measure-initial strong beats instead of measure-final ones. In practice, however, this notational convention respects the maxim of economy by encoding the high-frequency rhythmic option (initial prominence) into the basic notational scheme while relegating the low-frequency rhythmic option (final prominence) to piecemeal diacritic marking. Consequently, the notational system of music reflects the relative markedness of final prominence.[7]

Within the syllable, TROCHDEF demands that it is the first mora which forms the syllable-head and bears stress. This is illustrated in (18) below. (Asterisks indicate structures which are illicit under TROCHDEF — for the time being, we abstract away from HD-PROM.)

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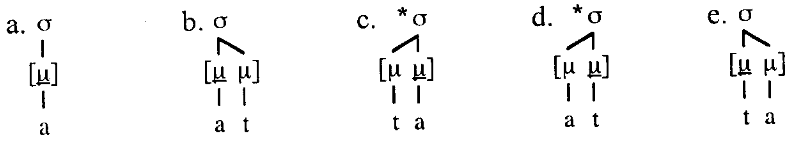
[7] A general preference for trochaicity is also expressed in Lerdahl's & Jackendoff's (1983) 'Metrical Preference Rules'. As William Idsardi (p.c.) points out, it is unclear to what extent this generalisation holds in non-Western musical traditions. Unfortunately, a thorough investigation of this issue extends beyond the scope of this thesis.

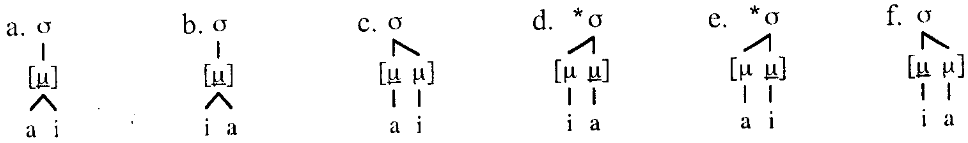
(18) TROCHDEF at the subsyllabic level



While TROCHDEF is satisfied trivially in (18)a because the domain contains only one mora, it is also satisfied in (18)b and (18)e, because in both cases the head mora is initial within the moraic domain. This is not the case in (18)c and (18)d, however, where the domain-initial mora is not the head, and consequently both violate TROCHDEF.

Again, analogous logic can be used for diphthongal sequences, as illustrated in (19) below.

(19) Mora-rhythmic structure of diphthongs under TROCHDEF



While TROCHDEF is satisfied trivially in the monomoraic syllables of (19)a and (19)b, it is also satisfied in (19)c and (19)f, where the initial mora forms the syllable-head. TROCHDEF is violated, however, in (19)d and (19)e due to the iambic rhythmic profile in these examples.

4.2.4 The Interaction of Prominence and Rhythm

4.2.4.1 The Distribution of Moraic Consonants

When taken together, the simultaneous satisfaction of HD-PROM and TROCHDEF produces a number of interesting effects with regard to the moraicity of segments in particular positions. Along the lines of a proposal by Prince (1983), the effects of *Weight-by-Position* (e.g. Hayes 1989) can be derived from constraint interaction (cf. Kager 1999;

Rosenthall & Van der Hulst 1999; Mellander 2001b, 2002c, in press a). This is shown in tableau (20) below, where four logically possible bimoraic representations of a CVC syllable (see examples (13) and (18) above) are evaluated against HD-PROM and TROCHDEF.[8]

(20) Weight-by-Position through constraint interaction (cf. Prince 1983)

Input: μμ / CVC	**HD-PROM**	**TROCHDEF**
a. 		*!
b. 	*!	
c. 	*!	*
d. ☞ 		

Candidate (20)a fatally violates TROCHDEF since the prominence profile across the bimoraic domain is iambic. Candidate (20)b fatally violates HD-PROM, due to the fact that the head mora of the syllable is less sonorous than the dependent mora. Candidate (20)c violates both constraints, leaving candidate (20)d as the optimal output. This candidate manifests both initial prominence and greater relative sonority on the head mora of the syllable.

Constraint interaction significantly restricts the range of licit structural configurations in a heavy syllable. While HD-PROM ensures that the most sonorous melody in the string will be associated with the head mora of the syllable, TROCHDEF ensures that the head mora will be the first in the domain. Together they force the syllable head to form a sonority peak (cf. *Sonority Sequencing*: Clements 1990) which is

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[8] We abstract away from possible $CV_{\mu\mu}C$ and $C_{\mu}VC_{\mu}$ candidates for present purposes.

followed by a less-sonorous mora. This mechanism provides a straightforward explanation the fact that coda consonants frequently contribute to syllable weight across the world's languages while onset consonants never do.[9] The asymmetric restriction of the Weight-by-Position rule to coda consonants emerges through constraint interaction and need not be formulated as a constraint in its own right (cf. Kager 1999; Rosenthall & Van der Hulst 1999).

4.2.4.2 Moraicity in Diphthongal Sequences

The interaction of HD-PROM and TROCHDEF also provides an account for why rising diphthongs are monomoraic. This effect is achieved by ranking *COMPLEX below the other two constraints, as illustrated in (21) below.[10]

(21) Monomoraic Rising Diphthongs

Input:	ia	**HD-PROM**	**TROCHDEF**	***COMPLEX**
a.	$[\underline{\mu}\ \mu]$ | | i a	*!		
b.	$[\mu\ \underline{\mu}]$ | | i a		*!	
c. ☞	$[\underline{\mu}]$ $\wedge$ i a			*

Whereas candidate (21)a fatally violates HD-PROM because the head is not the most sonorous mora of the sequence, candidate (21)b violates TROCHDEF because the head is not the first mora of the sequence. Given a rising sonority profile, the only way to satisfy both HD-PROM and TROCHDEF is with the monomoraic branching structure in (21)c, which incurs only a single violation of lower-ranked *COMPLEX, and is thus optimal.

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[9] See Davis (1988) for discussion of possible exceptions.

[10] *COMPLEX is assumed here to refer to structural complexity at the moraic level only.

The same is not true in the case of falling diphthongs, as shown in (22) below.

(22) Bimoraic Falling Diphthongs

Input: ai	**HD-PROM**	**TROCHDEF**	***COMPLEX**
a. $[\mu\ \underline{\mu}]$ $\vert\ \ \vert$ a i	*!	*	
b. ☞ $[\underline{\mu}\ \mu]$ $\vert\ \ \vert$ a i			
c. $[\underline{\mu}]$ $\wedge$ a i			*!

Candidate (22)a violates *both* HD-PROM *and* TROCHDEF; not only is the syllable head non-initial, it is constructed on the less sonorous mora. By contrast, candidate (22)b does not violate either of these constraints, despite the fact that it is bimoraic. Candidate (22)c fatally violates *COMPLEX since both melodies are associated to the same mora, leaving candidate (22)b as optimal.

HD-PROM and TROCHDEF can be satisfied simultaneously in a bimoraic domain iff the sequence is head-initial and exhibits a *falling* sonority profile, as in a nucleus-coda sequence ((20)d), or heavy falling diphthong ((22)b). A rising sonority profile across a bimoraic domain — be it onset-nucleus ((20)a-b), or heavy rising diphthong ((21)a-b) — pits HD-PROM and TROCHDEF against each other in such a way that the satisfaction of one necessarily entails the violation of the other. The only way around this conflict is to reduce the domain to a single mora and thereby inducing a violation for marked branching structure as in (21)c, cf. (22).

We are now in a position to understand the mechanism behind Rosenthall's structural well-formedness constraints in (9). The constraint in (9)a militating against heavy rising diphthongs follows from the conflict that necessarily ensues between HD-PROM and TROCHDEF when a rising sonority profile is imposed on a bimoraic domain. The ban on falling light diphthongs in (9)b reflects the fact that light diphthongs violate

*COMPLEX, and in the case of a falling sonority profile such a violation is never justified. This is because both constraints can be satisfied with the bimoraic output in (22)b.

The interaction of HD-PROM and TROCHDEF provides a principled theoretical motivation for the representations in (1) and accounts for the occurrence of heavy rising diphthongs (and moraic onsets) in some systems as a consequence of the variable ranking of HD-PROM and TROCHDEF with respect to other constraints. Such systems will be explored in the following section.

4.3 Heavy Rising Diphthongs through Constraint Re-ranking

As discussed above, heavy rising diphthongs are cross-linguistically marked because they necessarily violate either HD-PROM or TROCHDEF, depending on which mora the prominence peak is constructed upon. Since OT assumes that all constraints are in principle violable, however, we predict the existence of heavy rising diphthongs in some languages. The nature of constraint interaction leads us to predict two distinct types of heavy rising diphthong — one violating TROCHDEF and one violating HD-PROM. These two patterns are exemplified in Slovak and Frisian, respectively, and will be discussed in turn.[11]

4.3.1 Slovak

In Slovak, evidence for the bimoraic status of rising diphthongs comes from the fact that they pattern with long vowels distributionally (see the Slovak vowel inventory, example (1) on page 73) and in triggering phonological processes. For example, under the Slovak Rhythmic Law (see §3.2.1 starting on page 73) a long vowel is shortened if the previous

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[11] Chugach (§6.3.2) also exhibits heavy rising diphthongs. In contrast to Slovak (see below), however, Chugach incurs violations of TROCHDEF in long monophthongs as well, implying that different mechanisms are at work in the two systems (cf. Kenstowicz & Rubach 1987, who assume uniform right-headedness in Slovak nuclei).

syllable contains a long vowel as in (23) below. The process is also triggered by a (rising) diphthong, as in (24).

(23) Monophthongal triggers (Kenstowicz & Rubach 1987:467-8)

a.	/dla:t-a:x/	dla:tax	*dla:ta:x	'chisel' loc. pl.
b.	/mu:dr-i:/	mu:dri	*mu:dri:	'wise'

(24) Diphthongal triggers (Kenstowicz 1972:552, 556)

a.	/hɲiezd-a:x/	hɲiezdax	*hɲiezda:x	'nest' loc. pl.
b.	/biel-i:/	bieli	*bieli:	'white'

In shortening contexts, diphthongs undergo monophthongization, as shown in (25) below.

(25) Diphthongal targets (Dvonč 1955:10)[12]

a.	/pra:ts-iax/	pra:tsax	*pra:tsiax	'work' loc.pl.
b.	/kra:tʃ-iam/	kra:tʃam	*kra:tʃiam	'I step / stride'

The data in (24) and (25) constitute strong evidence for the bimoraic status of rising diphthongs in Slovak. Implicitly following HD-PROM, Kenstowicz & Rubach (1987:476) assume these structures to be iambic, in contrast to the trochaic structure of heavy falling diphthongs in languages like English and Quebec French.

Additional evidence for iambic or prominence-final representations of Slovak

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[12] There are a number of exceptions to monophthongization, e.g. *xva:lia* **xva:la* 'praise', *ska:lie* **ska:le* 'rock'. Such cases are standardly treated by Slovak grammarians as exceptions to the Rhythmic Law (for discussion see Dvonč 1955). Uhlár (1941/1942:236) observes, however, that in contrast to morphophonemic exceptions to the RL involving monophthongal targets, e.g. *ʃta:tʃi:* **ʃta:tʃi* 'bird' (adj.), native speakers do not *feel* that 'exceptions' involving diphthongal targets violate the rule, and suggests that diphthongs in such contexts might be better analysed as phonologically short.

rising diphthongs comes from an asymmetry between the behaviour of long vowels and diphthongs in a language game described by Birnbaum (1981). In words containing only monophthongal nuclei, the game can be described as follows: before every vowel, insert a short copy of that vowel followed by the segment /p/, as illustrated in (26) below. (Inserted material is given in *italics.*)

(26) Slovak language game: monophthongs

a.	buɟ	b*up*uɟ		'be' imp.
b.	re:va	r*epe*:v*ap*a	*re:*pe*va*pa*	'vine'

The fact that it is the first vowel which is a copy of the second (and not vice versa) is observable in (26)b where a long vowel is involved. We have already seen that rising diphthongs pattern with long vowels in Slovak and that their short counterparts are monophthongal. Thus, based on (26)b we expect /p/ to be inserted before a diphthong. This is the wrong prediction, however, as demonstrated by the data in (27) below.

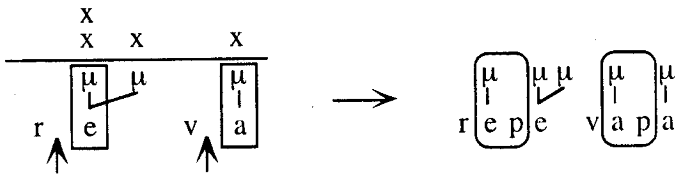
(27) Slovak language game: diphthongs

a.	bieli	bi*ep*el*ip*i	*b*ep*iel*ip*i	'white'
b.	lietʃeniu	li*ep*etʃ*ep*eni*up*u	*l*ep*ietʃ*ep*en*up*iu	'treatment' dat.

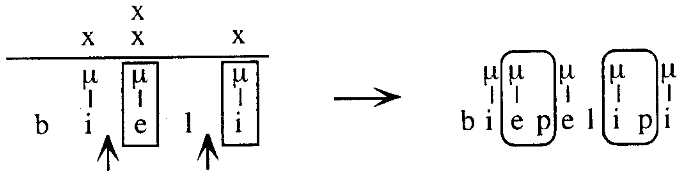
This result is unexpected since long vowels and diphthongs are both bimoraic and normally pattern together in Slovak. To account for this asymmetry, Birnbaum appeals to a rule which resyllabifies the onglide into the syllable onset and which is ordered before reduplication. While rule ordering is not available in the constraint-based framework assumed in the present analysis, the correct result can be obtained by appealing to an iambic prominence contour for heavy rising diphthongs in Slovak. If the language game refers to *prominence peaks* for purposes of copying and insertion, the asymmetry in the behaviour of heavy rising diphthongs and long vowels follows straightforwardly from the differing mora-rhythmic representations of the two structures, as illustrated in (28) below.

(28) Slovak language game: insertion before syllable peaks

a. Monophthongs (trochaic)



b. Rising Diphthongs



Material to be copied is that dominated by the peak-moras of syllables (enclosed in rectangles). Insertion points (indicated by arrows) are located immediately before prominence peaks. Accordingly, insertion occurs before the long monophthong in (28)a because the prominence peak is located on the first mora (cf. Kenstowicz & Rubach 1987; inserted material enclosed in rounded rectangles). By contrast, insertion occurs *between* the two moras of the input heavy rising diphthong in (28)b because the prominence peak is located on the second mora.

Given an iambic prominence contour in Slovak rising diphthongs, we infer that TROCHDEF is not highly-ranked in Slovak. By contrast, the regular monophthongization of rising diphthongs in shortening contexts (exemplified in (25) above) suggests that *COMPLEX is highly ranked in Slovak. A constraint ranking where HD-PROM and *COMPLEX outrank TROCHDEF is demonstrated in the tableau in (29) below, cf. (21) above, where HD-PROM and TROCHDEF outrank *COMPLEX.

(29) Bimoraic Rising Diphthongs in Slovak

Input:	ie	*COMPLEX	HD-PROM	TROCHDEF
a.	$[\underline{\mu}\ \mu]$ $\vert\ \vert$ i e		*!	
b. ☞	$[\mu\ \underline{\mu}]$ $\vert\ \vert$ i e			*
c.	$[\underline{\mu}]$ $\wedge$ i e	*!		

Candidate (29)a fatally violates HD-PROM, as the less sonorous mora forms the head, while candidate (29)c is ruled out by *COMPLEX since a single mora is associated to two melodies. This leaves candidate (29)b as optimal, despite a violation of lower-ranked TROCHDEF.

4.3.2 Frisian

In contrast to Slovak, TROCHDEF is never violated in Frisian. While heavy rising diphthongs do occur, the syllable-initial mora forms the head and the melody of the syllable-final mora undergoes reduction to schwa, as shown in (30) below.[13] (Data from Booij 1989:319.)

(30) Heavy rising diphthongs in Frisian

a.	bɪəm	'tree'
b.	fuət	'foot'

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[13] The analysis of such diphthongs as 'rising' here is based on the analysis of schwa as a mid vowel for purposes of sonority. This view contrasts with Crosswhite (1999) who assumes schwa to be a low-sonority vocoid, and vowel reduction as a characterized by a decline in sonority. Such an analysis is potentially attractive as vowel reduction could be interpreted as being driven by HD-PROM in order to increase the relative prominence of the head mora parallel to Trochaic Shortening in feet (see §3). Crosswhite provides no independent motivation for such an interpretation, however.

In certain contexts, Frisian heavy rising diphthongs undergo a process known as *breaking* whereby the first melody becomes a nonsyllabic onglide and the second melody is realised as a full vowel, as shown in (31) below.

(31) Breaking in Frisian

a.	bjɛmkə	'little tree'
b.	fwotən	'feet'

Both Van der Meer (1985) and Booij (1989) analyse breaking as shortening, although Booij demonstrates that onglides in breaking forms are part of the syllable onset rather than nuclear constituents.

As in Slovak, the ban on light rising diphthongs is consistent with the high-ranking of *Complex in Frisian. The trochaic representation for heavy rising diphthongs in Frisian follows straightforwardly if TrochDef and *Complex are ranked above Hd-Prom, as in (32) below (cf. (21) and (29)).

(32) Bimoraic Rising Diphthongs in Frisian

Input: ɪɛ	**TrochDef**	***Complex**	**Hd-Prom**
a. [μ μ̲] | | ɪ ɛ	*!		
b. ☞ [μ̲ μ] | | ɪ ə			*
c. [μ̲] ∧ ɪ ɛ		*!	

Candidates (32)a and (32)c fatally violate TrochDef and *Complex, respectively, leaving candidate (32)c as optimal, despite a violation of low-ranking Hd-Prom.

The factorial typology of grammars resulting from variable ranking of the three constraints thus accounts for the three attested types of rising diphthong: monomoraic (light) rising diphthongs, exemplified by Spanish, and two distinct types of bimoraic rising diphthong, exemplified by Slovak and Frisian, respectively. In the following section we explore the implications of the factorial typology in the case of falling diphthongs, and demonstrate that even under constraint re-ranking such configurations can never surface as optimal with respect to the three constraints under discussion.

4.4 No Light Falling Diphthongs through Constraint Reranking

Kaye (1985, 1989) suggests that light diphthongs *must* rise in sonority, i.e. that light falling diphthongs never occur. Rosenthall (1994:24) shares this view, claiming that *LIGHTFALLING ((9)b) is universally undominated and should therefore be considered part of *GEN*, the function which generates possible output candidates in OT grammars (Prince & Smolensky 1993).[14] This contrasts with *HEAVYRISING ((9)a), which Rosenthall notes is clearly dominated in some languages (p. 19). While this distinction in the status of these two constraints correctly rules out light falling diphthongs universally while admitting heavy rising diphthongs to account for systems like Slovak, it is vulnerable to the same criticism as the formulation of the constraints themselves (see §4.2.1 above, starting on page 122). Namely, it is *ad hoc*; notice that there is no

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[14] Cases of falling diphthongs in closed syllables do occur in certain systems. In Icelandic (Árnason 1980), such syllables are accounted for by syllabifying the consonant as a 'nonmoraic syllable appendix' (Rosenthall 1994:24 after Sherer 1994). In Fijian (§2.2.1.2, starting on page 21), light falling diphthongs can occur in Trochaic Levelling contexts, and presumably arise through a ranking where HD-GOV and segmental faithfulness constraints outrank *COMPLEX. Thanks to a member of the 2002 LSA audience for bringing this to my attention.

Taking a different approach, Kaye (1985:289) suggests that this may follow from a universal convention which requires the less sonorous melody in a complex segment to be pronounced first. Such a ban would account for the fact that affricates are stop-initial rather than fricative-initial, but would require a special provision for prenasalized stops (nasal-initial).

principled reason why heavy rising diphthongs should not be universally excluded and light falling diphthongs admitted. On the present analysis, however, this effect falls out of constraint interaction, as will be demonstrated presently.

Recall from the previous section that heavy rising diphthongs are predicted to occur under the factorial typology of rankings of HD-PROM, TROCHDEF and *COMPLEX. In the case of rising diphthongs, constraint interaction yields differing optimal outputs according to which of the three constraints is ranked *lowest* in the local hierarchy. Now consider the case of falling diphthongs. The six possible constraint rankings which generate the factorial typology are considered in tableaux (33)-(35) below.[15]

(33) Falling diphthongs under constraint interaction: ranking 1 (repeated from (22))

Input:	ai	**HD-PROM**	**TROCHDEF**	***COMPLEX**
a.	$[\mu\ \underline{\mu}]$ ∣ ∣ a i	*!	*	
b. ☞	$[\underline{\mu}\ \mu]$ ∣ ∣ a i			
c.	$[\underline{\mu}]$ ∧ a i			*!

(34) Falling diphthongs under constraint interaction: ranking 2 (cf. (29))

Input:	ai	***COMPLEX**	**HD-PROM**	**TROCHDEF**
a.	$[\mu\ \underline{\mu}]$ ∣ ∣ a i		*!	*
b. ☞	$[\underline{\mu}\ \mu]$ ∣ ∣ a i			
c.	$[\underline{\mu}]$ ∧ a i	*!		

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[15] Although there are six possible rankings, only three tableaux are provided since the relative ranking of the two higher-ranked constraints for each tableau plays no role in determining the output.

(35) Falling diphthongs under constraint interaction: ranking 3 (cf. (32))

Input:	ai	**TrochDef**	***Complex**	**Hd-Prom**
a.	[μ $\underline{\mu}$] | | a i	*!		*
b. ☞	[$\underline{\mu}$ μ] | | a i			
c.	[$\underline{\mu}$] ∧ a i		*!	

In sharp contrast to the case of rising diphthongs, where constraint reranking leads to different outputs, in the case of falling diphthongs, all three rankings select the same output: a (left-headed) heavy falling diphthong. This result follows again from the conflict that arises between Hd-Prom and TrochDef in the case of heavy rising diphthongs, whereby the satisfaction of one entails the violation of the other. This situation means that outputs may vary according to constraint ranking. In the case of heavy falling diphthongs, however, Hd-Prom and TrochDef function harmoniously, converging on the a single output regardless of constraint ranking. The fact that light falling diphthongs are universally unattested can thus be understood as an emergent property of constraint interaction rather than an explicit ban resulting from a universally undominated constraint or principle. With respect to these three constraints, there is simply no ranking for which a light falling diphthong would emerge the optimal output.

4.5 Long Vowel Diphthongization

A final area of consideration is with regard to the interaction of rhythmic and prominence constraints is the case of long monophthongs. Long monophthongs violate Hd-Prom because the intrinsic prominence of both head and dependent mora is equal.[16] In systems

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[16] Rosenthall & Van der Hulst (1999) formalize a dispreference for long monophthongs by means of the

where HD-PROM is highly-ranked, we expect long vowels to undergo diphthongization in order to increase the relative prominence of the head mora (cf. Trochaic Lengthening, §2.2.2.1) while at the same time preserving the underlying mora count.[17] Diphthongization would be expected to target long (bimoraic) vowels only, and would normally be expected to create falling diphthongs, in satisfaction of TROCHDEF. Exactly this pattern emerges in the Malmö dialect of Swedish and in Quebec French, as shown in (36) and (37) below, respectively.

(36) Synchronic diphthongization in Malmö Swedish (Bruce 1970:9)[18]

FRONT UNROUNDED	FRONT ROUNDED	BACK
iː → ei	yː → øy	uː → eu
eː → ɛe	ʉː → øʉ	oː → ɛo
ɛː → æɛ	øː → œø	ɔː → æɔ

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constraint NO-LONG-VOWEL (NLV).

[17] Another prediction is that bimoraic diphthongs may be well-formed in certain systems while bimoraic monophthongs are not. This appears to be the case in Dutch (Lahiri & Koreman 1988; Kager 1989).

This claim is also supported by perceptual evidence. Sanders (2002:11) observes that "[t]he duration contrast between a short vowel and a diphthong is better than that between a short vowel and a long vowel since diphthongization adds an extra acoustic signal (dynamic formants) as a cue to duration."

[18] Bruce transcribes the vowel /ɔ/ as /ɑ/. Acoustically, however, it has a higher F1 than /æ/ (p. 17), and Bruce identifies /ɑ/ featurally as [+lab] and [+mid] in contrast to /æ/ which is [-lab] and [-mid] (p, 13). It thus seems more appropriate to transcribe this vowel here as /ɔ/.

(37) Synchronic diphthongization in Quebec French (Dumas 1981:12)

FRONT UNROUNDED	FRONT ROUNDED	BACK
iː → ɪi	yː → ʏy	uː → ʊu
eː → ɛi	øː → œy	oː → ɔu
ɛː → ai	œː → ay	ɔː ɒː → ɑu
ẽː → ɛ̃i	œ̃ː → ãy	ɔ̃ː → ɔ̃u
		ɑ̃ː → ɑ̃u

An interesting fact about diphthongization in both systems is that the process is generally restricted to stressed syllables. In Malmö Swedish this is an absolute restriction (Bruce 1970:11), while in Quebec French there is some variability: diphthongization is systematic in stressed syllables, with unstressed long vowels undergoing diphthongization dialectically, notably in the Quebec City region and in Beauce (Dumas 1981:18-19). Data illustrating diphthongization in Quebec French are given in (38) below. (Long vocoids are underlined.)

(38) Quebec French diphthongization (Dumas 1981:18)

a.	ʏnpẽːtsʏ́yr	*une peinture*	'a painting'
b.	oːfʊ́ur	*au four*	'in the oven'
c.	ẽbleːzœ́y	*un blazer*	'a blazer'

As discussed in §2, HD-PROM is preferentially enforced in head position of the relevant prosodic category, a result that follows from the universal harmonic ordering repeated as (39) below.

(39) Universal Harmonic Ordering of HD-PROM Constraints (repeated from example (65) on page 51)

HD-PROM(HD) >> HD-PROM

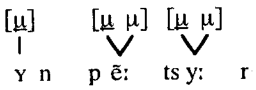
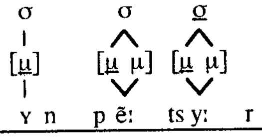
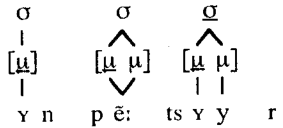
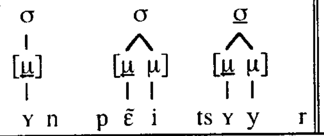
This ranking accounts for the fact that Trochaic Lengthening is restricted in many languages to the head-foot of the prosodic word (cf. §2.2.4 above, starting on page 50). With respect to the present case, the ranking in (39) means the constraint enforcing HD-PROM in the head-syllable of a foot outranks the more general constraint enforcing HD-PROM in all syllables. This is represented by the ranking in (40)b below

(40) Universal Ranking of HD-PROM Constraints at the Foot and Syllable Levels (repeated from example (66) on page 51)

a. HD-PROM(HD-Foot(PWd)) >> HD-PROM(Foot)
b. HD-PROM(HD-Syll(Foot)) >> HD-PROM(Syll)

If a faithfulness constraint such as IDENT-F is ranked between the two HD-PROM constraints, the result is diphthongization in the head syllables of feet only, as illustrated in (41) below, cf. Trochaic Lengthening in head-feet in (67)b on page 52.

(41) Diphthongization in the head syllable *only*[19]

Input: *une peinture* 	**HD-PROM(HD)**	**IDENT-F**	**HD-PROM**
a. 	*!		**
b. ☞ 		*	*
c. 		**!	

Candidate (41)a fatally violates HD-PROM(HD) since the final (head) syllable is a long monophthong, i.e. the head mora is no more intrinsically prominent than the dependent mora. Candidates (41)b and (41)c avoid this violation by diphthongizing the final long vowel at the cost of a faithfulness violation. Candidate (41)c incurs an additional faithfulness violation, however, for diphthongizing the unstressed long vowel as well, and is thus eliminated. This leaves candidate, (41)b as optimal, despite a violation of lower-ranking HD-PROM, which incurs a violation for each long monophthong, regardless of whether it occurs in a head syllable or not.

The universal harmonic ordering of HD-PROM constraints thus provides a straightforward account of the restriction of this type of diphthongization to stressed long vowels — it is precisely stressed long vowels that occur in the head position of feet.

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[19] While vowel length is phonemic in Quebec French, Dumas assumes that length in final syllables can also be derived. I abstract away from this issue here.

Diphthongization satisfies HD-PROM by matching the intrinsic sonority-prominence profile of the vocalic melody with the (trochaic) prominence contour of a bimoraic syllable.

4.6 Summary

The analysis presented in this chapter exploits the interaction of HD-PROM and TROCHDEF to provide a principled account for the observation that, cross-linguistically, rising diphthongs tend to behave as monomoraic while falling diphthongs tend to behave as bimoraic. This asymmetry arises out of a conflict between the prominence contour assigned over tautosyllabic moras and the intrinsic sonority-prominence of the segments associated to them. The occurrence of heavy rising diphthongs in Slovak and Frisian follows from the low-ranking in these grammars of TROCHDEF and HD-PROM, respectively, while the universal ban on light falling diphthongs follows from the fact that such structures are sub-optimal on all constraint rankings. Constraint interaction also explains patterns of synchronic diphthongization in Malmö Swedish and Quebec French, where heavy falling diphthongs are derived from long monophthongs in satisfaction of HD-PROM. The facts of diphthongization in these systems provide additional evidence for the universal harmonic ordering of HD-PROM constraints, according to which HD-PROM is preferentially enforced in prosodic heads.

In the following chapter we will extend the discussion of rhythm in prosodic domains, deriving TROCHDEF and other cross-linguistic asymmetries in patterns of rhythmic markedness through constraint interaction.

5. IAMBIC AND TROCHAIC RHYTHM IN PROSODIC DOMAINS

5.1 Introduction

While much work has been done in recent years on theories of metrical structure which depend crucially on the rhythmic notions of iambicity and trochaicity, relatively little progress has been made on the formal expression of the distinction between these two rhythmic forms. While in some theories the distinction is absorbed into other categories such as *foot type* (Hayes 1995), theories which recognize iambicity and trochaicity as primitives express them in terms of a simple binary parameter (Kager 1993) or two symmetric mutually-offsetting constraints (Prince & Smolensky 1993). A notable exception is Van de Vijver (1998), who characterizes iambic systems as those which militate against prominent syllables at word edges. Building on this work, the present chapter adapts Van de Vijver's analysis to moraic domains at the foot and syllable level, exploiting the same formal mechanism to account for a number of iambic/trochaic markedness asymmetries as well as the shapes of canonical iambic and trochaic feet. We begin with an overview of a number of markedness asymmetries — i.e. disproportionate cross-linguistic distribution of properties — between iambic and trochaic systems.

5.2 Iambic / Trochaic Markedness Asymmetries

5.2.1 The Syllabic Iamb

The theory of foot structure developed in §2.3.3 (starting on page 56) exploits two pairs of constraints — RHTYPE=T/I and RHUNIT=μ/σ — which generate the foot inventory in (1) below.

(1) Symmetric Parsing Foot Inventory (Kager 1993)

	Syllabic	*Moraic*
Trochee	($\underline{\sigma}$ σ)	($\underline{\mu}$ μ)
Iamb	(σ $\underline{\sigma}$)	(μ $\underline{\mu}$)

There are a number of markedness asymmetries between trochaic and iambic systems which do not fall out of this model, however. Across the world's languages, mora-based systems are much better attested than syllable-based ones, and trochaic systems are much better attested than iambic ones. The most striking asymmetry, however, is the fact that the syllabic iamb is *extremely* rare, attested in only three systems (Kager 1993:407) — Yidiɲ, Seneca, and Araucanian. The markedness of this structure led Hayes (1995) to exclude the quantity-sensitive iamb entirely from his inventory of possible foot types, accommodating such languages with a slightly expanded 'standard iamb' (see example (3) on page 14) If iambicity / trochaicity is seen to follow from a simple binary parameter or set of two freely-ranked mutually-negating constraints like RHTYPE=T/I, the extreme markedness of syllabic iamb systems must be viewed as accidental. One goal of the present chapter is thus to re-examine the nature of iambicity and attempt to derive this asymmetry from independently-motivated principles.

5.2.2 Iambic Lengthening

The expansion of the bimoraic even (L$\underline{\text{L}}$) iamb into the trimoraic (L$\underline{\text{H}}$) iamb through Iambic Lengthening is perhaps the most widely-attested quantitative process in prosodic theory. As mentioned in §2.2.2, the frequency of Iambic Lengthening across the world's languages is all the more conspicuous given the relative markedness of iambic systems *vis à vis* trochaic ones, cross-linguistically. In a study of over 150 languages, Hayes (1995:83, 148) lists just 5 systems as exemplars of /HL/ → ($\underline{\text{L}}$L) Trochaic Levelling, while Iambic Lengthening occurs in 19 systems. Moreover, while quantitative processes driven by HD-PROM are often restricted to the head constituent of a higher prosodic category (see §2.2.4 and §4.5), Iambic Lengthening typically applies in *every foot* in the word. For this reason, it seems prudent to look elsewhere for an explanation of this process. Following Kager (1993,1995, 1999), I focus on the rhythmic properties of iambic feet.

Kager (1993) sees the asymmetric tendency of moraic iamb systems to undergo lengthening as a consequence of rhythmic constraints against clash and lapse at the moraic level. On this view, Iambic Lengthening from (LL̲) = ([.][*]) to (LH̲) = ([.][* .]) serves to remove final-mora prominence within the foot, thereby forestalling the possibility of a mora-clash between feet in the event that the following foot is the prominence-initial (H̲) = ([* .]) iamb. By contrast, in a trochaic system augmentation from (L̲L) = ([*][.]) to (H̲L) = ([* .][.]) is unmotivated for purposes of clash avoidance since neither trochee (i.e. (L̲L) = ([*][.]) or (H̲) = ([* .])) has final prominence. Moreover, such augmentation would violate a ban on mora lapse, since it would create a sequence of two unstressed moras (cf. HD-GOV).

This argumentation relies crucially, however, on the assumption that the prominence contour within a heavy syllable falls (Prince 1983, cf., TROCHDEF, example (15) on page 127). In the following section we will derive this effect through constraint interaction.

5.3 Rhythm through Constraint Interaction

5.3.1 Deriving Trochaicity in Binary Domains

In addition to the utility of an assumption like TROCHDEF in making metrical theories such as that developed in the previous chapter function properly, there is substantial empirical evidence from a wide variety of sources that final prominence in binary domains is dispreferred. This evidence is summarized in table (2) below.

(2) Iambic markedness in binary domains

		Trochaic (unmarked)	*Iambic (marked)*
a.	*Moraic consonants*	codas, i.e. $[\underline{V}_\mu C_\mu]$	*onsets, i.e. *$[C_\mu \underline{V}_\mu]$
b.	*Heavy diphthongs*	falling, i.e. $[\underline{V}_\mu G_\mu]$	*rising, i.e. *$[G_\mu \underline{V}_\mu]$
c.	*Mora-based feet*	moraic trochees, i.e. $(\underline{\mu}\mu)$	*even iambs, i.e. *$(\mu\underline{\mu})$
d.	*Syllable-based feet*	syllabic trochees, i.e. $(\underline{\sigma}\sigma)$	*syllabic iambs, i.e. *$(\sigma\underline{\sigma})$

It is a well known linguistic fact that coda consonants often contribute to syllable weight creating heavy or bimoraic syllables, and giving the syllable a trochaic $[\underline{V}_\mu C_\mu]$ prominence profile at the moraic level (cf. *Weight-by-Position* in §4.2.4.1, starting on page 129). By contrast, the occurrence of weight-bearing onset consonants is extremely rare, as the result would be a bimoraic syllable with an iambic $[C_\mu \underline{V}_\mu]$ rhythmic profile. As we saw in §4, bimoraic diphthongs are overwhelmingly trochaic as well, i.e. falling in sonority from a peak to an offglide $[\underline{V}_\mu G_\mu]$ — while heavy rising $[G_\mu \underline{V}_\mu]$ diphthongs are attested in only a handful of languages. At the foot level, strictly binary mora-based feet almost universally display initial prominence: $(\underline{\mu}\mu)$, as do binary syllable-based or 'quantity-insensitive' feet: $(\underline{\sigma}\sigma)$, as mentioned above. Interestingly, the strong preference for initial prominence vanishes in larger domains such as trimoraic iambic feet and prosodic words. The solution to the problem would seem to lie in some property unique to binary domains.

In an extensive analysis of iambicity in prosodic phonology, Van de Vijver (1998) develops a formal mechanism which derives invariant initial prominence under constraint interaction just in case the rhythmic domain is binary. Although Van de Vijver does not specifically apply this mechanism to syllable-internal mora-rhythm, his proposal can be extended to such cases with only minimal modification.

We begin by assuming the general constraint in (3) below, which requires trochaic grouping regardless of domain size.

(3) PEAK-FIRST (Mellander 2001b; cf. TROCHEE: Van de Vijver 1998:6)

Metrical groupings are prominence-initial.

PEAK-FIRST demands initial prominence in metrical groupings, and is similar to other constraints which have been proposed in the recent literature, e.g. RH-TYPE=T (example (70) on page 56), TROCHDEF (example (15) on page 127), cf. RH-CONTOUR (example (9) on page 18).

Given PEAK-FIRST, a natural question which arises is why iambic rhythm exists at all. Following Van de Vijver (1998) and departing from the view developed in previous chapters, I will assume that there is no parallel constraint requiring final prominence *per se* (cf. RHTYPE=I, example (70) on page 56), as such a move would render the relative markedness of iambic structures accidental, given freely-ranked constraints. Instead, I adopt the following constraint, along the lines of Van de Vijver (1998).

(4) *EDGEMOST (cf. Van de Vijver 1998:7)

Within the foot, edge-adjacent elements may not be prominent.

Similar to the NONFINALITY constraint of Prince & Smolensky (1993: given as example (57) on page 112) banning PWd-heads in PWd-final position, *EDGEMOST militates against both domain-final *and* domain-initial prominence.

Given a binary domain, if PEAK-FIRST >> *EDGEMOST, a trochaic rhythmic profile emerges as a consequence of constraint interaction. This is illustrated in tableau (5) below.

(5) PEAK-FIRST >> *EDGEMOST: Trochaic Rhythm

Input: [μμ]	PEAK-FIRST	*EDGEMOST
a. ☞ [* .]		*
b. [. *]	*!	*

Candidate (5)b — representing final prominence within a bimoraic syllable — fatally violates high-ranking PEAK-FIRST because the domain-initial mora is not prominent. This means that the optimal output is candidate (5)a — representing initial prominence within a bimoraic syllable — despite a violation of lower-ranking *EDGEMOST.

Now consider the opposite ranking, where *EDGEMOST >> PEAK-FIRST, given in (6) below. Interestingly, this ranking also generates a trochaic rhythmic profile.

(6) *EDGEMOST >> PEAK-FIRST: Trochaic Rhythm

Input: [μμ]	*EDGEMOST	PEAK-FIRST
a. ☞ [* .]	*	
b. [. *]	*	*!

Candidates (6)a and (6)b both violate *EDGEMOST due to prominence at the syllable edge. In addition to this, however, candidate (6)b violates PEAK-FIRST due to a lack of initial prominence.

The fact that both rankings generate the same outcome follows from the fact that the effects of *EDGEMOST are neutralized in a domain consisting of only two elements, since it will be violated equally by both trochaic and iambic parses. The absence of a constraint which offsets PEAK-FIRST in this environment by specifically demanding final prominence means that PEAK-FIRST is the decisive constraint regardless of its ranking with respect to *EDGEMOST. Other things being equal, this mechanism predicts invariant initial prominence in binary domains.[1]

Armed with a principled explanation for the inherent trochaicity of heavy syllables and other binary rhythmic domains, we are now in a better position to understand iambic markedness in the foot inventory.

5.4 The Rhythmic Profile of Metrical Feet

Recall that stress systems are subject to HD-GOV, repeated below.

(7) HEAD GOVERNMENT (HD-GOV: repeated from example (4) on page 5)

Dependent elements within a foot must be governed by the foot-head, which is:

a. strictly adjacent to governed positions, and

b. associated with an edge-adjacent syllable.

HD-GOV effectively limits the maximal expansion of metrical feet to three moras or two syllables (see §2.3 for discussion, especially starting on page 56). Consequently, rhythmic groupings with four or more elements are omitted from the following tableaux. Since unary groupings consisting of a single element violate FT-BIN, they will be omitted as well. The range of consideration is thus limited to binary and ternary groupings.

5.4.1 Mora-based Feet

We consider first systems where feet are constructed upon groupings of moras. In (8) below, the five possible binary and ternary groupings are evaluated according to the ranking PEAK-FIRST >> *EDGEMOST.

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[1] As mentioned in the previous chapter, heavy rising diphthongs of the Slovak type arise through a constraint ranking where a rising prominence contour is optimally parsed as bimoraic to avoid violations of *COMPLEX, and not in response to a *rhythmic* requirement of iambicity.

(8) Moraic trochees under HD-GOV >> PEAK-FIRST >> *EDGEMOST

	HD-GOV	**PEAK-FIRST**	***EDGEMOST**
a. ☞ (* .)			*
b. (. *)		*!	*
c. (* . .)	*!		*
d. (. * .)		*!	
e. (. . *)	*!	*	*

Candidates (8)c and (8)e fatally violate HD-GOV, because in each case there is a dependent element which is not adjacent to the head. Candidates (8)b and (8)d are ruled out by PEAK-FIRST, since neither of these exhibits initial prominence. This leaves candidate (8)a as optimal, despite a violation of *EDGEMOST. The reverse ranking is given in (9) below.

(9) Moraic amphibrachs under HD-GOV >> *EDGEMOST >> PEAK-FIRST

	HD-GOV	***EDGEMOST**	**PEAK-FIRST**
a. (* .)		*!	
b. (. *)		*!	*
c. (* . .)	*!	*	
d. ☞ (. * .)			*
e. (. . *)	*!	*	*

Candidates (9)c and (9)e fatally violate HD-GOV while candidates (9)a and (9)b fatally violate *EDGEMOST, leaving candidate (9)d as optimal despite a violation of low ranking PEAK-FIRST.

In a string of moras, the ranking of PEAK-FIRST >> *EDGEMOST generates a binary prominence-initial foot — a moraic trochee. The moraic trochee can assume two possible shapes, as shown in (10) below, where foot-internal syllable boundaries are marked.

(10) Variable shapes of the moraic trochee

	HD-GOV	**PEAK-FIRST**	***EDGEMOST**
a. ☞ ([*][.])			**
b. ☞ ([* .])			**

Both the bisyllabic and monosyllabic parses of the moraic trochee fare equally well against all constraints and thus both are well formed. The two violations of *EDGEMOST result one each from syllable-peripheral and foot-peripheral prominence, respectively, in both candidates.

The situation is somewhat different in the case of the ranking *EDGEMOST >> PEAK-FIRST. Here, the optimal output is a trimoraic foot with prominence on the second mora — a moraic amphibrach (Kager 1993). There are three possible syllable parses for this configuration of moras, as illustrated in (11) below.

(11) Iambic realisation of a moraic amphibrach

	HD-GOV	***EDGEMOST**	**PEAK-FIRST**
a. ([.][*][.])	*!	*	
b. ([. *][.])		*	**!
c. ☞ ([.][* .])		*	*

The trisyllabic parse in candidate (11)a is ruled out by HD-GOV, which requires the head *syllable* to be edge-adjacent. The remaining two candidates each incur a violation of *EDGEMOST for peripheral prominence within the syllable and one violation of PEAK-

FIRST for non-initial prominence within the foot. However, candidate (11)b incurs a fatal second violation of PEAK-FIRST for non-initial prominence within the syllable, leaving candidate (11)c as optimal.

The canonical shapes of mora-based feet thus emerge straightforwardly through constraint interaction and are summarized in (12) below.

(12) Mora-based feet through constraint interaction

	Ranking	*Foot Types*	
Trochee	PEAK-FIRST >> *EDGEMOST	([*][.])	($\underline{L}$L)
		([* .])	($\underline{H}$)
Iamb	*EDGEMOST >> PEAK-FIRST	([.][* .])	(L$\underline{H}$)

A ranking of PEAK-FIRST >> *EDGEMOST generates moraic trochees which can occur freely as either ($\underline{L}$L) or ($\underline{H}$) while the ranking of *EDGEMOST >> PEAK-FIRST generates moraic iambs of the shape (L$\underline{H}$).

5.4.2 Syllable-based Feet

Now consider syllable-based feet. Since HD-GOV imposes the dual requirements that all dependent elements be adjacent to the head and that the head be adjacent to a foot-edge, all ternary parses are ruled out in syllable based systems. This is shown in (13) below, which evaluates candidates against the ranking PEAK-FIRST >> *EDGEMOST.

(13) Syllabic Trochees under Hd-Gov >> Peak-First >> *Edgemost

	Hd-Gov	**Peak-First**	***Edgemost**
a. ☞ (* .)			*
b. (. *)		*!	*
c. (* . .)	*!		*
d. (. * .)	*!	*	
e. (. . *)	*!	*	*

Candidates (13)c and (13)e violate Hd-Gov because the final and initial syllables, respectively, are not adjacent to the head. Candidate (13)d violates Hd-Gov because the head syllable is not edge-adjacent. Candidate (13)b fatally violates Peak-First, leaving candidate (13)a as optimal. Now consider the opposite ranking: *Edgemost >> Peak-First. This result is illustrated in (14) below.

(14) Syllabic trochees under Hd-Gov >> *Edgemost >> Peak-First

	Hd-Gov	***Edgemost**	**Peak-First**
a. ☞ (* .)		*	
b. (. *)		*	*!
c. (* . .)	*!	*	
d. (. * .)	*!		*
e. (. . *)	*!	*	*

Candidates (14)c, (14)d, and (14)e fatally violate Hd-Gov, while both remaining candidates fare equally well on *Edgemost. Candidate (14)b fatally violates Peak-First, however, leaving candidate (14)a as optimal.

Since Hd-Gov has the effect of imposing strict binarity on syllable-based systems (see §2.3.3.1 starting on page 58 for discussion), the outcome is exactly the same as that within the strictly binary domain of heavy syllables: no matter which ranking is selected, the result is trochaicity. This result is summarized in (15) below.

(15) Syllable-based feet through constraint interaction

	Ranking	*Foot Types*	
Trochee	PEAK-FIRST >> *EDGEMOST	(* .)	$(\underline{\sigma}\sigma)$
	*EDGEMOST >> PEAK-FIRST		
Iamb	--	--	

Stated differently, there is no ranking of these two constraints which will generate iambic prominence over a *structurally* bisyllabic domain (i.e. where RHUNIT=σ >> RHUNIT=μ, cf. the *nominally* bisyllabic but structurally trimoraic domain of the canonical moraic iamb in (11) above). The extreme markedness of syllabic iamb systems cross-linguistically thus follows straightforwardly from the interaction of the constraints assumed here.

5.5 Cross-linguistic Patterns of Rhythmic Organisation

5.5.1 Deriving the Iambic / Trochaic Law

A significant result in the present analysis is that the interaction of PEAK-FIRST and *EDGEMOST produces the iambic / trochaic quantitative asymmetries which constitute the Iambic / Trochaic Law (ITL). Kager's (1993:382) descriptive formulation is repeated as (16) below.

(16) Iambic/Trochaic Law (repeated from example (2) on page 13)

a. Trochaic systems have durationally even feet.

b. Iambic systems have durationally uneven feet.

We are now in a position to understand the mechanics between these two sets of correlated phenomena. The correlation between even quantity and initial prominence follows from the fact that quantitatively even groupings (e.g. moraic trochees) are binary at a structural level, and under constraint interaction such groupings invariably surface with initial prominence, as summarized in (17)a below.

(17) The Iambic Trochaic Law as a consequence of constraint interaction

a. *Even Quantity:* (μμ) (* .) ([*][.])

b. *Uneven Quantity:* (μμμ) (. * .) ([.][* .])

By contrast, quantitatively uneven groupings (e.g. moraic iambs) are *ternary* at a structural level, and under constraint interaction such groupings invariably surface with medial prominence, which is realised as final prominence when binarity is subsequently imposed, as shown in (17)b above.

On such a view, the ITL has nothing to do with 'quantity' in the sense of syllable weight or duration *per se*, but rather — and crucially — in terms of the number of rhythmic units in the domain. The asymmetry arises from the fact that a quantitatively even binary grouping is analysable in terms of two rhythmic units, and is thus *truly* binary for purposes of assessment against rhythmic constraints. Conversely, a quantitatively uneven binary grouping must by definition contain (at least) three rhythmic units, and is thus only ***nominally*** binary. The ultimate rhythmic organisation of the grouping reflects this basic structural distinction.

This interpretation is corroborated by evidence from quantitative processes. Recall from §2.3.1 that Trochaic Levelling, which creates even (LL) through shortening of a heavy syllable in an /HL/ or /LH/ sequence, occurs in mora-based systems *only,* i.e. in those systems where /HL/ and /LH/ sequences are interpreted as structurally ternary under moraic analysis. In syllable-based systems, Trochaic Levelling is unattested. This fact cannot be predicted on the standard view without appealing to true quantity insensitivity in syllabic trochee systems, which is difficult to motivate empirically (Kager 1992, Fitzgerald to appear), especially given the widely attested quantitative processes in such systems.[2] This result follows straightforwardly, however, on the present view because /HL/ and /LH/ sequences are fundamentally binary under syllabic analysis. The mechanics of Trochaic Levelling and Iambic Lengthening will be addressed in the following section.

5.5.2 Quantitative Processes

As mentioned in §2.2, the two major quantitative processes in mora-based systems are the Trochaic Levelling and Iambic Lengthening, repeated in (18) below.

(18) Quantitative Adjustment under the ITL (repeated from example (12) on page 19)

Iambic systems:

IAMBIC LENGTHENING: /LL/ → (L$\underline{\text{H}}$)

Trochaic systems:

TROCHAIC LEVELLING: /HL/ → ($\underline{\text{L}}$L), /LH/ → ($\underline{\text{L}}$L)

As we saw earlier in this chapter, however, Iambic Lengthening is far better attested than Trochaic Levelling.

In iambic systems, there is no way to parse the bimoraic /LL/ target sequence with a trimoraic canonical (L$\underline{\text{H}}$) iamb since the latter requires *three* moras and not two. The even (L$\underline{\text{L}}$) iamb is *rhythmically* sub-optimal, and thus quantity shift may ensue to optimize rhythmic well-formedness, as illustrated in (19) below.

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[2] See table (68) on page 54 for a breakdown of trochaic quantitative processes by system type.

(19) Iambic Lengthening

/LL/	*EDGEMOST	PEAK-FIRST	DEP-μ
a. ☞ ([.][* .])	*	*	*
b. ([.][*])	**!	*	

Candidate (19)b incurs a fatal second violation of *EDGEMOST due to foot-final stress, leaving candidate (19)a as optimal despite a violation of lower-ranked DEP-μ.

In a trochaic system, however, it is *always* possible to construct a well-formed trochee over an /HL/ or /LH/ sequence as (H)L or L(H), respectively. Since the (H) and (LL) moraic trochees are equally well-formed rhythmically, as demonstrated in (10) above, the quantity shift cannot improve the well-formedness of the foot. This is demonstrated in (20) below.

(20) No Trochaic Levelling

/HL/	PEAK-FIRST	*EDGEMOST	MAX-μ
a. ([*][.])		**	*!
b. ☞ ([* .])		**	

Since both candidates in (20) fare equally well on the rhythmic constraints, the extra violation of MAX-μ incurred by candidate (20)a for a quantity shift is not well-motivated and candidate (20)b surfaces as optimal.

While other constraints must be invoked to motivate Trochaic Levelling,[3] Iambic

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[3] A likely candidate is PARSE-σ, since Trochaic Levelling also has the effect of improving the overall parse of syllables into feet. There appear, however, to be no attested Trochaic Levelling systems which undergo the process obligatorily in all contexts where an unparsed syllable could be avoided (Mellander 2000a, b).

Lengthening follows directly from the interaction of rhythmic constraints. Other things equal, even iambs will lengthen while heavy syllables in /HL/ and /LH/ sequences will not undergo shortening. Constraint interaction thus offers a straightforward explanation for the relative markedness of Trochaic Levelling *vis à vis* Iambic Lengthening.

5.6 Concluding Remarks

The rhythmic mechanism developed in this chapter provides a principled account for a number of asymmetries which obtain between iambic and trochaic systems, including the markedness of iambic rhythm in binary domains, the asymmetric shapes of canonical iambic and trochaic feet, and quantitative processes. All these patterns fall out of the interaction of PEAK-FIRST and *EDGEMOST with varying outcomes as a function of domain size. On this view, the Iambic / Trochaic Law is seen to follow from the fact that durationally uneven groupings are structurally ternary and surface as iambic under constraint interaction, whereas durationally even groupings are structurally binary and surface as trochaic under constraint interaction,

One consequence of the analysis is invariant trochaicity in binary domains. While such a prediction is borne out in the overwhelming majority of cases, it is not universal. Although quite uncommon, iambic binary structures are attested, e.g. weight-bearing onsets (Davis 1988), heavy rising diphthongs (§4.3.1, starting on page 133), even moraic iambs (Hayes 1995:266-7) and the syllabic iamb as mentioned above (Kager 1993:407). Anomalies in broad cross-linguistic patterns are predicted to arise under the factorial typology of possible OT grammars, but the nature of the precise constraints which drive exceptional iambic rhythm in binary domains is left to future research.[4]

In the following chapter we will explore ternary stress systems, which are argued

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[4] See Mellander (2002c, in press a) for further work on PEAK-FIRST/*EDGEMOST.

to arise as special cases of binary stress where a premium is placed on the satisfaction of HD-PROM.

6. A PROMINENCE-DRIVEN MODEL OF TERNARITY

6.1 Introduction

While stress systems in the vast majority of the world's languages can be characterized in terms of binary rhythmic alternations between strong and weak elements, a number of systems exhibit a *ternary* pattern, i.e. strong beats occurring on every third element rather than every second element in a rhythmic domain. Ternary systems present an interesting challenge for prosodic theory for two reasons. Firstly, binary and ternary rhythm represent the exhaustive range of bounded stress systems attested in the world's languages; the formal expression of bounded rhythm must therefore exclude unattested quaternary and quinternary systems on *principled* grounds, stating binary and ternary rhythm as the sole *possible* outcomes, rather than as instantiations of a fundamentally *n*-ary rhythmic mechanism.

Secondly, ternary systems are quite uncommon across the world's languages, and thus as pointed out by Hayes (1995:307), an adequate analysis of ternarity must not only account for the range of attested ternary patterns, but must also explain why ternarity is a marked rhythmic option. Approaches which capture ternarity by augmenting the basic foot inventory to include ternary feet such as Halle & Vergnaud (1987) and Levin (1988) are vulnerable on this front as the cross-linguistic markedness of such foot types must be viewed as accidental. Other analyses, such as Hayes (1995) and Kager (1994), express ternarity as an alternative realisation of the standard inventory of foot types in which feet are required to be non-adjacent to one another.

These approaches all suffer from the fact that they require ternary-specific devices, however. In view of this problem, Elenbaas & Kager (1999) appeal to *LAPSE, a ban on sequences of three or more adjacent unstressed syllables, which they argue to be independently needed to account for certain phenomena in Sentani, a language with a binary stress system. While following the spirit of this endeavour, the present chapter offers a re-analysis of the Sentani facts which does not require *LAPSE, and proposes an alternative explanation for ternarity in terms of ternary realisations of the basic foot types developed in §2.

6.2 Sentani without *LAPSE

Sentani is a Papuan language spoken in Irian Jaya, Indonesia, and analysed by Elenbaas (1999). Main stress in Sentani falls on the penultimate syllable with secondary stress on the second syllable in words of four or more syllables. Secondary stress also occurs on the fourth syllable in seven-syllable words, as illustrated in (1) below. (Data from Elenbaas & Kager 1999.)

(1) Sentani stress

a.	bóhi	'next'
b.	walóbo	'spirit'
c.	fomàlɛ́re	'for we will go across'
d.	haxòmibóxe	'he obeyed them'
e.	molòkoxawále	'I wrote to you'
f.	molòkoxàwalɛ́ne	'because I wrote to you'

In seven-syllable words with schwa in the pre-antepenultimate syllable, stress shifts rightward to the antepenult resulting in a stress clash. Six-syllable words with schwa in the pre-antepenultimate syllable receive normal stress. These patterns are exemplified in (2)b and (2)a, respectively.

(2) Sentani stress with pre-antepenultimate schwa

a.	alɛ̂nnəxondɛ́re	'so that he gives a message with his feet'
b.	molònasəhàndéra	'after they will bury me'

6.2.1 Elenbaas' & Kager's (1999) Analysis

Elenbaas & Kager (1999) analyse the pattern of penultimate and peninitial stress in terms of *opposite dominance*, i.e. where a trochee is aligned with the right word-edge and an iamb is aligned with the left word-edge, as illustrated by the foot structure in (3).

(3) Opposite dominance analysis of Sentani stress (Elenbaas & Kager 1999)

a.	bóhi	(σ̲ σ)
b.	walóbo	σ (σ̲ σ)
c.	fomàlɛ́re	(σ σ̲) (σ̲ σ)
d.	haxòmibóxe	(σ σ̲) σ (σ̲ σ)
e.	molòkoxawále	(σ σ̲) σ σ (σ̲ σ)
f.	molòkoxàwalɛ́ne	(σ σ̲) (σ σ̲) σ (σ̲ σ)
g.	alɛ̂nnəxondɛ́re	(σ σ̲) ə σ (σ̲ σ)
h.	molònasəhàndéra	(σ σ̲) σ (ə σ̲) (σ̲ σ)

Formally, Elenbaas & Kager (1999) explain the pattern in (3) in terms of a fundamentally iambic system (RHTYPE=I >> RHTYPE=T: see §2.3.3 starting on page 56) in which trochaicity in the final foot is forced by the undominated constraints in (4) and (5) below. The trochaic main stress-foot is demonstrated in (6).

(4) ALIGN-HEAD-RIGHT (ALIGN-R: repeated from example (39) on page 36)

The head foot of the prosodic word is aligned with the rightmost edge of the prosodic word.

(5) NONFINALITY (repeated from example (57) on page 112)

No prosodic head of a prosodic word is final in the prosodic word.

(6) Trochaic head-foot in an iambic system (cf. Elenbaas & Kager 1999)

Input:	/σ σ σ/	ALIGN-R	NONFINALITY	RHTYPE=I	RHTYPE=T
a.	$\sigma\ (\sigma\ \underline{\sigma})$		*!		*
b.	$(\sigma\ \underline{\sigma})\ \sigma$	*!			*
c. ☞	$\sigma\ (\underline{\sigma}\ \sigma)$			*	
d.	$(\underline{\sigma}\ \sigma)\ \sigma$	*!		*	

Candidates (6)b and (6)d are ruled out by ALIGN-R for non-alignment of the head foot and the right word-edge, while candidate (6)a is ruled out by NONFINALITY for final stress.[1] This leaves the trochaic parse in (6)c as optimal despite the fact that RHTYPE=I >> RHTYPE=T.

Persistent peninitial secondary stress in longer words is accounted for by a constraint enforcing the alignment of a foot with the left word-edge. This constraint is given in (7) below. Other constraints are given in (8) and (9), and constraint interaction in longer words is demonstrated in (10).

(7) ALIGNFOOT-LEFT (ALIGNFT-L: cf. McCarthy & Prince 1993a)

The left word-edge is aligned with the edge of a foot.

(8) *CLASH (repeated from example (27) on page 91)

Adjacent syllables must not bear stress.

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[1] Elenbaas & Kager (1999) do not assess violations of NONFINALITY, for final syllables which are footed but unstressed, cf. Prince & Smolensky (1993).

(9) PARSE SYLLABLE (PARSE–σ: repeated from example (83) on page 65)

Syllables must be parsed by feet.

(10) Foot parsing in four-, six-, and seven-syllable words (cf. Elenbaas & Kager 1999)

	ALIGNFT-L	**RHTYPE=I**	***CLASH**	**PARSE-σ**
a. σ σ (σ̲ σ)	*!	*		**
b. ☞ (σ σ̲) (σ̲ σ)		*	*	
c. (σ̲ σ) (σ̲ σ)		**!		
d. σ σ σ σ (σ̲ σ)	*!	*		****
e. ☞ (σ σ̲) σ σ (σ̲ σ)		*		**
f. (σ σ̲) (σ σ̲) (σ̲ σ)		*	*!	
g. σ σ σ σ σ (σ̲ σ)	*!	*		*****
h. (σ σ̲) σ σ σ (σ̲ σ)		*		**!*
i. ☞ (σ σ̲) (σ σ̲) σ (σ̲ σ)		*		*

Candidates (10)a, (10)d and (10)g are eliminated by AlignFt-L since there is no foot aligned with the left word-edge. The remaining candidates all incur a single violation of RHTYPE=I for a trochaic foot at the right edge, but candidate (10)c incurs a second violation of RHTYPE=I which is fatal, leaving candidate (10)b as the optimal output for a four-syllable string. In six-syllable words the two medial syllables are left unparsed as in candidate (10)e, due to a violation of *CLASH by candidate (10)f. Finally, in seven-syllable words a third foot is constructed over the third and fourth syllables as in (10)i, which fares better with respect to PARSE-σ than its competitor, candidate (10)h. The constraint ranking ensures that *CLASH is violated in satisfaction of ALIGNFT-L (candidate (10)b), but never to satisfy PARSE-σ alone (candidate (10)f).

With regard to cases of pre-antepenultimate schwa, Elenbaas & Kager (1999) attribute stress-shift to a high-ranking constraint militating against syllables containing stressed schwa in open syllables, given in (11).

(11) *(C)ə́ (Elenbaas & Kager 1999)

No stressed schwa in open syllables.

Even with *(C)ə́, however, the analysis as presented so far fails to generate the correct output for (3)h. Observe that given the ranking *CLASH >> PARSE-σ necessary to explain the stress pattern of six-syllable words in (10) above, one would incorrectly predict the medial syllables forms like (3)h to remain unparsed as well. This undesirable result is illustrated in (12) below

(12) Medial lapse incorrectly predicted

Input:	/σ σ σ ə σ σ σ/	*(C)ə́	*CLASH	PARSE–σ
a.	(σ σ̲) (σ ə̲) σ (σ̲ σ)	*!		*
b.	(σ σ̲) σ (ə σ̲) (σ̲ σ)		*!	*
c.	(σ σ̲) (σ̲ ə) σ (σ̲ σ)		*!	*
d. ☛	(σ σ̲) σ ə σ (σ̲ σ)			***

Candidate (12)a fatally violates *(C)ə́ due to stressed schwa, while the grammatical candidate (12)b as well as candidate (12)c are eliminated by *CLASH for adjacent stressed syllables. This leaves the ungrammatical candidate (12)d as optimal despite three violations of low-ranking PARSE-σ.[2]

To avoid this outcome, Elenbaas & Kager (1999) posit an undominated anti-lapse

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[2] Note that a potential analysis of (3)h appealing to the relative well-formedness of (ə σ̲) over (σ σ̲) would be problematic, since medial syllables are not parsed into (ə σ̲) in (3)g.

constraint. Two possibilities are given below.

(13) PARSE-2 (Kager 1994)

Of every two stress units one must be parsed into a foot.

(14) *LAPSE (Elenbaas 1999)

Every weak beat must be adjacent to a strong beat or the word-edge.

Of these two options, Elenbaas & Kager (1999) argue that *LAPSE is empirically superior to PARSE-2 with regard to the Sentani facts. PARSE-2, they contend, is problematic since it leads to a ranking paradox. Observe that the presence of stress clash in seven-syllable words like (3)h requires that PARSE-2 >> *CLASH, while the absence of stress clash in six-syllable words like (3)e and (3)g requires that *CLASH >> PARSE-2, since two syllables are left unparsed. By contrast, since *LAPSE refers to grid-prominence rather than foot structure *per se*, it is not violated in (3)e and (3)g, and therefore the assumption that it is highly-ranked in Sentani is unproblematic.

Note, however, that the motivation for *LAPSE from Sentani is contingent on an opposite dominance analysis of the stress system, where medial unstressed syllables are crucially analysed as unfooted. In the following section, a different analysis of Sentani will be proposed, exploiting the rhythmic constraints developed in §5. It will be shown that the facts of Sentani stress can be accounted for in terms of PARSE-2, thereby removing the independent motivation for *LAPSE.

6.2.2 A Trochaic Analysis of Sentani

The pattern of penultimate and peninitial stress in (1) and (2) can be accounted for in terms of the ban on stress at PWd-edges given in (15) below.

(15) *EDGEMOST(PWd) (*EDGE-ω: Van de Vijver 1998, cf. example (4) on page 151)

Within the PWd, edge-adjacent elements may not be prominent.

*EDGE-ω militates against stressed syllables at PWd-edges. With respect to the analysis of Sentani, the assumption of *EDGE-ω rather than NONFINALITY allows us to do away with iambic footing altogether. A trochaic analysis of the pattern in (1) and (2) is given in (16) below.

(16) Sentani stress on a trochaic analysis

a.	bóhi	$(\underline{\sigma}\ \sigma)$
b.	walóbo	$\sigma\ (\underline{\sigma}\ \sigma)$
c.	fomàlɛ́re	$\sigma\ (\underline{\sigma})\ (\underline{\sigma}\ \sigma)$
d.	haxòmibóxe	$\sigma\ (\underline{\sigma}\ \sigma)\ (\underline{\sigma}\ \sigma)$
e.	molòkoxawále	$\sigma\ (\underline{\sigma}\ \sigma)\ \sigma\ (\underline{\sigma}\ \sigma)$
f.	molòkoxàwalɛ́ne	$\sigma\ (\underline{\sigma}\ \sigma)\ (\underline{\sigma}\ \sigma)\ (\underline{\sigma}\ \sigma)$
g.	alɛ̀nnəxondɛ́re	$\sigma\ (\underline{\sigma}\ \sigma)\ \sigma\ (\underline{\sigma}\ \sigma)$
h.	molònasəhàndéra	$\sigma\ (\underline{\sigma}\ \sigma)$ ə $(\underline{\sigma})\ (\underline{\sigma}\ \sigma)$

Since opposite dominance is no longer assumed, medial spans of two *unstressed* syllables in (16)e and (16)g must no longer be analysed as sequences of two *unfooted* syllables, cf. (3)e and (3)g.

An additional constraint is given in (17) below, followed immediately by the analysis for a six-syllable word in (18).

(17) FOOT BINARITY (FT-BIN: repeated from example (82) on page 65)

A foot must be binary at some level (syllable / mora).

(18) Six-syllable words

Input: /σ σ σ σ σ σ		**PARSE-2**	***EDGE-ω**	**ALIGN-R**	***(C)ə́**	**FT-BIN**	**PARSE–σ**
a.	$(\underline{\sigma}\ \sigma)\ \sigma\ \sigma\ (\underline{\sigma}\ \sigma)$	*!	*				**
b.	$(\underline{\sigma}\ \sigma)\ (\underline{\sigma}\ \sigma)\ (\underline{\sigma}\ \sigma)$		*!				
c.	$\sigma\ (\underline{\sigma}\ \sigma)\ (\underline{\sigma}\ \sigma)\ \sigma$			*!			**
d. ☞	$\sigma\ (\underline{\sigma}\ \sigma)\ \sigma\ (\underline{\sigma}\ \sigma)$						**
e.	$\sigma\ (\underline{\sigma}\ \sigma)\ (\underline{\sigma})\ (\underline{\sigma}\ \sigma)$					*!	*

Candidate (18)a incurs a fatal violation of PARSE-2 for a sequence of two unfooted syllables. Candidate (18)b is eliminated by *EDGE-ω due to initial stress while candidate (18)c fatally violates ALIGN-R since the head-foot is not right-aligned within the PWd. Finally, candidate (18)e is ruled out by FT-BIN for a non-binary foot, leaving candidate (18)d as the optimal output. Notice that PARSE-2 is not violated by candidate (18)d, since there is no sequence of two unfooted syllables, cf. (3)e.

The analysis also accounts for stress in seven-syllable words, as demonstrated in (19) and (20) below.

(19) Seven-syllable words without pre-antepenultimate schwa

Input: /σ σ σ σ σ σ σ/	PARSE-2	*EDGE-ω	ALIGN-R	*(C)ə́	FT-BIN	PARSE-σ
a. σ (σ̲ σ) σ σ (σ̲ σ)	*!					***
b. (σ̲ σ) σ (σ̲ σ) (σ̲ σ)		*!				*
c. σ (σ̲ σ) σ (σ̲ σ) σ			*!			***
d. ☞ σ (σ̲ σ) (σ̲ σ) (σ̲ σ)						*
e. σ (σ̲ σ) σ (σ̲) (σ̲ σ)					*!	**

Candidate (19)a fatally violates PARSE-2 due to a sequence of two unfooted syllables. This problem is avoided by candidate (19)b, but only at the cost of initial stress and a consequent fatal violation of *EDGE-ω. Candidate (19)c is ruled out by ALIGN-R for non-alignment of the head-foot and the right PWd-edge, while candidate (19)e is eliminated by FT-BIN. This leaves candidate (19)d as the optimal output despite a violation of low-ranking PARSE-σ.

In seven-syllable words with pre-antepenultimate schwa the situation is slightly different, as demonstrated in (20) below.

(20) Seven-syllable words with pre-antepenultimate schwa

Input: /σ σ σ ə σ σ σ/	PARSE-2	*EDGE-ω	ALIGN-R	*(C)ə́	FT-BIN	PARSE-σ
a. σ (σ̲ σ) ə σ (σ̲ σ)	*!					***
b. (σ̲ σ) σ (ə̲ σ) (σ̲ σ)		*!		*		*
c. σ (σ̲ σ) ə (σ̲ σ) σ			*!			***
d. σ (σ̲ σ) (ə̲ σ) (σ̲ σ)				*!		*
e. ☞ σ (σ̲ σ) ə (σ̲) (σ̲ σ)					*	**

Candidates (20)a, (20)b, and (20)c are ruled out just as in (19). Since the input string contains a pre-antepenultimate schwa, however, candidate (20)d with pre-antepenultimate stress incurs a fatal violation of *(C)ə́ for stress on a syllable containing schwa. As a consequence, the optimal output is candidate (20)e despite a violation of FT-BIN. Stress shift in conjunction with pre-antepenultimate schwa is thus correctly predicted to occur in seven-syllable words

The stress pattern of Sentani can thus be analysed unproblematically in terms of PARSE-2, thereby eliminating the compelling argument for *LAPSE in non-ternary systems. In the following sections, an analysis of ternarity will be developed which relies on HD-PROM, a constraint which has been motivated in previous chapters.

6.3 Ternarity through Split-Heads

In recent years, a number of proposals for ternary rhythm have emerged in which foot-heads are split across two syllables (Dresher & Lahiri 1991; Hewitt 1991, 1992; Crowhurst 1991; Rice 1992 and others). For example, in their analysis of Old English and other Germanic languages, Dresher & Lahiri (1991) and Lahiri & Dresher (1999) appeal to the *Germanic foot,* which contains an obligatorily heavy head (i.e. minimally bimoraic), plus an optional (light) weak position (cf. Halle et al. 1993). Possible shapes of the *Germanic foot*, with and without the optional weak branch, are given in (21) below.

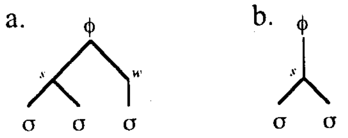
(21) The Germanic Foot (Dresher & Lahiri 1991)[3]

s-w: (H L), (L-L L), (L-H L)

s: (H), (L-L), (L-H)

One notices immediately upon inspecting (21) that foot-heads can contain an adjoined element, allowing them to spread over more than one syllable. Structurally, the second element is adjoined to the strong branch, forming a bipartite foot-head, as illustrated in (22) below.

(22) Foot-heads with adjoined elements.



In order to capture adjunction formally, we will assume the following constraint on prosodic heads, which is violated in such systems.

(23) HEAD INTEGRITY (HD-INT)

The head of a foot may dominate no more than one rhythmic unit μ/σ.

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[3] The use of hyphenation to indicate split bipartite heads in this chapter should not be confused with the use of hyphenation in underlying representations to denote morpheme boundaries elsewhere in this thesis.

Analogous to restrictions on adjunction in syntax, HD-INT bans the adjoined structures in (22) above, requiring foot-heads to be non-branching at the relevant level of structure, i.e. either syllable or mora depending on the rhythmic unit type (see §2.3.3, starting on page 56).

Another observation which can be made with regard to the feet in (21) is that all heads contain a minimum of two moras while the optional dependent position is invariably monomoraic. An interesting question which arises is how such feet fare with regard to satisfaction of HD-PROM. Implicit in the application of HD-PROM is the idea that bimoraic syllables have greater intrinsic prominence than their monomoraic counterparts (Piggott 1998). This view implies a *Prominence Hierarchy* of prosodic constituents, according to which the relative prominence of heads and dependents can be evaluated. A formulation of this hierarchy is given in (24) below.

(24) The Prominence Hierarchy[4]

$$\begin{array}{c} \sigma_{\mu\mu} \\ | \\ \sigma - \sigma \\ | \\ \sigma_{\mu} \end{array}$$

A central aspect of prominence is the notion of *concentration*. Prominence is enhanced when material is heaped together or clustered around a particular point within a domain. Conversely, prominence diminishes when material is spread out over a large area. Precisely this idea is expressed in the *Prominence Hierarchy* in (24) above, which states

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[4] As indicated by the hyphen, the disyllabic sequence here is assumed to be a constituent. A revised formulation is given below as example (71) on page 213. As with the Sonority Hierarchy (e.g. Clements 1990), not all languages are sensitive to all contrasts and thus the formulation given here is assumed to be a subset of the exhaustive Prominence Hierarchy available to UG.

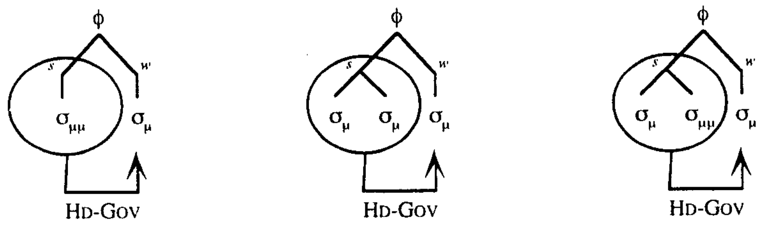
that a heavy syllable has greater intrinsic prominence than a disyllabic sequence, which in turn has greater prominence than a single light syllable. The intrinsic prominence of heavy syllables results not only from the fact that such structures contain two moras, but — and more importantly — from the fact that the two moras are concentrated on a single syllable and not dispersed over two separate syllables.

Recalling that the foot-heads in (21) are obligatorily (minimally) bimoraic with an optional dependent position which is maximally monomoraic, stress systems exploiting this foot type can be characterized as grammars where HD-PROM is *always* satisfied, even at the expense of HD-INT.

A final characteristic of such feet concerns HD-GOV. Since the head of the Germanic foot is always associated with an edge-adjacent syllable, and since the dependent syllable is always adjacent to the head, all exemplars of the this foot type satisfy HD-GOV, assuming a syllabic trochee analysis as shown in (25) below.

(25) The Germanic Foot as a Potentially-ternary Syllabic Trochee[5]

a. (H L) b. (L-L L) c. (L-H L)



The choice of syllabic rather than moraic analysis is motivated by (25)c, where the final

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[5] Feet of the shape (H-L L) are generally predicted not to occur since the first two syllables can be parsed as (25)a, satisfying HD-PROM without incurring a violation of HD-INT. Such feet will arise, however, in cases where a ternary expansion is necessary to satisfy PARSE-σ, as in Estonian (§6.4, starting on page 206).

light syllable would be ungovernable under moraic analysis, where the head would comprise only the first two moras.[6]

In terms of the present analysis then, ternary stress systems find expression through the constraint ranking in (26) below, where both HD-GOV and HD-PROM are satisfied at the expense of HD-INT.

(26) Basic ranking for ternary systems

HD-GOV, HD-PROM >> HD-INT

Note that HD-GOV and HD-PROM are not crucially ranked with respect to one another in (26). The tableau for a /L L L/ string under this ranking in a trochaic system is given in (27) below.

(27) Ternarity through constraint interaction

Input: /L L L /	**HD-GOV**	**HD-PROM**	**HD-INT**
a. (L L)(L)		*!	
b. (L L L)	*!	*	
c. ☞ (L-L L)			*

Candidate (27)a parses only the string, into separate feet. While both feet satisfy HD-GOV, the even (LL) trochee violates HD-PROM since the head syllable is no more prominent than the dependent syllable. Candidate (27)b fares even worse; not only does it violate HD-PROM, since the head syllable is no more prominent than the two dependent syllables, but HD-GOV is violated since the final syllable is not adjacent to the head. This

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[6] For purposes of satisfying HD-GOV, the final syllable may be heavy as well under syllabic analysis (cf. (74)c and (74)d on page 59 above), although this would violate HD-PROM.

leaves candidate (27)c as optimal, despite a violation of low-ranking HD-INT. By splitting the foot-head across two syllables, the head acquires greater relative prominence, satisfying HD-PROM. At the same time, the right edge of the head moves rightward one syllable, allowing the final syllable of a ternary foot to be head-adjacent and therefore governable under HD-GOV. Given this ranking, a split foot-head is forced under constraint interaction.

On this analysis, ternarity results from the *minimal violation* of HD-INT in order to satisfy both HD-GOV and HD-PROM. Unattested quaternary and quinternary patterns are ruled out by the fact that the adjunction of additional elements is never justified by HD-PROM. This is illustrated in (28) below.

(28) Ternarity under HD-PROM and minimal violation of HD-INT

Input: /L L L L L /	**HD-GOV**	**HD-PROM**	**HD-INT**
a. (L L) LLL		*!	▨
b. ☞ (L-L L) LL			*
c. (L-L-L L) L			**!
d. (L-L-L-L L)			**!*

The binary foot in candidate (28)a is ruled out due to a fatal violation of HD-PROM. This is not the case in the other three candidates, where adjunction draws greater prominence to the foot-head. Adjunction comes at a price, however, and violations of HD-INT accumulate for each adjoined element. While the adjunction of one extra element is well-motivated by the need to satisfy HD-PROM, additional adjunctions are gratuitous and result in fatal violations of HD-INT in the quaternary and quinternary feet in candidates (28)c and (28)d. This leaves the ternary foot in (28)b as the optimal output. Thus, when the ranking in (26) obtains in a string of light syllables, all feet are obligatorily ternary.[7] The following sections will address Cayuvava and Chugach, respectively — two systems which exhibit exactly this pattern.

6.3.1 Cayuvava

6.3.1.1 Data

Ternary rhythm is observable in Cayuvava, a Bolivian language with no phonemic quantity (Key 1961, 1967; Halle & Vergnaud 1987; Levin 1988; Dresher & Lahiri 1991; Hayes 1995; Rodier 1998; Elenbaas & Kager 1999). In words of three or more syllables, main stress in Cayuvava falls on the antepenult with secondary stresses falling on every third syllable preceding the antepenult. Words containing two to eleven syllables are listed in (29) below. (Data from Hayes 1995:309, attributed to Key 1961, 1967; marked below as K61 and K67, respectively.)

(29) Ternary stress in Cayuvava

a.	éɲe	"LL	'tail'	K61:144
b.	ʃákahe	"LLL	'stomach'	K61:144
c.	kihíbere	L "LLL	'I ran'	K61:144
d.	ariúutʃa	LL "LLL	'he came already'	K61:149
e.	dʒìhiraríama	'LLL "LLL	'I must do'	K67:71
f.	maràhahaéiki	L 'LLL "LLL	'their blankets'	K61:150
g.	ikitàparerépeha	LL 'LLL "LLL	'the water is clean'	K61:149
h.	tʃàadiròboßurúrutʃe	'LLL 'LLL "LLL	'ninety-nine (1st digit)'	K67:60
i.	medàrutʃetʃèirohíiɲe	L 'LLL 'LLL "LLL	'fifteen each (2nd digit)'	K67:61
j.	tʃaadàiroboìrohíiɲe	LL 'LLL 'LLL "LLL	'ninety-nine (2nd digit)'	K67:60

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[7] Consistent with §2, we assume HD-GOV to be universally undominated.

An interesting problem in Cayuvava is the occurrence of double upbeats — two initial unstressed syllables — in words of *3n+2* syllables in length, as illustrated in (30) below

(30) Double Upbeats in Cayuvava (cf. (29)d, g, j above)

a. LL "LLL

b. LL 'LLL "LLL

c. LL 'LLL 'LLL "LLL

The absence of initial secondary stresses is puzzling in this context, particularly in light of the fact that disyllabic words do occur in Cayuvava and receive initial stress. The problem of explaining this pattern has proved quite a challenge for metrical theory, since bounded stress systems will normally construct a foot when it is at all possible, in order to maximally parse the string. Hayes (1995) accounts for this problem in terms of *weak local parsing*. Hayes assumes a parameter in foot parsing according to which feet are constructed either immediately adjacent to one another (strong local parsing) or with intervals of 'minimal prosodic distance' defined as one mora (weak local parsing). The one-mora interval combined with final extrametricality and a ban on degenerate feet allows Hayes to account for double upbeats as in (31) below. (Extrametrical material is given in angle brackets.)

(31) Weak Local Parsing in Cayuvava (Hayes 1995)

a. LL ("LL) <L>

b. LL ('LL) L ("LL) <L>

c. LL ('LL) L ('LL) L ("LL) <L>

Since feet may not be degenerate and since they must be constructed respecting the one-mora interval, double upbeats are the predicted result. In OT, Kager (1994) achieves the same results by means of the constraint *FTFT, which bans adjacent feet.

A potential problem with weak local parsing or its OT equivalent is that it lacks a principled explanation for why intervals between feet are tolerated. Indeed, the very appeal to foot structure assumes that metrically weak elements are parsed into constituents with metrically strong ones, and that parsing extends exhaustively across domains. Accounts of ternarity which employ obligatory skipping fail to achieve an exhaustive parse of syllables into feet. This is not the case on the present analysis, where the ternary extension of basic foot types is contained within the feet themselves and does not involve the parsing mechanism. Another weakness of Hayes' (1995) account is that the markedness of ternary systems cross-linguistically depends crucially on the stipulation that weak local parsing is a *marked* parametric setting.[8] Finally, as mentioned above, weak local parsing and other approaches to ternary rhythm which appeal to ternarity-specific devices such as *FTFT are *ad hoc*, in that such constraints are not independently motivated.

Other scholars have analysed Cayuvava in terms of amphibrachic feet with extrametricality and a ban on degenerate feet as in (32) below.

(32) Amphibrachic Feet in Cayuvava (Halle & Vergnaud 1987, Levin 1988)

a. L (L "L L) <L>

b. L (L 'L L) (L "L L) <L>

c. L (L 'L L) (L 'L L) (L "L L) <L>

While such an analysis achieves the desired results, it introduces a new foot type into the

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[8] The circularity of this argumentation is perhaps less problematic than it seems at first blush, however, as it is couched in a more general theory which assumes binary marked and unmarked parametric settings globally.

inventory, thus rejecting any direct link between binary and ternary feet. Such an approach increases the complexity of the theory unnecessarily, and — as noted above — does little to explain why ternary systems are so uncommon.

On the present analysis, however, the basic parse in (32) above can be derived without the loss of generality that comes with the introduction of a new foot type. Given final extrametricality, the desired results are achieved by assuming a left-to-right parse of iambic ternary feet following the basic constraint ranking in (26). This result is given in (33) below.[9]

(33) Iambic Feet in Cayuvava

a. L (L "L-L) <L>

b. L (L 'L-L) (L "L-L) <L>

c. L (L 'L-L) (L 'L-L) (L "L-L) <L>

While the parse in (33) exploits the same foot boundaries as that in (32), the effect is captured through augmented iambs rather than through appeal to a new foot type. The analysis under constraint interaction is laid out below.

6.3.1.2 Analysis

As discussed in the analysis of Oromo (§3.5, starting on page 109) final-syllable extrametricality is captured formally by the ranking PARSE–σ >> NONFINALITY. The interaction of these constraints in Cayuvava is illustrated in (34).

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[9] Dresher & Lahiri (1991) propose a similar ternary analysis for Cayuvava, but without extrametricality and where feet are trochaic. The present iambic analysis is superior, however, because it requires no special statement to account for double upbeats.

(34) Final extrametricality in Cayuvava

Input: /L L L L /	NONFINALITY	PARSE–σ
a. ☞ (L "L-L) L		*
b. (L 'L) (L "L)	*!	

Candidate (34)b fatally violates NONFINALITY due to the fact that the final syllable is footed. This leaves candidate (34)a as optimal, despite a violation of lower-ranked PARSE–σ due to an unfooted syllable.

While extrametricality requires NONFINALITY to dominate PARSE–σ, ternarity demands that the latter constraint outrank HD-INT. This is illustrated in (35) below.

(35) Ternarity requires PARSE–σ >> HD-INT

Input: /L L L/	PARSE–σ	HD-INT
a. ☞ (L "L-L)		*
b. (L "L) L	*!	

Candidate (35)b fatally violates PARSE–σ due to an unfooted syllable, leaving candidate (35)a as optimal despite a violation of lower-ranked HD-INT. Note that if the reverse ranking were to obtain, ternary feet would never occur, as the cost of a split-head would outweigh the benefit of parsing all syllables in the string.

Another necessary constraint is FT-BIN, introduced in §2.4.1 and repeated in the analysis of Sentani earlier in this chapter (example (17) on page 171). In their implementation of FT-BIN Blevins & Harrison (1999:221) interpret binarity to mean the presence of both a head as well as a dependent position, i.e. (17) is violated by feet lacking a dependent element. This is the case even in split-head feet which contain two elements, e.g., (L) and (L-L) feet both violate FT-BIN because they lack a dependent element while (L L) and (L L-L) both satisfy FT-BIN because they have both a head and dependent element.[10]

Foot parsing in Cayuvava is achieved through the constraint ranking in (36) below. This ranking generates the double upbeat pattern, as illustrated by the tableau in (37).

(36) Cayuvava constraint ranking

HD-GOV, FT-BIN, HD-PROM, NONFINALITY >> PARSE–σ >> HD-INT

(37) Double Upbeats in Cayuvava

Input:	/L L L L L/	**HD-GOV**	**FT-BIN**	**HD-PROM**	**PARSE-σ**	**HD-INT**
a.	(L L "L-L) L	*!			*	*
b.	('L-L) ("L-L) L		*!*		*	**
c.	(L 'L) (L "L) L			*!*	*	
d. ☞	L (L "L-L) L				**	*

Candidate (37)a parses all four non-final syllables into a single foot, fatally violating HD-GOV, as not all syllables within the foot are adjacent to the head. Candidate (37)b parses these same four syllables into two feet, each comprising a split-head with no dependent position and thus a violation of FT-BIN is assessed for each foot. Candidate (37)c also forms two disyllabic feet, but here the result is two even iambic feet, which both violate

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[10] While such an interpretation appears somewhat questionable with respect to the specific formulation of this constraint, it does follow the spirit of FT-BIN in the sense that it extends the notion of mandatory head and dependent positions to ternary systems. A possible reformulation could explicitly require all feet to have a dependent position (cf. BRANCHHEAD: Rodier 1998:140).

HD-PROM. This leaves candidate (37)d as optimal despite two violations of PARSE–σ.[11]

In the following section, the analysis will be extended to a similar ternary system, Chugach, where disyllabic feet are less uncommon.

6.3.2 Chugach

6.3.2.1 Words without Heavy Syllables

Chugach is one of two major dialects of Alutiiq (also called Pacific Yupik; Leer 1985a, b, c, 1989; Rice 1992; Halle 1990; Hewitt 1991, 1992; Kager 1993, Hayes 1995, Rodier 1998, Van de Vijver 1998, Elenbaas & Kager 1999). In words with only light syllables, stress falls on the second syllable and every third syllable thereafter, as shown in (38) below. (Data from Hayes 1995:334, attributed to Leer 1985a, b, c.)

(38) Light syllable words in Chugach

a.	a.tá.ka	L 'L L	'my father'
b.	a.kú.ta.mə́k	L 'L L 'L	'(kind of food)' abl. sg.
c.	a.tú.quːni.kí	L 'L L L 'L	'if he (refl.) uses them'
d.	pi.sú.qu.ta.qú.ni	L 'L L L 'L L	'if he (refl.) is going to hunt'
e.	ma.ŋáχ.su.qu.tá.qu.ní	L 'L L L 'L L 'L	'if he (refl.) is going to hunt porpoise'

The stress pattern in (38) can be derived through a left-to-right parse of syllables into ternary iambic feet as shown in (39) below. Chugach is thus in a sense the mirror image of Cayuvava, where syllables are parsed into ternary iambic feet from *right to left* (ALLFT-R >> ALLFT-L, see example (85) on page 66) but unlike Cayuvava, Chugach

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[11] The occurrence of initial stress on disyllabic words in Cayuvava presumably results from a requirement that all words be stressed, which outranks FT-BIN in order to place stress on the initial syllable, i.e. a foot of the shape (<u>L-L</u>).

exhibits no extrametricality (cf. Cayuvava extrametricality in (33) above).

(39) Prosodic structure of light syllable words in Chugach

a. (L 'L-L)
b. (L 'L) (L 'L)
c. (L 'L-L) (L 'L)
d. (L 'L-L) (L 'L-L)
e. (L 'L-L) (L 'L)(L 'L)

Another crucial difference between the stress system of Chugach and Cayuvava is the treatment of stray syllables at word edges in words of *3n+1* and *3n+2* syllables. Recall that in Cayuvava stray syllables are left unparsed, an effect that follows from the relatively low ranking of PARSE–σ, cf. (36). Syllables which cannot be incorporated into a ternary foot are simply left unparsed under such a ranking. This is not the case in Chugach, however, which differs crucially from Cayuvava in that PARSE–σ outranks HD-PROM, resulting in an exhaustive parse of syllables into feet, even if this means sacrificing ternary rhythm.[12] This ranking is given in (40) below, and is demonstrated in the tableau in (41).

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[12] In the Hayesian framework this effect is equivalent to *persistent footing* (Myers 1991).

(40) Chugach constraint ranking[13]

HD-GOV, FT-BIN, PARSE–σ >> HD-PROM >> HD-INT

(41) Exhaustive parsing in Chugach

Input:	/L L L L L/	HD-GOV	FT-BIN	PARSE-σ	HD-PROM	HD-INT
a.	(L L L 'L-L)	*!*				*
b.	(L 'L-L) ('L-L)		*!			**
c. ☞	(L 'L-L) (L 'L)				*	*
d.	(L 'L-L) L L			*!*		*

Candidate (41)a incurs two violations of HD-GOV for two footed syllables which are non-adjacent to the foot-head. Candidate (41)b fatally violates FT-BIN, due to a foot lacking a dependent branch. Candidate (41)d is eliminated by two violations of PARSE–σ, leaving candidate (41)c as optimal despite a violation of lower-ranking HD-PROM.

Foot parsing in Cayuvava and Chugach can thus be distinguished (abstracting away from final extrametricality in Cayuvava) through minimal re-ranking of PARSE–σ and HD-PROM. Unlike Cayuvava, however, Chugach also has heavy syllables, the behaviour of which can be captured straightforwardly through a minor extension of the

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[13] The high ranking of FT-BIN here is consistent with what appears to be a complete ban on degenerate feet in Chugach, as suggested by the fact that stray light initial syllables are made heavy (and stressed) through the gemination of a following onset consonant, and that a clear case for the existence of degenerate feet is lacking. Hayes (1995:344) notes, however, that a rule of final shortening creates what might be analysed as degenerate feet in certain contexts. Such an analysis seems to conflict, however, with Van de Vijver's (1998) view that reported final stresses in iambic systems are generally reanalysable as intonational phenomena (see also §5).

analysis developed so far. This will be taken up in the following section.

6.3.2.2 Words with Heavy Open Syllables

Both monophthongal and diphthongal CVV syllables behave as phonologically heavy in Chugach.[14] The fact that heavy syllables attract stress regardless of their position in the word obscures the basic ternary pattern somewhat, as shown in (42) below. (Data from Hayes 1995:335-6, attributed to Leer 1985a, b, c.)

(42) Chugach words with heavy syllables

a.	naá.qaá	'H 'H	'she's reading it'
b.	u.xá.tʃi.maán	L'LL 'H	'you must be good at it'
c.	naá.qu.ma.lú.ku	'HL L'LL	'apparently reading it'
d.	naá.ma.tʃí.quá	'H L'L 'H	'I will suffice'

At first glance, the left-to right ternary pattern is barely recognizable in words with heavy syllables, but the pattern is recoverable if feet are assumed to be constructed on moras rather than syllables.

Following Kager (1993) and Elenbaas & Kager (1999), we assume that underlying long vowels and diphthongs in Chugach are consistently right-headed at the moraic level.[15] There are two pieces of evidence which support such a view: firstly, heavy diphthongal sequences in Chugach are invariably rising in sonority-prominence

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[14] Long vowels also arise in Chugach through non-neutralizing lengthening of stressed light open syllables. Since such syllables pattern with light syllables for purposes of stress placement, however, they are analysed here as monomoraic.

[15] Following Kager (1993), uniform right-headedness in heavy syllables is taken to be a language-specific property of Chugach (cf. Slovak §4.3.1). See also Mellander (2002c, in press a) for a proposal linking the occurrence of such structures to the interaction of foot-level structural well-formedness constraints.

(i.e. glide-first or iambic as in Slovak; see §4.3.1 starting on page 133); secondly, tonal patterns from Central Alaskan Yupik indicate rising tone in underlyingly heavy syllables (Kager 1993:412, citing Miyaoka 1985:54). Finally, Leer consistently marks underlyingly long vocoids with an accent on the second element. (We follow the same marking scheme in (42) above.)

Right-headedness at the moraic level in underlyingly heavy syllables in Chugach has interesting implications for the ternary pattern. Among other things, it means that despite the fact that Chugach feet are iambic, a light dependent syllable can never precede a heavy syllable foot internally, because the mora in such a syllable would be non-adjacent to the head mora and therefore would violate HD-GOV. Thus, heavy syllables are predicted to be invariably foot-initial in Chugach. This prediction is confirmed by a process of phonetic strengthening in foot-initial consonants (Leer 1985a:86; see also Hewitt 1992:39ff), which applies consistently in the onset consonants of heavy syllables.

The emerging account of Chugach stress is thus straightforward. Given maximally trimoraic feet, the only possible foot-shapes for feet with heavy syllables are ($\underline{\text{H}}$) and ($\underline{\text{H-L}}$), i.e. $(\mu\underline{\mu})$ and $(\mu\underline{\mu.\mu})$, as illustrated in (43) below, where moraic representations for, the patterns in (42) are given.

(43) Iterative trimoraic feet in Chugach

a. 'H 'H $(\mu\underline{\mu})(\mu\underline{\mu})$

b. L'LL 'H $(\mu.\underline{\mu.\mu})(\mu\underline{\mu})$

c. 'HL L'LL $(\mu\underline{\mu.\mu})(\mu.\underline{\mu.\mu})$

d. 'H L'L 'H $(\mu\underline{\mu})(\mu.\underline{\mu})(\mu\underline{\mu})$

The fact that heavy syllables are invariably stressed follows from the fact that the stressed mora is invariably the first in a bipartite head, consistent with the analysis for strings of light syllables. As before, parsing is left-to-right and exhaustive, with no degenerate feet.

A final case are Chugach words with heavy closed syllables, which will be addressed presently.

6.3.2.3 Words with Heavy Closed Syllables

Closed syllables count as heavy in the Chugach stress system uniquely in word-initial position. Examples are given in (44) below.

(44) Chugach words with initial closed syllables

a.	pín.ka	'HL	'mine' pl.
b.	án.ŋa.qá	'H L'L	'my older brother'
c.	án.tʃi.qu.kút	'HL L'L	'we'll go out'
d.	íq.ɬu.kií.ŋa	'HL 'HL	'she lied to me'

Hayes (1995:333-4) accounts for the restriction on moraic codas to word-initial position by reducing the domain of application of the *Weight-by-Position* rule to initial syllables in Chugach, as well as the Norton Sound dialect of Central Alaskan Yupik where similar facts obtain. Taking a different approach, Rosenthall & Van der Hulst (1999) attribute the moraicity of coda consonants in initial syllables to a constraint requiring main stress to be leftmost within the prosodic word, crucially outranking a constraint demanding nonmoraic codas.

More important for our immediate purposes than the precise formal mechanism which results in initial heavy CVC syllables is the shape of the feet which contain them. Indeed, initial closed syllables pose a challenge for the present analysis because prominence in a heavy CVC syllable is manifested on the initial rather than the second mora, a highly unusual result if the initial mora is assumed to be a dependent position within the foot (cf. Hewitt 1992). The solution to this problem is actually quite simple; in the case of initial CVC syllables, the initial foot is trochaic rather than iambic. The representations for the words in (44) are given in (45) below.

(45) Foot structure of Chugach words with initial closed heavy syllables

a.	'HL	$(\underline{\mu\mu}.\mu)$
b.	'H L'L	$(\underline{\mu}\mu)(\mu.\underline{\mu})$
c.	'HL L'L	$(\underline{\mu\mu}.\mu)(\mu.\underline{\mu})$
d.	'HL 'HL	$(\underline{\mu\mu}.\mu)(\mu\underline{\mu.\mu})$

Initial trochaicity in words beginning with heavy CVC in Chugach can be captured with the addition of two constraints, given in (46) and (47) below.

(46) HEAD PROMINENCE(Syllable) (repeated from example (12) on page 125)

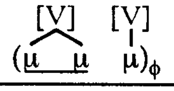
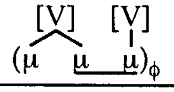
The head of a syllable is intrinsically prominent

(47) *EDGEMOST (repeated from example (4) on page 151)

Within the foot, edge-adjacent elements may not be prominent.

As discussed in §4 and §5, respectively, HD-PROM(Syll) requires a syllable-head to be intrinsically more prominent than a dependent mora, while *EDGEMOST militates against prominent moras at foot-edges. If HD-PROM(Syll) is ranked above *EDGEMOST, trochaic rhythm will maintain in cases where iambic rhythm would result in a syllable-head being assigned to a less-prominent mora. To illustrate, consider the following tableau.

(48) Iambic rhythm in Chugach initial CVV (cf. (42)c-(43)c above)

Input: $CV_{\mu\mu}CV_{\mu}$	**HD-PROM(Syll)**	***EDGEMOST**
a. 		*!
b. ☞ 		

In a trimoraic sequence parsed into an iambic foot, prominence would normally be expected to fall on the medial mora. This result is represented as candidate (48)b above, corresponding to Chugach words with initial underlying CVV. Prominence on the second mora is precisely what we would expect given the invariant right-headedness of underlying long vowels and diphthongs in Chugach. Candidate (48)a is ruled out by *EDGEMOST for illicit initial prominence, leaving (48)b as optimal.

In the case of initial heavy CVCs, however, the situation is different as shown in (49) below.

(49) Trochaic rhythm in Chugach initial CVC

Input: $CV_\mu C_\mu CV_\mu$		**HD-PROM(Syll)**	***EDGEMOST**
a. ☞	[V C] [V] | | | $(\underline{\mu \quad \mu} \quad \mu)_\phi$		*
b.	[V C] [V] | | | $(\mu \quad \underline{\mu \quad \mu})_\phi$	*!	

In the case of an initial heavy CVC, the iambic candidate, exemplified in (49)b is ruled out by HD-PROM(Syll), since such a parse would place stress on the coda consonant, which is less sonorous than the preceding homosyllabic vowel. This forces a trochaic parse, exemplified by candidate (49)a. Notice that except for headedness, the resulting foot is no different from other feet in Chugach — it is ternary at the moraic level, and satisfies HD-GOV, FT-BIN, PARSE–σ, and HD-PROM at the expense of HD-INT (cf. the ranking in (40) above).

In the following section we will examine Gilbertese, another system with trimoraic feet, but where these feet are trochaic rather than iambic as in Chugach.

6.3.3 Gilbertese

6.3.3.1 Data & Analysis

In Gilbertese (Kiribati: Blevins & Harrison 1999), a Micronesian language, moras are grouped into ternary left-headed constituents. The analysis presented here does not differ substantially from that of Blevins & Harrison, which can be adapted straightforwardly to the present framework.

Gilbertese exhibits three degrees of syllable weight (cf. Estonian in §6.4, starting on page 206 below). Consequently there are four logical possibilities for a ternary parse of moras into feet, all of which are attested, as shown in (50) below.[16] (Data from Blevins & Harrison 1999:217. Note that sonorant consonants can be moraic and even syllabic in Gilbertese.)

(50) Trimoraic foot shapes in Gilbertese

a.	(μ.μ.μ)	(a.ra.na)	'his/her name'
b.	(μμ.μ)	(an.ti)	'to sleep'
c.	(μ.μμ)	(ma.tuu)	'spirit, ghost'
d.	(μμμ)	(aoi)	'dew'

Trimoraic feet occur either as trisyllabic ((50)a), bisyllabic ((50)b and (50)c), or as

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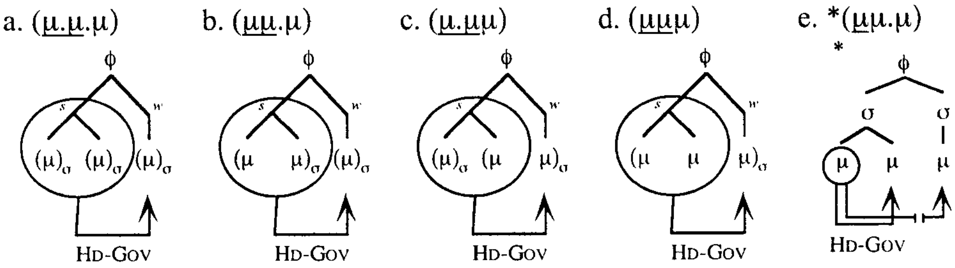
[16] Blevins & Harrison (1999:219-20) note that Gilbertese feet can also begin in the middle of a bimoraic syllable, e.g. (te.ta.ka)(a.ka.ro) where there is no syllable boundary between the two feet. The splitting of a syllable into separate feet violates the principle of *Syllable Integrity* (Prince 1976, 1980; Kager 1993; Hayes 1995) which is normally assumed to be inviolable across the world's languages. It would be interesting to explore the question of whether Gilbertese could be reanalysed as a syllable-based ternary system with no phonemic quantity, e.g. as in Cayuvava. Such an analysis would obviate the need to tolerate violations of Syllable Integrity but would require a detailed examination of primary data. This idea is not pursued here.

monosyllabic superheavy syllables ((50)d). Ternarity in Gilbertese is assumed to follow from the same basic constraint ranking as in the other ternary systems discussed so far, where Hd-Gov and Hd-Prom outrank Hd-Int (this ranking is given as example (26) above). The violability of Hd-Int allows trimoraic feet to occur (thereby satisfying Hd-Prom) without violating Hd-Gov, as illustrated in (51)a through (51)d below. Since feet are constructed on moras rather than syllables, syllabic constituency has no bearing on foot-internal structure.

(51) Trochaic feet in a ternary moraic system



a. $(\underline{\mu.\mu}.\mu)$ b. $(\underline{\mu\mu}.\mu)$ c. $(\underline{\mu.\mu}\mu)$ d. $(\underline{\mu\mu}\mu)$ e. $*(\underline{\mu}\mu.\mu)$

It is precisely due to the ranking in (26), — the hallmark of ternarity — that an uneven $(\underline{\mu\mu}.\mu)$ trochee can be a well-formed foot in a moraic system. The fact that the head is split over two moras means that the foot-final mora is still adjacent to the head, thereby satisfying Hd-Gov, as shown in (51)b above. Compare the illicit uneven $*(\underline{\mu}\mu.\mu)$ trochee in a non-ternary system given in (51)e (repeated from example (75)c on page 59 above). In this foot, the monomoraic head fails to govern the foot-final mora because the adjacency requirement is not met (see §2.3.3, starting on page 56).

The split bipartite head analysis of metrical feet is independently corroborated in Gilbertese by phonetic data which show a pitch peak on the first mora of every foot and an intensity or loudness peak on the second mora of every foot.[17] The third mora is

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[17] As Megan Crowhurst (p.c.) points out, these two cues could also be interpreted as marking the foot-

characterized by substantially lower pitch and intensity. Foot parsing is iterative from right to left, as shown in (52) below. (Data from Blevins & Harrison 1999:218. I follow Blevins' & Harrison's transcription system, according to which a pitch peak is marked by an acute accent, an intensity peak by a grave accent.)

(52) Iterative parsing of trimoraic feet in Gilbertese

a. (ákèa)	‘there is no … ’
b. (ńnà ka)(rákìna)	‘I will recount s.t.’
c. (áìka)(kám̀ʷ o)(ŋóràa)	‘those of you who are listening’

Sequences of two stray syllables at the left edge do occur in Gilbertese, but Blevins & Harrison (1999:218) report conflicting data as to whether the initial syllable carries an intensity peak and do not take a position on this issue.

Gilbertese also imposes ternarity on the minimal word. Accordingly, bimoraic lexical words undergo augmentation through mora insertion creating an uneven (HL) trochee, as shown in (53) below.[18] (Data from Blevins & Harrison 1999 and Rehg 1984.)

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head and a foot-boundary on a weak local parsing analysis.

[18] Augmentation fails to occur in two contexts: 1) when the bimoraic base contains a long vowel, e.g. *paa* ‘(the/some) leaves’, and 2) when the first mora of the base is a preconsonantal nasal, e.g. *mka* ‘(the/some) compost’. Blevins & Harrison (1999:215) point out that mora insertion in such contexts would produce ill-formed structures, either a trimoraic monophthong $*V_iV_iV_i$ or a geminate preconsonantal nasal.

(53) Trimoraic word-minimality in Gilbertese: augmentation of disyllables[19]

a.	/piri/	piiri	'run' imp.	B&H214
b.	/p^{w}ata/	p^{w}aata	'(the/some) huts'	B&H214-5
c.	/tona/	toona	'(the/some) yaws'	R56
d.	/ika/	iika	'(the/some) fish'	R56

The augmentation process in (53) above is basically parallel to Trochaic Lengthening in Mohawk, Selayarese and other languages discussed in §2.2.2 above (starting on page 23).

Ternary word-minimality in Gilbertese is also enforced through a different augmentation pattern. Bimoraic monosyllables are augmented to superheavy trimoraic syllables, which then form monosyllabic feet, as shown in (54) below. (Data from Blevins & Harrison 1999 and Rehg 1984.)

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[19] Other Micronesian languages undergo penultimate lengthening but with compensatory loss of the final mora. In Woleaian, final vowels are devoiced after lengthened penults while in Ponapean the final vowel is deleted entirely, as illustrated in the examples below. (Data from Rehg 1984:53, 55.)

Woleaian:	/laŋo/	laaŋø̥	'fly'	*Ponapean:*	/kili/	kiil	'skin'
	/yafi/	yaafi̥	'fire'		/seti/	seet	'sea'

Rehg (1984) shows, however, that diachronically such lengthening was not compensatory in nature, and indeed preceded final mora loss, suggesting that a trimoraic minimal word may have been enforced in the ancestor languages of modern Micronesian as well.

(54) Trimoraic word-minimality in Gilbertese: augmentation of monosyllables[20]

a.	/nim/	niim	'drink them' imp.	B&H214
b.	/pai/	paai	'(the/some) arms/wings'	B&H214-5
c.	/on/	oon	'(the/some) turtles'	B&H214-5
d.	/pen/	peen	'ripe coconut	R56

Both augmentation processes follow straightforwardly under constraint interaction in a ranking very similar to that exploited for the analysis of Trochaic Lengthening in §2.2.3.1 (starting on page 29). Augmentation in Gilbertese follows from the constraint ranking in (55) below.

(55) Constraint ranking for Gilbertese

HD-GOV, HD-PROM, FT-BIN >> HD-INT, IDENTWEIGHT

As in the analysis of (<u>H</u>L)-creating processes in §2.2.3.1, HD-PROM crucially dominates IDENTWEIGHT in (55) above. This ranking accounts for Trochaic Lengthening in Gilbertese straightforwardly, as illustrated in (56) below.

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[20] The analysis of final nasals as coda consonants follows from distributional evidence: obstruents are illicit codas in Gilbertese. Moreover, Blevins & Harrison (1999:209-11) analyse all morpheme-final nasals as moraic, based on a number of mora preservation processes which apply under resyllabification in morphologically-complex words.

(56) Trochaic Lengthening in Gilbertese: /µ.µ/ → $(\underline{\mu\mu}.\mu)$

Input: /µ.µ/	**HD-GOV**	**HD-PROM**	**FT-BIN**	**HD-INT**	**IDENTWT**
a. $(\underline{\mu}.\mu)$		*!			
b. $(\underline{\mu.\mu})$			*!	*	
c. ☞ $(\underline{\mu\mu}.\mu)$				*	*

Candidate (56)a fatally violates HD-PROM, as the foot-head is no more prominent than the dependent syllable. Candidate (56)b, by contrast, satisfies HD-PROM at the expense of FT-BIN, due to the fact that the foot contains no dependent element. Candidate (56)c thus surfaces as optimal, since its only violations are IDENTWEIGHT for non-identity of input and output syllable weights and HD-INT, since the foot-head is spilt between two constituent elements (moras). Candidate (56)c does not violate HD-PROM, since the foot-head is heavy and therefore inherently prominent, nor does it violate FT-BIN, as it contains a dependent position. Finally, candidate (56)c does not violate HD-GOV because the one dependent element is adjacent to the head (as illustrated in example (51)b above). Trochaic Lengthening in Gilbertese thus follows straightforwardly as a consequence constraint interaction.

6.3.3.2 Gilbertese and Weak Local Parsing

The Gilbertese facts are problematic for a Hayesian ternary analysis based on weak local parsing. Consider the trimoraic word-minimality requirement, which is captured straightforwardly in the present analysis by appealing to a ternary moraic foot. This analysis is consistent with the standard view (McCarthy & Prince 1986) that in many languages the minimal prosodic word is a foot. Now consider how such a requirement would be captured under weak local parsing. Since ternary constituents are unavailable on such a view, the formal description of trimoraic word minimality in Gilbertese must appeal to a special template incorporating a bimoraic foot plus an extrametrical mora, as in (57) below.

(57) Gilbertese minimal word template (Blevins & Harrison 1999:225)

[(μ μ)<μ>]$_{\text{PWd}}$

Not only does the weak local parsing account require a special template such as that in (57) to account for the trimoraic minimal word requirement, it also misses the generalisation that Gilbertese stress in longer words can be characterized by left-to-right iteration of this template across the word. On the present account, both facts follow from a ternary moraic foot.

One might conjecture that such augmentation results from the enforcement of NONFINALITY and FT-BIN at the expense of HD-PROM, as shown in (58) below.

(58) Trochaic Lengthening through NONFINALITY (cf. (56))

Input:	/μ.μ/	**NONFINALITY**	**FT-BIN**	**HD-PROM**	**IDENT-WT**
a.	(μ̲.μ)	*!		*	
b.	(μ̲) <μ>		*!		
c. ☞	(μ̲μ) <μ>			*	*

While such an analysis achieves the *quantitatively* desired results (i.e. correctly predicts lengthening), it makes false predictions with respect to the distribution of prominence over the trimoraic domain and must therefore be rejected. While Blevins & Harrison (1999) do not mark prominence on the trochaic lengthening data, the ranking in (58) entails final extrametricality in *all* Gilbertese words, with the penultimate mora in a dependent position. This prediction is clearly false, as demonstrated by the forms in (52) above, where the penultimate mora consistently bears an intensity peak. Moreover, in longer words the NONFINALITY analysis would have no explanation why the intensity peak remains on the antepenultimate mora rather than shifting to the pre-antepenultimate mora to create a trimoraic foot and thereby avoid a violation of HD-PROM. If ternarity is assumed throughout, however, all these facts fall neatly into place.

A second and more serious problem involves the realisation of prominence. An excerpt of Blevins' & Harrison's (1999:225) discussion on this issue are provided below.

> "Recall that in Gilbertese, the prominence within the foot is split into a pitch peak and an intensity peak, and these peaks fall on successive moras. In a phonetic sense, prosodic prominence within the Gilbertese foot cannot be associated with a single mora: it is bipartite. How then can the parameter of weak local parsing be applied to Gilbertese? By definition, skipped moras must be necessarily weak, that is, lacking in prosodic prominence. However, by skipping Gilbertese weak moras the foot is a succession of moraic prominence peaks and cannot be fit into the trochaic or iambic mold ... choosing one or the other mora in [a putative foot such as] (té.tà) or (á.kà) as head seems arbitrary and unmotivated: there is no sense in which pitch and loudness can be ranked in terms of their importance in determining prominence. In fact [...] primary stressed syllables typically have both higher pitch and greater loudness than secondary stressed syllables, suggesting that both features play a role in the stressed/unstressed contrast."

The manifestation a prominence on two of three elements within a ternary foot corresponds exactly to the prominence-driven model of ternarity advanced in this chapter.[21]

6.3.4 Sardinian

Trochaic Lengthening in Sardinian is restricted to penultimate syllables, and indeed this system has been analysed previously in terms of a ternary foot (Bolognesi 1998; Molinu 2001). An interesting aspect of Trochaic Lengthening in Sardinian is that it is accompanied in certain dialects by a nasalization process, which is argued to enhance the prominence of the head syllable (Molinu 2001). If this is correct, such a process clearly follows the spirit of HD-PROM by augmenting the relative prominence of the foot-head.

The facts of the nasalization process in the dialects which manifest it are as follows. In words with penultimate stress, a post-tonic nasal /n/ is deleted and nasalization is realised on the tonic vowel, as shown in (59)a below. A pre-tonic /n/ is always retained, however, with no nasalization on the following (tonic) vowel, as shown in (59)b. Finally, in words with antepenultimate stress, post-tonic /n/ is never deleted and the tonic vowel is not nasalized, as shown in (59)c. (Data from Molinu 2001:8-9, with ternary foot structure added)

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[21] If this model is correct, a natural question that arises is why is it only in Gilbertese that prominence is observable on both elements of a split head. One reason that this is a marked property may be the general *rhythmic* tendency favouring greater prominence on the first element of a grouping, and in particular the extremely strong propensity for this rhythmic pattern to obtain in *binary* constituents such as a bipartite head. Another contributing factor likely involves the available data upon which descriptive analyses are based. While Blevins' & Harrison's analysis of the Gilbertese facts is based largely on audio tapes which can be subjected to acoustic analysis to determine the location of various types of peaks, the data upon which analyses for many ternary systems are based come from older descriptive grammars for which no acoustic data are available. It is reasonable to assume that non-uniformity of end results may be attributable to non-uniformity in methods of data collection and analysis. It would not be surprising, therefore, if acoustic data were to reveal similar facts in other ternary systems.

(59) Nasalization in Sardinian dialects

	Nasalization Dialects		*Non-nasalization Dialects*	
a.	(pã́ː.i)		(páː.ne), (páː.ni)	'bread'
	(mã́ː.u)		(má.nu)	'hand'
	ko (ʒĩ́ː.a)		ko (ɣíː.na)	'kitchen'
	an (dʒɔ̃́ː.i)		an (dzɔ́ː.nɛ), an (dzɔ́ː.ni)	'lamb'
b.	an dʒo (néɖ.ɖu)	* an dʒo (ẽ́ɖ.ɖu)		'little lamb'
c.	(á.ni.ma)	*(ã́.i.ma)		'soul'

If Sardinian is assumed to have a ternary prosodic structure, the restriction of the deletion/nasalization process to post-tonic /n/ in stressed penults can be seen to follow from HD-PROM. Such an analysis could be made to work if one were to assume feature-specific formulation of HD-PROM, such as that given in (60) below.

(60) HEAD PROMINENCE [NASAL] (cf. HD-PROM: example (3) on page 4)

The head of a prosodic category is intrinsically prominent with respect to the feature [nasal].

HD-PROM[NAS] is violated when the nasal prominence of a foot-head is no greater than that of a dependent position, i.e. HD-PROM[NAS] requires the foot-head to be specified for the feature [nasal] *and* that the foot-dependent lack the feature [nasal]. This interpretation is consistent with the idea — developed throughout this thesis — that HD-PROM is sensitive to *relative* rather than absolute intrinsic prominence within a domain.

An additional constraint required for the analysis of Sardinian is given in (61) below.

(61) MAX-SEG (McCarthy & Prince 1995)

Every segment in the input has a correspondent in the output.

MAX-SEG militates against segmental deletion, and is assumed to be outranked by HD-PROM[NAS] in Sardinian. The tableau for the penultimate stress case is given in (62) below.[22]

(62) Nasalization of stressed penults in Sardinian dialects

	HD-PROM[NAS]	**MAX-SEG**
a. ☞ (pã́ː.i)		*
b. (páː.ni)	*!	

Candidate (62)b fatally violates HD-PROM[NAS], because the head syllable is not specified for the feature [nasal] while the dependent syllable is. This leaves candidate (62)a as optimal despite a violation of MAX-SEG for segmental deletion.[23]

As illustrated by the second data point in (59)a, nasalization/deletion applies even if nasality is already present in the head syllable. This result is predicted, since the removal of nasality in the dependent syllable increases the *relative* prominence of the head-syllable with respect to nasality. This is analogous to Trochaic Shortening (see §3 starting on page 72).

The process is predicted not to apply in other contexts, however, as illustrated in the following tableaux.

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[22] Input forms are omitted, as Molinu provides no underlying representations for the relevant words. The presence of underlying /n/ can nevertheless be established by examining surface forms in non-nasalization dialects given in (59)a.

[23] Since the presence of nasality in the winning candidate is assured by the high-ranking constraint HD-PROM[NAS], it is unnecessary to appeal to a faithfulness constraints on nasality, e.g. MAX-[NAS]-IO.

(63) No deletion of pre-tonic /n/ in Sardinian dialects

		HD-PROM[NAS]	**MAX-SEG**
a.	an dʒo (ẽ́ɖ.ɖu)		*!
b. ☞	an dʒo (néɖ.ɖu)		

Candidates (63)a and (63)b fare equally well with regard to HD-PROM[NAS] because in both candidates nasality is present in the foot-head and not in the dependent position. Candidate (63)a incurs a fatal violation of MAX-SEG, however, for deletion of the pre-tonic nasal segment, leaving candidate (63)b as optimal. Deletion/nasalization applies in the case of post-tonic /n/ because the nasality is transferred from the dependent position to the head of the foot, thereby increasing the relative prominence of the head. In the case of pre-tonic /n/, however, a transfer of nasality is not well-motivated under HD-PROM[NAS] since nasality is already associated with the foot-head through the onset consonant. Exactly the same logic explains the non-occurrence of this process in words with antepenultimate stress, as illustrated in (64) below.

(64) No nasalization of stressed antepenults in Sardinian dialects

		HD-PROM[NAS]	**MAX-SEG**
a.	(ã́.i.ma)		*!
b. ☞	(á.ni.ma)		

Even though the /n/ occurs in post-tonic rather position in candidate (64)b, the fact that the foot-head spans two syllables means that nasality is still associated with the foot-head, and thus no violation of HD-PROM[NAS] is triggered. Deletion of the post-tonic /n/ in candidate (64)a, however, results in a fatal violation of MAX-SEG, leaving candidate (64)b as optimal. The principle of HD-PROM in conjunction with the model of ternarity advanced in this chapter thus provides a straightforward account of the implementation of prominence-enhancing nasalization in Sardinian dialects.

In the following section we turn the discussion to Estonian, a syllable-based ternary system with three degrees of quantity.

6.4 Ternarity and Syllable Weight: the Case of Estonian

A final system examined in this thesis which exhibits ternary rhythm is Estonian (Finno-Ugric: Hint 1973; Prince 1980; Hayes 1995; Rodier 1998). With a number of lexical and morphological exceptions, main stress in Estonian falls on the initial syllable.[24] Iterative secondary stresses vary freely between binary and ternary alternation following main stress, although this variation is constrained in certain prosodic contexts. Iteration is thus left-to-right, and unlike Cayuvava and Chugach, feet are trochaic. Estonian poses an unusual challenge for prosodic theory in that ternary stress is not obligatory, but rather coexists in a state of free variation with the binary pattern. An adequate analysis of Estonian stress must therefore provide a formal explanation for both patterns, as well as the status of free variation between the two.

6.4.1 Words without Overlength

Representative examples of binary and ternary stress patterns in words without *overlength* (see §6.4.2) are given in (65) below. (Final consonants do not contribute to syllable weight in Estonian, and thus appear outside of final syllables. Estonian data from Rodier 1998:132-3, attributed to Kager 1994. Gloss irregularities in original.)

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[24] Hayes (1995:316) notes that Hint assumes non-initial primary stresses to mark the beginning of new prosodic words.

(65) Estonian words without overlength

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

As evidenced in (65)e-g, final light syllables are never stressed in Estonian. This restriction can be attributed to a more general ban in Estonian on degenerate feet (cf. FT-BIN: example (82) on page 65), which a final stressed light syllable entails, given trochaic footing. More intriguing in (65), however, is the absence of optional ternarity in certain words. The relevant generalisation is more readily apparent in (66) below, where prosodic representations for the words in (65) above are given.

(66) Prosodic representations of Estonian words without overlength

	Binary Stress	*Ternary Stress*	
a.	$\mathrm{(\underline{L}\ L)(\underline{H})}$		$\mathrm{*(\underline{L\text{-}L}\ H)}$
b.	$\mathrm{(\underline{L}\ L)(\underline{L}\ L)}$		$\mathrm{*(\underline{L\text{-}L}\ L)(\underline{L})}$
c.	$\mathrm{(\underline{L}\ L)(\underline{L}\ H)}$	$\mathrm{(\underline{L\text{-}L}\ L)(\underline{H})}$	
d.	$\mathrm{(\underline{L}\ L)(\underline{H}\ H)}$		$\mathrm{*(\underline{L\text{-}L}\ H)(\underline{H})}$
e.	$\mathrm{(\underline{L}\ H)(\underline{L}\ L)\ L}$	$\mathrm{(\underline{L\text{-}H}\ L)(\underline{L}\ L)}$	
f.	$\mathrm{(\underline{L}\ H)(\underline{L}\ H)\ L}$	$\mathrm{(\underline{L\text{-}H}\ L)(\underline{H}\ L)}$	
g.	$\mathrm{(\underline{L}\ H)(\underline{H}\ L)\ L}$		$\mathrm{*(\underline{L\text{-}H}\ H)(\underline{L}\ L)}$
h.	$\mathrm{(\underline{L}\ H)(\underline{L}\ L)(\underline{H})}$	$\mathrm{(\underline{L\text{-}H}\ L)(\underline{L\text{-}H})}$	
i.	$\mathrm{(\underline{H}\ H)(\underline{L}\ H)(\underline{H})}$	$\mathrm{(\underline{H\text{-}H}\ L)(\underline{H\text{-}H})}$	
j.	$\mathrm{(\underline{L}\ L)(\underline{L}\ L)(\underline{L}\ L)}$	$\mathrm{(\underline{L\text{-}L}\ L)(\underline{L\text{-}L}\ L)}$	
k.	$\mathrm{(\underline{L}\ L)(\underline{L}\ H)(\underline{L}\ L)}$	$\mathrm{(\underline{L\text{-}L}\ L)(\underline{H\text{-}L}\ L)}$	
l.	$\mathrm{(\underline{L}\ L)(\underline{H}\ H)(\underline{L}\ L)}$		$\mathrm{*(\underline{L\text{-}L}\ H)(\underline{H\text{-}L}\ L)}$
m.	$\mathrm{(\underline{H}\ H)(\underline{H}\ L)(\underline{L}\ L)}$		$\mathrm{*(\underline{H\text{-}H}\ H)(\underline{L\text{-}L}\ L)}$

With the exception of (66)b where the absence of optional ternarity can be attributed to the ban on degenerate feet, all exemplars of mandatory binary stress in (66) share a common structural property: optional ternarity is blocked just in case the final syllable of a putative ternary foot would be heavy. Note that this restriction cannot follow from a requirement in the ternary pattern that heavy syllables be stressed (e.g. WSP: example (8) on page 79), as unstressed heavy syllables are tolerated in head position, e.g. (66)e, (66)f, (66)h and (66)i. This sensitivity to quantity in the ternary pattern comes as somewhat of a surprise given the insensitivity to syllable quantity in the binary system, where binary alternating stress prevails regardless of syllable weight.

Recall that the analysis being advanced in this chapter assumes ternarity to follow from a constraint ranking where HD-PROM dominates HD-INT, i.e. where foot-heads are allowed to split in order to ensure that the head has greater intrinsic prominence than the dependent. If ternarity does indeed arise in order to satisfy HD-PROM, one would expect ternary stress only in cases where outputs satisfy HD-PROM. This is exactly the situation in Estonian; in words without overlength, optional ternarity is blocked just in case the potential output would contain a heavy syllable in the dependent position of a ternary foot. Such feet necessarily violate HD-PROM according to the Prominence Hierarchy (example (24) on page 176), and thus the violation of HD-INT required for ternarity is unmotivated.

The variability between binary and ternary patterns can be accounted for by assuming that HD-PROM and HD-INT are crucially unranked with respect to one another. If violations are calculated with respect to prosodic words rather than individual feet — that is, if within the prosodic word a violation is assessed if *any or all* feet are ill-formed with respect to the relevant constraint — constraint conjunction results in two optimal outputs in the unmarked case.[25] In the tableau below, the two attested outputs for an input string of six light syllables (example (66)j above) are derived.

(67) Variability through constraint conjunction

Input:	/LLLLLL/	**HD-PROM**	**HD-INT**
a. ☞	($\underline{\text{L}}$ L)($\underline{\text{L}}$ L)($\underline{\text{L}}$ L)	*	
b. ☞	($\underline{\text{L-L}}$ L)($\underline{\text{L-L}}$ L)		*

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[25] This method of violation assessment is intended mainly for expository purposes. Clearly, an analysis based on a foot-by-foot assessment of these constraints will yield skewed effects due to the fact that binary and ternary patterns result in differing numbers of feet per word, in most cases. While this line of inquiry seems promising in accounting for rhythmic variability in Estonian as well as its asymmetric sensitivity to quantity, I do not have a complete analysis available at this time.

Candidate (67)a violates HD-PROM because it contains at least one foot in which the head is no more intrinsically prominent than the dependent position; this is not the case for candidate (67)b. On the other hand, candidate (67)b violates HD-INT, because at least one foot contains a split head; this is not true for candidate (67)a. Since HD-PROM and HD-INT are crucially unranked with respect to one another, however, both candidates are equally well-formed and thus both are optimal outputs, accounting for the variation between the two patterns.

Now consider an input string like /LLHHLL/ (e.g., example (66)l above).

(68) No optional ternarity

Input:	/LLHHLL/	**HD-PROM**	**HD-INT**
a. ☞	(L L)(H H)(L L)	*	
b.	(L-L H)(H-L L)	*	*!

Candidates (68)a and (68)b both violate HD-PROM because both contain at least one foot where the head is no more prominent than the dependent position. Candidate (68)b additionally violates HD-INT, however, as it contains at least one foot with a split-head. This results in a fatal second violation, leaving candidate (68)a as the sole optimal output. Optional ternarity is thus correctly predicted to be unavailable in this case.

Such an approach not only rules out optional ternarity in exactly the desired contexts, it also explains why quantity-sensitive parsing co-occurs with ternary stress but not with binary stress: it is precisely in the ternary pattern where satisfaction of HD-PROM is an imperative, because it is only in ternary feet that a violation of HD-INT must be compensated for by an offsetting violation of HD-PROM. This same logic extends to cases of overlength, discussed in the following section.

6.4.2 Words with Overlength

An interesting and rather unusual aspect of Estonian stress is the presence of a third degree of syllable quantity, known as *overlength.* Overlong syllables are restricted to word-initial position and are described by native speakers as bearing an "extra heavy stress" (Hayes 1995:318). At the phonetic level, overlong syllables are characterized by added duration of nuclear and/or post-nuclear melodies. Prince (1980) treats overlong syllables as independent feet in the synchronic grammar, noting that unlike other initial syllables, they can be followed by a stressed syllable, and Hayes (1995:318) notes that overlong syllables in Estonian, like those in Hindi, derive from disyllabic sequences historically. Optional ternarity is also available in words with overlength, as shown in (69) below.

(69) Estonian words with overlength

	Binary Stress	*Ternary Stress*	
a.	vánk:.rìt.t		'carriage' part. sg.
b.	jál:.kè.tes.t	jál:.ke.tès.t	'trick' ell. pl.
c.	júl:.kès.se		'bold' ill. sg.
d.	trúu:.tù.se.lè.ki	trúu:.tu.sè.le.ki	'...'
e.	hái.kùs.test.t	hái.kus.tèst.t	'desease (*sic*)' ell. pl.
f.	tǿøs:.kùs.tes.se	tǿøs:.kus.tès.se	'industry' ill. sg.
g.	áu:.sàt.te.le	áu:.sat.tè.le	'honest' all. sg.
h.	téot:.tàt.tut.tèl.t	téot:.tat.tùt.tel.t	'backe (*sic*)' abl. pl.
i.	kínt:.lùs.te.lè.ki	kínt:.lus.tè.le.ki	'...'
j.	káu:.kèt.tes.sè.ki	káu:.ket.tès.se.ki	'...'

Following Hayes (1989,1995) and Rodier (1998), I assume overlong syllables to be *superheavy* or trimoraic syllables (denoted below by 'S'). the prosodic representations for the patterns in (69) are given in (70) below.

(70) Prosodic representations of Estonian words with overlength

	Binary Stress	*Ternary Stress*	
a.	(S)(H)		*(S H)
b.	(S)(L H)	(S L)(H)	
c.	(S)(H L)		*(S H)(L)
d.	(S)(L L)(L L)	(S L)(L-L L)	
e.	(S)(H H)	(S H)(H)	
f.	(S)(H H) L	(S H)(H-L)	
g.	(S)(H L) L	(S H)(L-L)	
h.	(S)(H H)(H)	(S H)(H-H)	
i.	(S)(H L)(L L)	(S H)(L-L L)	
j.	(S)(H H)(L L)	(S H)(H-L L)	

Optional ternarity in words with overlength actually turns out to be less restricted than in words without overlength. Crucially, heavy syllables are tolerated in the dependent position of a foot following overlong syllables in the ternary pattern, as shown in examples (70)e through (70)j above.[26] This contrasts sharply with the situation in words without overlength, where optional ternarity is unavailable when it would result in a heavy syllable being parsed into a dependent position due to a violation of HD-PROM. The failure of feet of the shape (S H) to trigger a violation of HD-PROM follows straightforwardly from the fact that overlong syllables are intrinsically more prominent

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[26] According to Hayes (1995:318, 325-6) the ill-formedness of (70)a is systematic in Estonian, a fact which cannot be captured straightforwardly in the present analysis. Such cases are also problematic for Hayes, however, who appeals to a rule of reparsing to account for this restriction.

than heavy syllables, a reasonable assumption given native speaker judgements and the phonetic effects associated with overlength. The revised Prominence Hierarchy reflecting the supremacy of overlong syllables is given in (71) below.

(71) The Prominence Hierarchy (revised, cf. example (24) on page 176)

$$\begin{array}{c} \sigma_{\mu\mu\mu} \\ | \\ \sigma_{\mu\mu} \\ | \\ \sigma - \sigma \\ | \\ \sigma_{\mu} \end{array}$$

The ability of overlong syllables to behave as independent feet in the binary system but not in the ternary system closely parallels Hayes' (1995) analysis based on weak local parsing. However, while the ban on heavy syllables in the dependent position of a ternary foot follows straightforwardly from HD-PROM with no additional assumptions other than a natural extension of the Prominence Hierarchy, the Hayesian model must take the differential behaviour of light versus heavy syllables in parsing as a primitive, i.e. through the notion of 'minimal prosodic distance' which has to be assumed in the definition of weak local parsing.

6.5 Evaluating the Prominence-based Model

6.5.1 Ternarity as an Extended Binary Structure

By appealing to the notion of HD-PROM and the violable constraint HD-INT, the proposed model views ternarity as a prominence-driven extension of the basic system of bounded (binary) feet developed in §2. Ternarity is thus not to be understood as a rhythmic primitive in its own right as in certain other frameworks (cf. Halle & Vergnaud 1987), but rather a special case of binary rhythm in line with Hayes (1995) and Elenbaas & Kager (1999). The non-existence of quaternary and quinternary systems is thus a predicted result rather than an accidental gap, following straightforwardly from this mechanism, since additional dependent elements would be ungovernable under the inviolable HD-GOV constraint, due to non-adjacency to the foot-head.

The current proposal carries a number of advantages over Hayes' (1995) *weak local parsing* account and its OT equivalents. Firstly, the prominence-based model provides for a complete parse of syllables into metrical units — something which is generally assumed to be a central objective of metrification (Prince 1983) — but which is not possible in the Hayesian framework due to skipping. Secondly, the formal mechanisms which produce ternarity — adjunction and HD-PROM — are both independently required in other areas of linguistic theory. Thus, the present analysis is not vulnerable to the criticism that it requires a ternary-specific device such as *weak local parsing,* *FTFT and *LAPSE. Finally, the difficulty posed by the facts of Gilbertese where adjacent prominent units iterate across words is captured straightforwardly on the prominence-based model while deeply problematic for the Hayesian view. Additional advantages of the present proposal come to light in the discussion of typological markedness, to which we will turn presently.

6.5.2 Ternarity and Typological Markedness

At the beginning of this chapter, we alluded to Hayes' (1995:307) contention that — in addition to providing an empirically-adequate explanation of the relevant facts — an adequate account of ternarity should also account for the cross-linguistic markedness of such systems. The present analysis takes a firm step in this direction. In order to produce the effect of ternarity, four constraints must outrank HD-INT in the constraint hierarchy, as shown in (72) below.

(72) Full constraint ranking for ternarity

HD-GOV, FT-BIN, HD-PROM, PARSE-σ >> HD-INT

Given the typology of OT grammars where constraints can be ranked in any order, only one in five grammars is predicted to display the ternary effect.

Yet ternarity appears to be a property of far fewer than one in five languages. One relevant consideration is of course history, which generates its own distributional asymmetries by constraining available inputs. Another explanation for the rarity or ternary systems may be cross-linguistic variation in the language-specific realisation of the Prominence Hierarchy (example (71) above). As with language-specific variation in the fine-tuning of the Sonority Hierarchy (e.g., whether /i/ or /u/ are more sonorous), it is conceivable that such variation may result in systems where split-heads do not yield greater intrinsic prominence. In such cases, there would be no way for a learner to acquire the ranking in (72) necessary for ternarity.

It is important to keep in mind as well that this issue is not completely resolved in the Hayesian framework either. Even if one accepts the notion of a marked/unmarked binary parameter, there is no way to formally express *degree of markedness* in a binary parametric value. For example, while ternary stress and coda consonants are both cross-linguistically marked, the fact that coda consonants occur in hundreds of languages while ternary stress is attested in perhaps ten must be considered accidental on such a view.

6.6 Summary

The prominence-based model of ternarity presented here is a straightforward extension of the theory developed in §2, through the introduction of a single constraint: HD-INT. The introduction of this constraint allows the foot-head to extend over two elements (syllable / mora) in satisfaction of HD-PROM under the Prominence Hierarchy. In so doing, the maximal size of a bounded foot under HD-GOV is extended to three elements regardless of headedness (cf. §2.3.5), creating the effect of ternary rhythm. A number of ternary systems are analysed according to the proposed model, including systems exhibiting ternarity at the moraic level.

7. SUMMARY AND CONCLUSIONS

The central innovation of this thesis is the identification and elaboration of (HL)-creating processes as a class of *phonological* quantitative shifts and their incorporation into a theory of foot structure. On the empirical side, the analysis draws upon data from Mohawk, Selayarese, Central Slovak, Gidabal and Oromo, to demonstrate that a phonetic account of such processes is not tenable. The theoretical basis of the analysis relies on the notion of relative intrinsic prominence within prosodic domains, formalized as HD-PROM (Piggott 1998). By enforcing a preference for greater relative intrinsic prominence in the head positions of feet, HD-PROM is shown to account for processes of Trochaic Lengthening (/LL/ → (HL): §2), Trochaic Shortening (/HH/ → (HL): §3), and ternary stress systems (§6).

The effects of HD-PROM in feet can be generalized to syllables as well (§4), suggesting that HD-PROM is a general property of prosodic domains. An examination of quantity-prominence relations in diphthongal sequences reveals a strong preference for greater sonority on the head mora. When analysed in terms of HD-PROM, an increase in sonority-prominence of the head mora in a bimoraic syllable, e.g. [uu] → [ʊu], is exactly parallel to an increase in quantity-prominence in the head syllable of a disyllabic foot, e.g. (LL) → (HL). Moreover, the cross-linguistic preference for Trochaic Lengthening in the head-foot of the prosodic word parallels the cross-linguistic preference for long-vowel diphthongization in higher prosodic heads. Both patterns follow from the assumption the HD-PROM is a harmonically-ordered constraint family (Prince & Smolensky 1993).

The admission of the uneven (HL) trochee into the inventory of well-formed trochaic feet has far-reaching implications for prosodic theory, particularly the Iambic / Trochaic Law (ITL: §2, §5) which requires that trochaic feet be quantitatively even and iambic feet quantitatively uneven. The ITL can account neither for the existence of (HL)-creating processes nor for the observation that while (HL)-creating processes occur only in syllable-based feet, (LL)-creating processes occur only in mora-based feet. In sharp contrast, the analysis presented here provides an explicit link between foot-type (mora-based / syllable-based) and the type of quantitative adjustment ((HL)-creating / (LL)-creating) a given system may exhibit, allowing foot-type to *predict* QA-type, and vice versa. Both types of quantitative adjustment, as well as ITL asymmetries in foot inventories are captured through a single constraint on the maximal expansion of feet, HD-GOV (§2).

In contrast to previous work on HD-GOV (Mellander 2001c, 2002b), the absence of languages which *require* violations of HD-GOV implies that this constraint is universally inviolable, contra the standard assumptions of OT. This view is also supported in the analysis of ternary stress systems (§6), where the absence of unattested quaternary and quinternary systems relies crucially on the inviolability of HD-GOV.

A seemingly contradictory conclusion is reached in the analysis of diphthongal sequences (§4), where the cross-linguistic absence of languages with phonemic quantity but where falling diphthongs are consistently light is shown to be an emergent property of constraint interaction rather than the result of a universal ban on such structures as proposed in previous work (Rosenthall 1994). Since the existence of inviolable constraints has the potential to undermine the basic tenets of OT, future research must either modify the framework or seek alternative explanations for the generalisations captured by HD-GOV but without appealing to universal inviolability.

A final contribution of this thesis is the development of a preliminary model to explain asymmetries in structure and markedness between iambic and trochaic systems, including the ITL. Based on work by Van de Vijver (1998) this approach abandons traditional symmetric notions of iambicity and trochaicity in favour of an asymmetric pair of constraints — PEAK-FIRST and *EDGEMOST. Asymmetries between iambic and trochaic systems consequently emerge as artefacts of constraint interaction and require no additional theoretical machinery. On this view, the choice of iambicity or trochaicity is understood as a function of quantity (more specifically, the number of rhythmic units in the metrical domain) rather than vice-versa as the ITL is standardly interpreted (Hayes 1995).

REFERENCES

Alber, Birgit. (1997). 'Quantity Sensitivity as the Result of Constraint Interaction.' In Geert Booij and Jeroen van de Weijer (eds), *Phonology in Progress – Progress in Phonology*, The Hague: Holland Academic Press. *HIL Phonology Papers III.* 1-45.

Alderete, John. (1999). Head Dependence in Stress-Epenthesis Interaction. In Ben Hermans and Marc van Oostendorp (eds.), *The Derivational Residue in Phonological Optimality Theory*, 29-50. Amsterdam: John Benjamins.

Allen, W. Sidney. (1973). *Accent and Rhythm.* Cambridge Studies in Linguistics 12, Cambridge, U.K.: Cambridge University Press.

Árnason, Kristjan. (1980). *Quantity in Historical Phonology.* Cambridge: C.U.P.

Bělič, Jaromir, Alois Jedlička, Eugen Jóna, Eugen Pauliny, Josef Růžička, and Josef Štolc. (1964). *Slovenština: Vysokoškolská učebnice pro studující českého jazyka.* Praha: Státní Pedagogické Nakladatelství.

Bell, Alan. (1977). 'Accent placement and perception of prominence in rhythmic structures.' In Larry Hyman (ed.), *Studies in Stress and Accent.* Southern California Occasional Papers in Linguistics 4. Dept. of Linguistics, USC. Los Angeles.

Bethin, Christina Y. (1998). *Slavic Prosody: Language Change and Phonological Theory.* Cambridge, U.K.; New York, NY, USA: Cambridge University Press. *Cambridge Studies in Linguistics* 86.

Birnbaum, David J. (1981). 'Rising diphthongs and the Slovak rhythmic law.' *Harvard Studies in Phonology* 2:1-16.

Blevins, J. and S. P. Harrison. (1999). 'Trimoraic feet in Gilbertese.' *Oceanic Linguistics* 38(2):203-230.

Bolognesi, Roberto. (1998). *The phonology of Campidanian Sardinian.* HIL dissertations 38. Holland Institute of Generative Linguistics. Leiden

Bolton, Thaddeus L. (1894). 'Rhythm.' *American Journal of Psychology* 6:145-238.

Booij, Geert. (1989). 'On the representation of diphthongs in Frisian.' *Linguistics* 25:319-332.

Broselow, Ellen, Su-I Chen and Marie Huffman. (1997). 'Syllable weight: convergence of phonology and phonetics.' *Phonology* 14: 47-82.

Broselow, Ellen. (1999). 'Stress, epenthesis, and segmental transformation in Selayarese loans.' In Steve S. Chang, Lily Liaw, and Josef Ruppenhofer (eds.) *Proceedings of the 25th annual meeting of the Berkeley Linguistics Society*. Berkeley: Berkeley Linguistics Society. 311-25.

Browne, Wayles. (1971). 'Some questions of Slovak morphology.' *Jazykovedný časopis* 22(1):49-57.

Bruce, Gösta. (1971). 'Diphthongization in the Malmö dialect.' *Working Papers, Phonetics Laboratory, Lund University* 3:1-16.

Buckley, E. (1998). Iambic lengthening and final vowels. *International Journal of American Linguistics* 64:179-223.

Carlson, Lauri. (1978). 'Word stress in Finnish,' Unpublished ms., MIT.

Carlton, Terence R. (1991). *Introduction to the Phonological History of the Slavic Languages*. Columbus, Ohio: Slavica Publishers.

Casali, Roderic F. (1998). *Resolving Hiatus.* New York & London: Garland Publishing.

Chung, Sandra. (1983). 'Transderivational Relationships in Chamorro Phonology.' *Language* 59(1):35-66.

Churchward, C. Maxwell. (1953). *Tongan Grammar*. London: Oxford University Press.

Clements, George N. (1990). 'The Role of the Sonority Cycle in Core Syllabification.' In Kingston, John and Mary Beckman (eds.), *Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech.* Cambridge: C.U.P.

Crosswhite, Katherine M. (1999). Vowel Reduction in Optimality Theory. Ph.D. thesis. UCLA.

Crowhurst, Megan J. (1991). Minimality and foot structure in metrical phonology and prosodic morphology. Ph.D. thesis. University of Arizona, Tucson. Distributed 1993, Indiana University Linguistics Club.

Crowhurst, Megan J. (1996). 'An optimal alternative to Conflation.' *Phonology* 13:409-424.

Crowhurst, Megan J. and Mark S. Hewitt. (1995). 'Prosodic overlay and headless feet in Yidiny.' *Phonology* 12:39-85.

Davis, Stuart M. (1988). 'Syllable Onsets as a Factor in Stress Rules.' *Phonology* 5:1-19.

Davis, Stuart M., and Michael Hammond. (1995). 'On the status of onglides in American English.' *Phonology* 12:159-182.

Dixon, Robert M. W. (1988). *A Grammar of Boumaa Fijian.* Chicago: University of Chicago Press.

Dresher, B. Elan and Harry van der Hulst. (1995). 'Head-dependent asymmetries in phonology.' In H. van der Hulst and J. van de Weijer (eds.) *HIL Phonology Papers I*, 401-431. Holland Academic Graphics, Den Haag.

Dresher, B. Elan, and Aditi Lahiri. (1991). 'The Germanic Foot: Metrical Coherence in Old English.' *Linguistic Inquiry* 22:251-86.

Dumas, Denis. (1981). 'Structure de la diphthongaison québécoise.' *Canadian Journal of Linguistics* 26:1-61.

Ďurovič, Ľubomír. (1973). 'Vokalický systém slovenčiny.' *International Journal of Slavic Linguistics and Poetics* 16:22-42.

Dvonč, Ladislav. (1955). *Rytmický zákon v spisovnej slovenčine*. Bratislava,: Vydavateľstvo Slovenskej akadémie vied.

Elbert, Samuel and Mary Kawena Pukui. (1979). *Hawaiian Grammar.* Honolulu: University Press of Hawaii.

Elenbaas, Nine. (1999). A unified account of binary and ternary stress: considerations from Sentani and Finnish. Ph.D. thesis. Utrecht University.

Elenbaas, Nine, and René Kager. (1999). 'Ternary rhythm and the Lapse Constraint.' *Phonology* 16:273-329.

Feldman, Harry. (1978). 'Some notes on Tongan phonology.' *Oceanic Linguistics* 17:133-9.

Fitzgerald, Colleen M. (1997). O'odham Rhythms. Ph.D. thesis. University of Arizona.

Fitzgerald, Colleen M. (To appear). 'How prosodically consistent is Tohono O'odham?' In Barragan, Luis and Jason Haugen (eds.) *MIT Working Papers in Endangered and Less Familiar Languages*. Boston: MIT.

Fong, Eugene A. (1979). 'Vowel and consonant quantity in Abruzzese.' *Orbis* 28:277-89.

Geytenbeek, Brian and Helen Geytenbeek. (1971). *Gidabal Grammar and Dictionary*. Australian Institute of Aboriginal Studies. Canberra.

Goldsmith, John. (1990). *Autosegmental & Metrical Phonology*. Oxford: Basil Blackwell.

Gragg, G. (1976). 'Oromo of Wellegga.' In M.L. Bender (ed.), *The Non-Semitic Languages of Ethiopia*. Michigan State University African Studies Center. East Lansing.

Gragg, G. (1982). *Oromo Dictionary*. Michigan State University African Studies Center. East Lansing.

Hála, Bohuslav. (1929). 'Základy spisovné výslovnosti slovenské.' Praha: FFUK.

Halle, Morris and Jean-Roger Vergnaud. (1978). 'Metrical Structures in Phonology.' Unpublished ms., MIT.

Halle, Morris and Jean-Roger Vergnaud. (1987). *An Essay on Stress*. Cambridge: MIT Press.

Halle, Morris and William Idsardi. (1995). 'General properties of stress and metrical structure.' In Goldsmith, John A. (ed.), *The Handbook of Phonological Theory*. Cambridge, Mass. Blackwell. 403-443.

Halle, Morris, Wayne O'Niel, and Jean-Roger Vergnaud (1993). 'Metrical coherence in

Old English without the Germanic foot.' *Linguistic Inquiry* 24: 529-538.

Halle, Morris. (1990). 'Respecting Metrical Structure.' *Natural Language and Linguistic Theory* 8:149-76.

Hammond, Michael. (1986). 'The Obligatory Branching Parameter in Metrical Theory.' *Natural Language and Linguistic Theory* 4:185-228.

Harris, James W. (1983). *Syllable structure and stress in Spanish: a nonlinear analysis.* Cambridge, Mass., MIT Press.

Hayes, Bruce. (1979). 'Extrametricality.' *MIT Working Papers in Linguistics* 1:77-86.

Hayes, Bruce. (1981). 'A Metrical Theory of Stress Rules.' Ph.D. thesis (1980), MIT. [Revised version distributed by Indiana University Linguistics Club, Bloomington, and published by Garland Press, New York, 1985.]

Hayes, Bruce. (1984). 'The Phonology of Rhythm in English.' *Linguistic Inquiry* 15:33-74.

Hayes, Bruce. (1985). 'Iambic and Trochaic Rhythm in Stress Rules.' In *Proceedings of the Berkeley Linguistics Society*, 429-446.

Hayes, Bruce. (1987). 'A Revised Parametric Metrical Theory.' *Northeastern Linguistic Society* 17:274-89.

Hayes, Bruce. (1989). 'Compensatory Lengthening in Moraic Phonology.' *Linguistic Inquiry* 20:253-306.

Hayes, Bruce. (1995). *Metrical stress theory: principles and case studies.* Chicago: University of Chicago Press.

Hermans, Ben. (1999). 'Yer triggerred vowel lengthening in Slovak.' *Linguistics in the Netherlands* 16: 67-80.

Hewitt, Mark S. (1991). 'Binarity and Ternarity in Alutiiq.' *Proceedings of the Arizona Phonology Conference* 4. University of Arizona.

Hewitt, Mark S. (1992). Vertical Maximization and Metrical Theory. Ph.D. thesis. Brandeis University.

Hewitt, Mark S. and Megan J. Crowhurst. (1996). 'Conjunctive constraints and templates.' In *Proceedings of NELS* 26:101-116. Amherst MA.

Hint, Mati. (1973). *Eesti Keele Sönafonoloogia I.* Eesti NSV Teaduste Akadeemia, Tallinn, Estonia.

Hoff, Berend. (1968). *The Carib Language.* Verhandelingen van het Koninklijk Instituut voor Taal-, Land- en Volkenkunde 55. M. Nijhoff, Den Haag.

Hulst, Harry van der. (1996). 'Separating primary and secondary accent.' In R. Goedemans, H. van der Hulst & E. Visch (eds.), *Stress Patterns of the World, Part 1: Background.* The Hague: Holland Academic Graphics.

Hyman, Larry M. (1985). *A Theory of Phonological Weight.* Publications in Language Sciences 19. Foris, Dordrecht.

Hyman, Larry M. (2001). 'The limits of phonetic determinism in phonology: *NC revisited'. In Hume, E. and K. Johnson (eds.) *The role of speech perception in phonology.* Academic Press, San Diego.

Idsardi, William. (1992). The Computation of Prosody. Ph.D. thesis. MIT.

Itô, Junko, Armin Mester and Jay Padgett. (1995). 'Licensing and Underspecification in Optimality Theory.' *Linguistic Inquiry* 26:571-613.

Jakobson, Roman. (1931/1962). 'Phonemic notes on standard Slovak.' In *Selected Writings*, 221-230. The Hague: Mouton.

Kager, René. (1989). *A metrical theory of stress and destressing in English and Dutch.* Dordrecht; Providence, RI: Foris Publications.

Kager, René. (1992). 'Are there any truly quantity-insensitive systems?' In L. A. Buszard-Welcher, L. Lee, and W. Weigel (eds), *Proceedings of the 18th annual meeting of the Berkeley Linguistics Society.* Berkeley: Berkeley Linguistics Society. 123-32.

Kager, René. (1993). 'Alternatives to the iambic-trochaic law.' *Natural Language and Linguistic Theory* 11:381-432.

Kager, René. (1995). 'Review of Hayes (1995).' *Phonology* 12:437-464.

Kager, René. (1994). 'Ternary Rhythm in Alignment Theory.' Unpublished ms., Utrecht University.

Kager, René. (1999). *Optimality Theory*. Cambridge, U.K.; New York: Cambridge University Press.

Kaye, Jonathan, J. Lowenstamm, and J-R. Vergnaud. (1990). 'Constituent structure and government in phonology.' *Phonology* 7:193-231.

Kaye, Jonathan. (1985). 'On the syllable structure of certain West African languages.' In D. Goyvaerts (ed.), *Essays in memory of M.W.K. Semikenke*, 285-308: Benjamins.

Kaye, Jonathan. (1989). *Phonology: A Cognitive View*. Hillsdale: LEA Publishers.

Kenstowicz, Michael J. (1972). 'The morphophonemics of the Slovak noun.' *Papers in Linguistics* 16:550-567.

Kenstowicz, Michael J. and Charles Kisseberth. (1979). *Generative Phonology: Description and Theory*. Academic Press, New York.

Kenstowicz, Michael J. and Jerzy Rubach. (1987). 'The phonology of syllabic nuclei in Slovak.' *Language* 63(3):463-497.

Key, Harold H. (1961). 'Phonotactics of Cayuvava.' *International Journal of American Linguistics* 27, 143-150.

Key, Harold H. (1967). *Morphology of Cayuvava*. Janua Linguarum. Series practica 53, Mouton, The Hague.

Kiparsky, Paul. (1973). ''Elsewhere' in phonology.' In S. R. Anderson and P. Kiparsky (eds.) *A Festschrift for Morris Halle*. New Tork: Rinehart & Winston. 93-106.

Kiparsky, Paul. (1984). 'On the Lexical Phonology of Icelandic.' In Claes-Christian Elert, Irére Johansson, and Eva Strangert (eds), *Nordic Prosody III: Papers from a Symposium*. Stockholm: Almqvist and Wiksell. 135-64.

Knudsen, Lyle M. (1975). 'A Natural Phonology and Morphophonemics of Chimalapa Zoque.' *Papers in Linguistics* 8:283-346.

Kochik, John Michael. (1971). The Inflectional Morphology of Standard Slovak: A Descriptive Analysis. Ph.D. thesis. University of Pittsburgh.

Krajčovič, Rudolf. (1988). *Vývin slovenského jazyka a dialektólogia*. Bratislava: Alovenské Pedagogické Nakladateľstvo.

Kráľ, Ábel. (1988). *Pravidlá slovenskej výslovnosti*. Bratislava: Slovenské Pedagogické Nakladateľstvo.

Lahiri, Aditi and B. Elan Dresher. (1999). 'Open Syllable Lengthening in West Germanic.' *Language* 75(4):678-719.

Lahiri, Aditi and Jacques Koreman. (1988). 'Syllable Weight and Quantity in Dutch.' *West Coast Conference on Formal Linguistics* 7:217-28.

Lass, Roger. (1992). 'Phonology and Morphology.' In N. F. Blake (ed.), *The Cambridge History of the English Language*. Cambridge, U.K.; New York, NY, USA: Cambridge University Press. Vol. 2:23-155.

Leer, Jeff. (1985a). 'Prosody in Alutiiq (The Koniag and Chugach dialects of Alaskan Yupik).' In Krauss, Michael (ed.), *Yupik Eskimo Prosodic Systems: Descriptive and Comparative Studies*. Alaska Native Language Center, Fairbanks. 77-133.

Leer, Jeff. (1985b). 'Evolution of Prosody in the Yupik Languages.' In Krauss, Michael (ed.), *Yupik Eskimo Prosodic Systems: Descriptive and Comparative Studies*. Alaska Native Language Center, Fairbanks. 135-57.

Leer, Jeff. (1985c). 'Towards a Metrical Interpretation of Yupik Prosody.' In Krauss, Michael (ed.), *Yupik Eskimo Prosodic Systems: Descriptive and Comparative Studies*. Alaska Native Language Center, Fairbanks. 159-72.

Leer, Jeff. (1989). 'Prosody in Chugach Alutiiq.' Unpublished ms., Alaska Native Language Center, Fairbanks.

Lerdahl, Fred and Ray Jackendoff. (1983). *A generative theory of tonal music*. Cambridge, MA: MIT Press.

Levin, Juliette. (1988). 'Generating Ternary Feet.' *Texas Linguistic Forum* 29:97-113.

Liška, Josef. (1942/1943). 'Rozriešíme si otázku pôvodu východnej slovenčiny.' *Slovenská reč* 10:167-173.

Liška, Josef. (1944). *K otázce pôvodu východoslovenských nárečí.* Turčiansky Svätý Martin.

Liberman, Mark and Alan Prince. (1977). 'On stress and linguistic rhythm.' *Linguistic Inquiry* 8:249-336.

Liberman, Mark. (1975). The Intonational System of English. Ph.D. thesis. MIT. [Distributed by Indiana University Linguistics Club, Bloomington.]

Lombardi, Linda and John J. McCarthy. (1991). 'Prosodic circumscription in Choctaw morphology.' *Phonology* 8:37-72.

McCarthy, John J. (1995). 'Extensions of faithfulness: Rotuman revisited.' Unpublished ms., University of Massachusetts, Amherst. [ROA-110, http://roa.rutgers.edu/]

McCarthy, John J. and Alan Prince. (1986). 'Prosodic Morphology.' *Technical Reports of the Rutgers Center for Cognitive Science* 32. Piscataway, NJ.

McCarthy, John J. and Alan Prince. (1993a). 'Generalized Alignment.' *Technical Reports of the Rutgers Center for Cognitive Science* 7. Piscataway, NJ.

McCarthy, John J. and Alan Prince. (1993b). 'Prosodic Morphology I: Constraint Interaction and Satisfaction.' *Technical Reports of the Rutgers Center for Cognitive Science* 3. Piscataway, NJ.

McCarthy, John J. and Alan Prince. (1993c). 'A case of surface constraint violation.' *Canadian Journal of Linguistics (Special Issue)* 38(2):169-195.

McCarthy, John J. and Alan Prince. (1995). 'Faithfulness and reduplicative identity.' In J. Beckman, S. Urbanczyk, and L. Walsh (eds.), *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, 249-384. Amherst: Graduate Linguistic Students Association.

Meer, G. van der (1985). *Frisian 'Breaking.' Aspects of the origin and developments of a sound change.* Gronigen: Stiftung FERUG.

Mellander, Evan. (1999). 'A sonority-based account of vowel-zero alternations in Czech and Slovak.' *McGill Working Papers in Linguistics.* 14:71-109.

Mellander, Evan. (2000a). 'The uneven trochee and quantitative adjustment.' Paper delivered at the Fourth Utrecht Biannual Phonology Workshop, Utrecht Institute of Linguistics OTS, June 22-23.

Mellander, Evan. (2000b). 'The iambic law: quantitative adjustment in typological perspective.' Unpublished ms., McGill University.

Mellander, Evan. (2001a). 'A prosodic account of rhythmic shortening and stress in Central Slovak.' *McGill Working Papers in Linguistics* 15(2):81-100.

Mellander, Evan. (2001b). 'Conflict resolution in rising diphthongs: prominence vs. mora rhythm.' In Caroline Féry, Antony Dubach Green and Ruben van de Vijver (eds.), *Proceedings of HILP5*, Linguistics in Potsdam 12:86-105. University of Potsdam.

Mellander, Evan. (2001c). 'Quantitative processes in trochaic systems.' In K. Megerdoomian and L. A. Bar-el (eds.), *Proceedings of the Twentieth West Coast Conference on Formal Linguistics.* 414-427. Somerville, MA: Cascadilla Press.

Mellander, Evan. (2002a). 'Prominence contours and diphthongal moraicity.' Paper delivered at the 2002 Annual Meeting of the Linguistic Society of America, San Francisco, Jan. 3-6.

Mellander, Evan. (2002b). '(HL)-creating processes in a theory of foot structure' Unpublished ms., McGill University.

Mellander, Evan. (2002c). A unified account of positional asymmetries in metrical domains. *McGill Working Papers in Linguistics.* 17(1):25-40.

Mellander, Evan. (In press a). 'On rhythmic asymmetries in metrical groupings.' In *Proceedings of the Twenty-first West Coast Conference on Formal Linguistics.* Somerville, MA: Cascadilla Press.

Mellander, Evan. (In press b). 'On the interaction of stress, epenthesis, and syllable weight in Mohawk and Selayarese.' *McGill Working Papers in Linguistics Special*

Issue in Memory of Lara Riente 17(2).

Mester, R. Armin. (1994). 'The Quantitative Trochee in Latin.' *Natural Language and Linguistic Theory* 12:1-61.

Michelson, Karin. (1988). *A Comparative Study of Lake Iriquoian Accent.* Dordrecht: Kluwar.

Mithun, Marianne and Hasan Basri. (1986). 'The Phonology of Selayarese.' *Oceanic Linguistics* 25:210-254.

Miyaoka, Osahito. (1985). 'Accentuation in Central Alaskan Yupik.' In Krauss, Michael (ed.), *Yupik Eskimo Prosodic Systems: Descriptive and Comparative Studies.* Alaska Native Language Center, Fairbanks. 51-75.

Molinu, Lucia. (2001). 'On metaphony, nasalization, and vowel reduction in Sardinian.' Paper delivered at the University of Manchester, May 23, 2001.

Munro, Pamela and Charles Ulrich (1984). Structure Preservation and Western Muskogean Rhythmic Lengthening. *West Coast Conference on Formal Linguistics* 3:191-202.

Myers, Scott. (1991). 'Persistent rules.' *Linguistic Inquiry* 22:315-344.

Myers, Scott. (2002). 'Gaps in factorial typology: The case of voicing in consonant clusters'. Unpublished ms., University of Texas at Austin. [ROA-509, http://roa.rutgers.edu/]

Nicklas, T. D. (1975). Choctaw Morphophonemics. In J. M. Crawford (ed.) *Studies in Southeastern Indian Languages.* Athens, University of Georgia Press: 237-250.

Novák, Ľudovít. (1933-1934). 'Fonologia a štúdium slovenčiny.' *Slovenska reč* 2:97-107, 143-157, 161-171.

Oravec, Ján, and Vincent Laca. (1975). *Príručka slovenského pravopisu pre školy.* Bratislava: Slovenské Pedagogické Nakladatelstvo.

Paradis, Carole and Darlene LaCharité. (1997). 'Preservation and Minimality in Loanword Adaptation.' *Journal of Linguistics* 33: 379-430.

Pater, Joe. (1995). 'On the nonuniformity of weight-to-stress and stress preservation effects in English.' Unpublished ms., McGill University.

Pauliny, Eugen, Josef Štolc, and Josef Růžička. (1955). *Slovenská Grammatika*. Osveta: N. P. Martin.

Pauliny, Eugen, Josef Štolc, and Josef Růžička. (1968). *Slovenská Grammatika*. Bratislava: Slovenské Pedagogické Nakladateľstvo.

Pauliny, Eugen. (1997). *Krátka Gramatika Slovenská*. Bratislava: Národné Literárne Centrum.

Peciar, Štefan. (1946). 'Slovenská kvantita a rytmický zákon.' *Slovenská reč* 12(5/6):137-52.

Piggott, Glyne L. (1995). 'Epenthesis and syllable weight.' *Natural Language and Linguistic Theory* 13:283-326.

Piggott, Glyne L. (1998). 'Foot form and the parsing of weightless syllables.' In M. Gruber, D. Higgins, K. Olson, and T. Wysocki (eds.), *CLS 34: Main Session,* 315-332. Chicago: Chicago Linguistic Society.

Piggott, Glyne L. (1999). 'At the Right Edge of Words.' *The Linguistic Review* 16:143-185.

Piggott, Glyne L. (2001). 'The phonotactics of a 'Prince' language: A case study.' Unpublished ms., McGill University.

Piggott, Glyne L. (2002). 'Invariance and Variability in Nasal Harmony.' *McGill Working Papers in Linguistics* 17(1):43-75.

Polgárdi, Krisztina. (1995). 'Lengthening: Phonological or Phonetic?.' In H. van der Hulst and J. van de Weijer (eds.) *HIL Phonology Papers I,* 355-368. Holland Academic Graphics, Den Haag.

Prince, Alan and Paul Smolensky. (1993). 'Optimality Theory: Constraint Interaction in Generative Grammar.' *Technical Reports of the Rutgers Center for Cognitive Science* 2. Piscataway, NJ.

Prince, Alan. (1976). 'Stress.' Unpublished ms., University of Massachusetts, Amherst.

Prince, Alan. (1980). 'A Metrical Theory for Estonian Quantity.' *Linguistic Inquiry* 11:511-62.

Prince, Alan. (1983). 'Relating to the grid.' *Linguistic Inquiry* 14:19-100.

Prince, Alan. (1992). 'Quantitative consequences of rhythmic organization.' In K. Deaton, M. Noske, and M. Ziolkovski (eds.), *CLS 26-II: Papers from the Parasession on the Syllable in Phonetics and Phonology*, 355-98. Chicago: Chicago Linguistic Society.

Prunet, Jean-François, and Christine Tellier. (1985). 'Interaction des Niveaux en Phonologie: L'Abrègement vocalique en Pulaar.' *McGill Working Papers in Linguistics* 2(1):65-88.

Rehg, Kenneth. (1984). 'The origins of 'compensatory lengthening' rules in Micronesian languages.' In Bender, Byron W. (ed.) *Studies in Micronesian Linguistics.* Pacific Linguistics Series C No. 80. Department of Linguistics, research School of Pacific Studies. The Australian NationalUniversity.

Riad, Tomas. (1992). Structures in Germanic prosody: a diachronic study with special reference to Nordic languages. Ph.D. thesis. Stockholm University.

Rice, Curtis. (1992). Binarity and Ternarity in Metrical Theory: Parametric Extensions. Ph.D. thesis, University of Texas at Austin.

Roberts, John C. (1987). *Amele.* Biddles. Guildford, England.

Rodier, Dominique. (1998). Prosodic Domains in Optimality Theory. Ph.D. thesis. McGill University.

Rose, Yvan. (1995). Minimalité, préservation et tolérance dans les emprunts français en kinyarwanda. M.A. thesis. Université Laval, Québec.

Rose, Yvan. (1999). 'A Structural Account of Root Node Deletion in Loanword Phonology.' *Canadian Journal of Linguistics* 44: 359-404.

Rosenthall, Sam and Harry van der Hulst. (1999). 'Weight-by-Position by Position.'

Natural Language and Linguistic Theory 17:499-540.

Rosenthall, Sam. (1994). Vowel/Glide Alternation in a Theory of Constraint Interaction. Ph.D. thesis. University of Massachusetts, Amherst.

Rubach, Jerzy. (1993). *The Lexical Phonology of Slovak.* Oxford, New York: Clarendon Press; Oxford University Press.

Sanders, Nathan. (2002). 'Dispersion in OT: Color contrast in Middle Polish nasal vowels.' Handout from paper delivered at the Twenty-first West Coast Conference on Formal Linguistics. U.C. Santa Cruz. April 5-7.

Schane, Sanford. (1987). 'The resolution of hiatus.' In A. Bosch, B. Need, and E. Schiller (eds.), *CLS 23: Parasession on Autosegmental and Metrical Phonology*, Chicago: Chicago Linguistic Society, 279-290.

Schane, Sanford. (1995). 'Diphthongization in Particle Phonology.' In John A. Goldsmith (ed.), *The Handbook of Phonological Theory*. 586-608. Cambridge, MA: Blackwell.

Scheer, Tobias. (To appear). 'The Rhythmic Law in Czech: Vowel-final Prefixes.' In *Papers from FDSL 3*.

Schütz, Albert J. (1978). 'English Loanwords in Fijian.' In A. J. Schütz (ed.) *Fijian Language Studies: Borrowing and Pidginization*. Bulletin of the Fiji Museum 4. Suva, Fiji Museum.

Schütz, Albert J. (1985). *The Fijian Language*. Honolulu: University of Hawaii Press.

Selkirk, Elisabeth. (1980). 'Prosodic domains in phonology: Sanskrit revisited.' In M. Aronoff and M.-L. Kean (eds.), *Juncture*, 107-129. Saratoga, Ca.: Anna Libri.

Selkirk, Elisabeth. (1984a). *Phonology and Syntax: The Relation between Sound and Structure*. MIT Press. Cambridge, Mass.

Selkirk, Elisabeth. (1984b). 'On the Major Class Features and Syllable Theory.' In M. Aronoff and R. Oehrle (eds.), *Language, Sound, Structure*, 107-136. MIT Press.

Sherer, Timothy. (1994). Prosodic Phonotactics. Ph.D. Thesis, UMass.

Sluyters, Willebrord. (1990). 'Length and Stress Revisited: A Metrical Account of

Diphthongization, Vowel Lengthening, Consonant Gemination and Word-final Vowel Epenthesis in Modern Italian.' *Probus* 2:65-101.

Stanislav, Ján. (1958). *Dejiny Slovenského Jazyka*. Bratislava: Vydavateľstvo Slovenskej Akadémie Vied.

Stanislav, Ján. (1967). *Dejiny slovenského jazyka*. Bratislava: Vydavateľstvo Slovenskej Akadémie Vied.

Street, John C. (1963). *Khalkha Structure*. Uralic and Altaic series 24. Indiana University. Bloomington.

Uhlár, Vlado. (1941-1942). 'Rytmické krátenie a príčastie prítomné typu píšúci, píšúca, píšúce.' *Slovenská reč* 9:234-242.

Ulrich, Charles. (1986). Choctaw Morphophonology. Ph.D. thesis, UCLA.

Vijver, Ruben van de. (1998). *The iambic issue: iambs as a result of constraint interaction*. HIL Dissertations 37. Holland Institute of Generative Linguistics. Leiden.

Woodrow, Herbert. (1909). 'A Quantitative Study of Rhythm.' *Archives of Psychology, N.Y.*(14):1-66.

Woodrow, Herbert. (1951). 'Time Perception.' In S. S. Stevens (ed.), *Handbook of Experimental Psychology*, 1224-1236. New York: Wiley.

Yip, Moira. (2000). 'Tone and prominence: a cross-linguistic perspective.' Paper delivered at The 8th Manchester Phonology Meeting. University of Manchester.

Ziegenrücker, Wieland. (1977). *ABC Musik*. Leipzig: VEB Deutscher Verlag für Musik.

Zoll, Cheryl. (1992). 'When syllables collide.' Unpublished ms., U.C. Berkeley.

Zoll, Cheryl. (1997). 'Conflicting directionality.' *Phonology* 14:253-86.